Appendix 4. WP1 - Deliverables D1-D4

Project no. 502487

Project acronym: POPA-CTDA

Project title:
Policy pathways to promote the development and adoption of cleaner technologies

Instrument: STREP

Thematic Priority 8.1, Policy-oriented research (SSP), FP6-2002-SSP-1

Deliverable D1-D4 : Sectoral Background Studies

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	R

Sectoral Background Studies Structure

This Annex contains four sectoral background studies (Agriculture, Energy, Industry and Transport. The sectoral studies aimed at scoping and facilitating the selecting case studies in eight technological clusters in the sectors of interest (two case studies per sector). To provide a background that enables the comparison of the general wisdom concerning the drivers and barriers in the sectors of interest with the empirical results of WP2. Last, to place into context proposed policy options generated in work package four (i.e., sectoral policy design workshops). In order to guide the desk research the research consortium agreed to have a common structure for all the background studies, this is outlined below.

Introduction

The introduction must outline the importance of clean technologies in the sector of interest; relate this to ETAP and the Popa-CTDA project

Policy developments

This section aimed to review and critical analyzed recent and current technology policy developments and initiatives with regard to clean integrative technology in the EU and the sectors of interest (e.g., EU Action Plan in Cleaner Technologies);

Environmental issues

Review and definition the most pressing environmental issues in the sectors of interest.

Selection of technology(ies) and preliminary selection of case studies.

In reference to the environmental issues, survey and selection of technological solutions; foresight studies and similar innovation assessment for identification of mega trends, available BREFs will be used as complementary references; The selection of the case study considered pressing environmental issues, best available (or future) technologies, adequate geographical and regional representation in the EU and Accession countries.

Review of barriers and drivers (desk research)

This section aimed to review (only an update to the starting date of the project) concerning the drivers and barriers for the development and adoption of cleaner integrated technologies. Special emphasis was placed in the exploration of economic, market and technological barriers that limit the diffusion of existing technologies and promising technologies;

Analysis of sector development

This analysis was conducted in order to place the technologies used as case studies in relation to the context in which the development or adoption could occur, the major characteristics of the sector were described.

References

NOTE: The content of the background studies will reviewed and updated during the draft of the Final Report. This was considered appropriate given the learning of new policy and economic developments in the sectors in the following year.

Appendix 4.1 –Deliverable D1

Project no. 502487

Project acronym: POPA-CTDA

Project title:

Policy pathways to promote the development and adoption of cleaner technologies

Instrument: STREP

Thematic Priority 8.1, Policy-oriented research (SSP), FP6-2002-SSP-1

Deliverable number D1

Agriculture Sector Background Study

Due date of deliverable: May 30, 2004

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Institute of Technology Assessment, Austrian Academy of Sciences

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Project co-funded by the European Commission within the Sixth Framework Programme		
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Contents

Introduction

Sector specific technology and policy development are interdependent activities in the context of sector development (see figure 1). The successful development of technologies and generation of ideas to prevent future environmental problems would be possible if policy and sector development go hand in hand with the development process for appropriate innovative technologies. Barriers and drivers influence the generation of new ideas, design of new solutions and development and implementation of innovative technologies. These factors could be within or outside a sector. Energy policy is an example of an external factor that can be a driver or a barrier for biomass production for energy use in the agricultural sector. Farming tradition is an example of an internal factor.

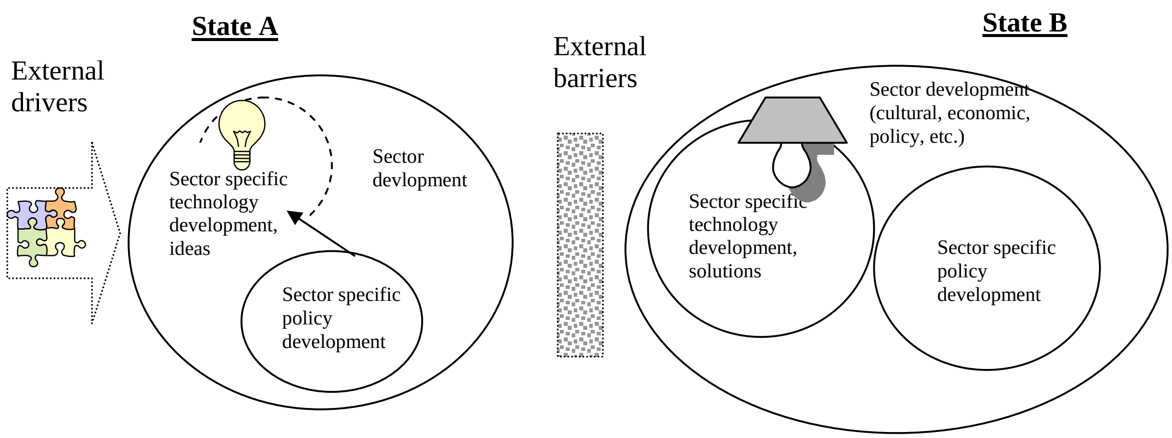

Figure 1: Promoting technology development in the context of sector and policy development; a movement is desired from state A to B. There are implicit internal barriers and drivers within the sector.

In this contribution we start with a definition of clean technologies and a description of the connection between this study and the Environmental Technologies Action Plan (ETAP). In Chapter 3 to 6 we present the results of the desk research on environmental issues in the agricultural sector, policy development beyond ETAP, technology clusters which address the environmental issues identified the barriers and drivers and sector development as the context of technology and policy development.

1.1 The importance of clean technologies in the agricultural sector

"Cleaner production" is a term coined by a working group of the United Nations Environment Programme's Industry and Environment Office (UNEP/IEO) in 1989. (Jackson 1993) UNEP adopted the concept of cleaner production, using it to refer to goods, processes and services in the framework of sustainable development. "*Cleaner production is the continuous application of an integrated preventive environmental strategy to processes, products, and services to increase overall efficiency, and reduce risks to humans and the environment. Cleaner production can be applied to the processes used in any industry, to products themselves and to various services provided in society.*" [1]

[1] http://www.unepie.org/pc/cp/understanding_cp/home.htm

The most important criteria of the concept are the need to look forward and to bring stakeholders together; its aim to prevent future environmental problems and to consider the negative economic value of waste.

A description of cleaner technology found in a review of cleaner production in ECOTEC (Parliament and Council 2002, Annex 2) is: "End-of-pipe solutions do not usually result in efficiency or productivity gains, therefore representing a pure cost to the firms. Cleaner technology on the other hand, improves process efficiency. Furthermore, cleaner technology usually reduces polluting emissions to all media instead of shunting them from one to the other."[2]

Cleaner production can be implemented in the agricultural sector mainly as practices or activities to prevent the over consumption of natural resources to conserve or improve water, soil and air quality and landscape maintenance. In this report we present activities such as integrated crop management, organic farming and agri-environmental options which include bundles of strategies and processes to increase water efficiency and reduce water pollution from intensive farming as well as to improve soil in agricultural sector.

In addition we present technologies which aim at reducing greenhouse gas emissions and combating climate change in the non-food sector, namely the use of biomass for bio-energy or bio-refineries.

Clean technologies will be important particularly in the new member states, addressing among other things land use problems emerging from the old structure of the agricultural sector. The existing non-rational land-use structure that has evolved under the pressure of past agricultural policies aimed at the intensification of the sector proves to be one of the main issues that national agri-environmental programmes need to address. Although short term trends show that the land-use structure is rather stable, restructuring and rationalizing means in many cases significant changes in land use, the setting aside of cultivated land or the introduction of more extensive ways of farming in previously intensively cultivated areas.

1.2 The ETAP and POPA-CTDA project

ETAP

On 28 January 2004, the Commission adopted the Environmental Technology Action Plan[13] (ETAP[4]) with the aim of harnessing the full potential of environmental technologies to reduce the pressures on natural resources, improve the quality of life of European citizens and stimulate economic growth. It should therefore add additional momentum to the process of encouraging the development and uptake of clean technologies, with a view of using this to support achieving the objectives set at the European Council in Lisbon in March 2000, namely of '*to become the most dynamic and competitive knowledge based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion*'. Depending on national approaches to respond to and implement ETAP, this may be an additional and important driver for cleaner production patterns while at the same time increasing competitiveness. We should therefore see the following (noted in the Gothenburg Council conclusions):

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[2] http://europa.eu.int/comm/environment/enveco/industry_employment/annex2.pdf

[3] Communication from the Commission to the Council and the European Parliament *Stimulating Technologies for Sustainable Development: An Environmental Technologies Action Plan for the European Union* - COM(2004)38. See also European Commission (2002) COM(2002) 122 final. *Environmental technology for sustainable development.* Report from the Commission, Brussels 13.03.2002

[4] For additional information on the ETAP see: http://europa.eu.int/comm/environment/etap/

- **Decoupling economic growth from resource use –** we can expect industry initiatives for technological innovation to make an important contribution to this
- "**Getting prices right"-** we can expect further efforts to reduce or reform subsidies and state aids, and efforts to increase taxes on products and fuels – with subsequent price signals to business, encouraging development and uptake of clean(er) technologies and techniques
- **Global dimension and trade –** we can expect efforts to further develop the EU presence in international markets of environmental goods and services; encouragement to ensure EU environmental standards are respected in trade.

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TNO…

1.3 The methodology for the background study

The study is based on desk research by an interdisciplinary team with the support of a structured literature survey method for OECD, and EU documents as well as some specific references. The research covered the period of 1995 to 2004. Supplementary information about new member states was provided by REC (Regional Environmental Centre).

The discussion of international documents from beyond the EU is important for the investigation of their interface with EU strategies (subsidies of domestic production, imports, etc.). In addition the development of the agricultural sector in EU member states also depends directly on the commitments of OECD and WTO.

Diffusion of clean technologies in the agricultural sector is a multi disciplinary issue. The technical terms used are often actor group (farmers, politicians, scientist, etc.) and country specific. For the transparent presentation of differences and similarities of terminology we have used original citations from references and avoided the interpretation of this information at this stage of the work.

Policy developments

The following section contains a brief overview of global developments relating to agricultural policy (chapter 2.1) and a more detailed part on developments in EU countries including EU-enlargement issues (chapter 2.2). Finally we present the most important aspects of these policies and incentives with regard to clean integrative technologies in the EU agricultural sector (chapter 2.3).

1.4 Global developments

Agriculture is intimately tied to the WEHAB (Water, Energy, Health, Agriculture, Biodiversity) priorities established at the WSSD (World Summit on Sustainable Development in South Africa). Even in the context of climate change it is seen as a main issue as global warming is projected to decrease productivity in the tropics and sub-tropics for almost any amount of warming. In addition food production needs to double to meet the needs of an additional 3 billion people in the next 30 years. Thus strategies to achieve this target have to be developed but also to prevent negative impacts e.g. on environment. (Watson 2003)

1.4.1 OECD

Organic agriculture is expanding in all OECD countries to meet increasing consumer demand. There is a wide range of policy approaches for addressing issues in organic agriculture. Policy options include those that are

- enabling – e.g. providing certification and labelling frameworks, research and extension services;
- enforcing – e.g. establishing regulations and standards; and
- encouraging – e.g. providing financial incentives, bringing together agents along the production chain to establish partnerships and procurement policies. (OECD 2002)

1.4.2 World Trade Organisation

Agricultural Trade is an important issue for the World Trade Organisation. Currently, Agricultural Trade is now firmly within the multilateral trading system. The WTO Agriculture Agreement, together with individual countries' commitments to reduce export subsidies, domestic support and import duties on agricultural products were a significant first step towards reforming agricultural trade. In the Doha Declaration (Nov. 2001) the ministers took note of the non-trade concerns (such as environmental protection, food security, rural development, etc)[5].

The reform strikes a balance between agricultural trade liberalization and governments' desire to pursue legitimate agricultural policy goals, including non-trade concerns. It has brought all agricultural products (as listed in the agreement) under more effective multilateral rules and commitments, including "tariff bindings" The member governments have agreed to prohibit subsidies that exceed negotiated limits for specific products. The commitments to reduce domestic support are a major innovation and are unique to the agricultural sector.

In addition an important objective of the new negotiations should be to bring agricultural trade under the same rules and disciplines as trade in other goods. [6] (WTO 2004)

It should be mentioned that the 5th Ministerial of WTO in Cancún, Mexico, collapsed on 14 September 2003 with no agreement reached because on a range of substantive issues, individual countries and country-groups were unable to reach agreement through the usual WTO negotiating processes.[7] The EU's failure on agriculture was an own goal resulting from a lack of coherence between its policies on trade, development and agriculture. The developed world was requested to accept that if its agricultural policies harm developing countries—and trade-distorting domestic support and export subsidies clearly do—then, they must be changed. (House of Commons et al. 2003)

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[5] Among the topics covered in the debate: Are environmental concerns best handled through comprehensive liberalization and "targeted, transparent and non- or minimally-distorting" Green Box supports? Or is agriculture special – i.e. is some support linked more directly to production necessary, particularly in areas where agricultural production has a low potential because production is needed for environmental reasons? (Phase 2 Papers or "non-papers" form: Cairns Group, Japan and Norway). WTO 2004

(Remark: WTO def. of Green Box: Green Box subsidies must not distort trade, or at most cause minimal distortion. They have to be government funded and must not involve price support. They also include environmental protection and regional development programmes.)

[6] Some countries have described the mandate given by Article 20 as a "tripod" whose three legs are export subsidies, domestic support, and market access (these are more commonly called "the three pillars" of agricultural trade reform). Non-trade concerns and special and differential treatment for developing countries would be taken into account as appropriate. Others say it is a "pentangle" whose five sides also include non-trade concerns and special and differential treatment for developing countries as separate issues in their own right. So far, these differences of approach have not delayed the discussions." Ibid.

[7] Beside Agricultural matter there arised problems related to the process matters (Time, timing and organisation), Geopolitics matters (New country-groups and the failure of brinkmanship) and Substance matters (most: Agriculture, cotton subsidies and the Singapore)

1.5 EU policy developments

In 2001, the Göteborg European Council launched the EU strategy for sustainable development. In March 2001, the Stockholm European Council decided that the EU should have a Strategy for Sustainable Development, and that the European Council in Spring 2002 should review the contribution that the environment technology sector can make to promoting growth and employment. In June 2001, the Göteborg European Council launched the EU Sustainable Development Strategy. The current EU strategy focuses only on a small number of serious problems. The main issues being associated to agriculture are food safety, loss of bio-diversity, soil loss, water scarcity, and long term effects of hazardous chemicals. The Commission subsequently in 2002 and 2003 produced two Communications[8] as part of the development for a future Action Plan. The potential of technology to create synergies between environmental protection and economic growth was recognised by the October 2003 European Council. In January 2004 the Environmental Technologies Action Plan (ETAP) emerged. It aims to harness the full potential of environmental technologies to reduce pressures on natural resources, improve the quality of life of European citizens and stimulate economic growth. The following chapter shows a compilation of the main policy instruments on European level.

Since ETAP-implementation policy is the main focus of this project, it is described in introduction chapter.

1.5.1 6th Environmental Action Programme (6EAP)

The 6EAP (6th Environmental Action Programme)(Parliament and Council 2002)/ DECISION No 1600/2002/EC) in general identifies four priority areas on which particular attention needs to be focused over the period 2002-2012:

1. Climate Change
2. Nature and Bio-Diversity
3. Health and Quality of Life
4. Management of Natural Resources and Wastes.

Agriculture is intimately tied to the four priority areas of the 6EAP.

"....the Programme aims to achieve a ***decoupling between environmental pressures and economic growth***…" (p. 1/8). In Article 2 (Principles and overall aims) it is explained, how this should be reached. "Better resource efficiency and resource and waste management to grind about more sustainable production and consumption patterns, thereby decoupling the use of resources and the generation of waste from the rate of economic growth and aiming to ensure that the consumption of renewable and non-renewable resources does not exceed the carrying capacity of the environment." (p. 3, Art. 2, 2)

In Art. 8, 2. priority actions for ***sustainable use and management of natural resources and wastes*** are defined:

(a) developing thematic strategy on the sustainable use and management of resources

(b) a review of the efficiency of policy measures and the impact of subsidies

(c) establishment of goals and targets for resource efficiency and the diminished use of resources, decoupling the link between economic growth and negative environmental impacts

(d) promotion of extraction and production methods and techniques to encourage eco-efficiency and the sustainable use of raw-materials, energy, water and other resources

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[8] COM(2002)122 and COM(2003)131

(e) development and implementation of a broad range of instruments including research, technology transfer, market-based and economic instruments, programmes of best practice and indicators of resource efficiency. (p. 13 Art. 8, 2.)

Regarding ***market instruments*** the introduction mentions "…incorporating new ways of working with the market, involving citizens, enterprises and other stakeholders is needed in order to induce necessary changes in both production and public and private consumption patterns that influence negatively the state of, and trends in, the environment.." (p. 1/14).

The Promotion of sustainable production and consumption patterns needs to internalise the negative as well as the positive impacts on the environment through the use of blend of instruments, including market based and economic instruments (Art. 3, 4.). This is specified among others by

- encouraging reforms of subsidies that have considerable negative effects on the environment (but it is weakened by the mid-term review, a list of criteria allowing such environmentally negative subsidies to be recorded)
- promoting and encouraging the use of fiscal measures such as environmentally related taxes and incentives .

In Art. 2, 3. it is ensured that "the environmental outcomes …. are met by the most effective and appropriate means available…" with emphasis amongst others on "analysis of benefits and costs, taking into account the need to ***internalise environmental costs***. (p. 3 and 4/30-31).

Referring to agriculture article 6, 2. says that it is important to promote "the ***integration of biodiversity considerations*** in agricultural policies and encourage sustainable rural development, multifunctional and sustainable agriculture through:

- encouraging full ***use of current opportunities of the CAP*** and other policy measures,
- encouraging more ***environmentally responsible farming***, including, where appropriate, extensive production methods, integrated framing practices, organic farming and agro-biodiversity, in future reviews of the CAP, taking account of the need for a balanced approach to the multifunctional role of rural communities."

1.5.2 Common Agricultural Policy (CAP) Reform 2003 – EU Policy

In recent years the EU has placed increasing emphasis upon the need to promote sustainable development and, in particular to integrate environmental considerations more fully into the sector policies of the Union.

Ever since 1992, the CAP has been immersed in a fundamental reform process, aimed at moving away from a policy of price and production support to a more comprehensive policy of farmer income support. The last step in this process was the decision reached at the Luxemburg Council on 26 June 2003 regarding the 2003 CAP reform. The central feature of the CAP of the future will be the single farm payment, applicable from 2005 which cuts the link between eligibility for direct payments and the production decision. (European Commission 2003a)

The CAP Reform of 2003 can be divided into the following main components:

- First Pillar Measures; i.e. commodity related,
- Second Pillar Measures; i.e. Structural and Rural Development Measures (e.g. Natura 2000),
- Horizontal Measures (including agri-environmental measures).

There are many environmental arguments for shifting resources away from the first pillar of the CAP – i.e. reducing the proportion of the budget that is spent on commodity supports –

and increasing the resources devoted to second pillar measures. Under Agenda 2000, Member States have the option to use modulation of direct payments in order to create additional resources for spending on the accompanying measures. In 2002 the ***UK*** and France have implemented modulation, while Portugal has passed legislation to implement it in 2003 and ***Germany*** and the ***Netherlands*** have indicated an intention to do likewise. However, in constructing an environmental integration strategy for the CAP several different elements are still required drawing on both agricultural and environmental policy. (IEEP 2002)

1.5.3 EU Enlargement

"The future of agriculture is a big issue for Enlargement, given that the pre-accession countries have large agricultural sectors. For most of these countries the share of agriculture in GDP and employment is between three and ten times higher than in the countries of the EU 15". (Braun et al. 2002) [9]

Agriculture, the agro-food chain and rural development in the New Member States have experienced immense change during the last decade. The environmental impact of farming in these countries during the past 20-30 years has had both positive and negative aspects. During the regime of the planned economy, many countries suffered greatly from malpractice, causing degradation of soil and fertility, ground water, etc. as well as of human resources. The positive side of environmental impact of farming in Candidate Countries is that fertilizer and pesticides have been used to a much lesser degree than in the EU, in the last years.

Extending CAP to New Member States is expected to imply also the adoption of EU practices in farming: intensification of farming, larger farms, increased use of fertilizers and pesticides. Nevertheless, the number of organic farms has grown rapidly the last 5 years in many PACs, but there is hardly any substantial amount of certified organic farming yet, although some of the basic conditions are met due to low levels of usage of fertilizers, pesticides and herbicide. (Braun et al. 2002)

Within the CAP reform special subsidies for New Member States in the field of rural development are planned. Special measures for environmental issues are currently not mentioned. "Rural development programmes are open to the Accession Countries. The condition is that you must have a rural development programme which is adopted by the EC and has a certain rate of co-financing. For the AC is 80% from the EU and the rest from the own government. …. Agri-environment is a part of the rural development plan". (European Environmental Bureau 2002) In this context ***Romania, Bulgaria, Poland*** are very important because they are still heavily relying on agriculture as a buffer in times of economic restructuring. (see Braun et al. 2002).

One of the most important programmes of CEE countries at national level expected to have a big impact on agriculture - thus also on the production of biomass for energy purposes - is the ***SAPARD programmes***, developed by each country as part of the preparations towards adopting the *"Acquis communautaire"* in the field of agriculture and rural development. Based on objectives like marketability of agricultural products, food safety, sustainable development of rural areas, environmental issues etc. financial support is given for activities to achieve these targets.
The fact that the share of agri-environmental projects within the total allocated budget remains in the range of 2-3% indicates that such opportunities are rather limited. Additional opportunities arise from a well thought through set-aside system, but this requires specific support schemes that are favourable for biomass production on set aside plots. Although, as stated above, agri-environmental considerations represent a rather small part within national

[9] Namely 4.1% of the acceding countries GDP comes from agriculture compared to 2.1% in the EU15. REC 2004

SAPARD programmes, some countries, notably Hungary, have well-developed ***national agri-environmentall programmes*** underway, and within these, funding for complementary schemes is provided from domestic sources. The overall objectives of these programmes are to minimize the negative environmental impact of agriculture

Most of these measures are being implemented on a voluntary basis. Similarly to SAPARD programmes, the plantation of energy forests, or the shift to growing energy plants/biomass is not explicitly recognized in these programmes as aspects worth expanding, but such activities indeed represent an opportunity, especially in those areas where this is a requirement but where growing conditions are not suitable for any other agricultural activities.

CEE countries acceding to the European Union have been requested to develop integrated ***national development plans*** and within these plans ***national rural development strategies*** in order to receive further support from common EU sources[10]. The overall goal of these plans is to define main objectives and priorities of sustainable development in rural regions as well as to determine the institutional background and main rules for the implementation of all measures.

Measures identified within the national rural development strategies address many different aspects of sustainable development in rural areas – e.g. agri-environment, support for less favoured areas and areas under environmental restrictions, increasing employment conditions through supporting early retirement of farmers, supporting the marketing of products through the setting-up of producers` groups, etc. – one of them being the forestation of agricultural areas. Keywords in this context are: economic use of poor land, environmentally friendly and natural energy resources, using in-country resources, renewable energy and raw materials. Since some of above measures such as supporting the early retirement of farmers or forestation of agricultural areas are controversial issues, they have to be discussed in depth.

1.6 Summary

The ETAP is the most recent and direct policy development for the adoption of cleaner technology. It aims to reduce pressure on natural resources, improve the quality of life of European citizens and stimulate economic growth. Together with the strategies described in this chapter it can influence e.g. strategic, methodological and technical development and decision making in the agricultural sector. Additional national or even regional policies can support these effects. The development of direct support mechanisms and a conscious integration within different policies - i.e. energy policy, agricultural policy, forestry policy and nature conservation policy – can foster the implementation.

The following compilation gives an overview of measures regarding environmental issues and addressing the targets of the different policy instruments. Examples are given for Spain, Germany, Netherlands, Austria, United Kingdom, Sweden and the new member states.

Spain: The agricultural policy takes increasingly into account the environmental impact of agricultural activities. The support given by EAGGF (The European Agricultural Guidance and Guarantee Fund) is for the benefit of the farmers and their families, who need to have a steady income, for the consumers, who look for quality food produced in the best way, and for the natural environment and the rural areas.

Measures: Agri-environment (mandatory), compensatory allowances in less favoured areas, early retirement, afforestation of agricultural land, Investment in agricultural holdings, setting up of young farmers and management of water resources.

[10] European Agricultural Guidance and Guarantee Fund (EAGGF) for rural development (EC regulation No 1257/1999).

Germany*: Measures: Some examples are improving rural structures, improving production and marketing structures, sustainable farming: compensatory payments for organic farming and multi-annual set-aside.*

Netherlands*: Measures: Developing sustainable agriculture: promoting innovation, market opportunities such as non-food crops and new food products using new agricultural methods, processing and marketing techniques, providing training and services to farmers to aid diversification and business ventures that benefit society. Support for LFA through nature conservation. Agri-environmental measures, including organic farming. Some other necessary measures are improving the quality of nature and the landscape, sustainable water management, economic diversification, promoting tourism and recreation, improving the quality of rural life.*

Austria*: Measures: Modernising agriculture: Investment aid is available for non-residential buildings and on-farm technical facilities, such as machinery, roads, biomass plant and food preparation/processing equipment. Any livestock housing must be welfare-friendly and keep stocking below 2.5 LU/hectare. Young farmers setting up are eligible for a one-off payment according to labour use on the holding. Vocational training, Compensation payments for LFA: based on area, land type, holding type and the level of natural handicap (higher rate for the first six hectars and progressively reduced up to 60 hectars), agri-environmental measures: a basic measure, extensification, preserving landscapes and traditional farming methods, soil and water protection, and project-linked measures on individual plots."*

United Kingdom: *Measures: Creating a productive and sustainable rural economy: energy crops offer new income opportunities, farm diversification and encouragement of rural tourism, water resource management. Conserving and enhancing the rural environment. Payments for LFA, agri-environmental schemes (Organic Farming Scheme (OFS) to convert to organic production methods, Countryside Stewardship Scheme (CSS) for commitment of farmers to environmentally friendly farming methods and Environmentally Sensitive Area Scheme (ESAS))"*

Sweden*: Measures: The major features of the extensive reform in 1991 were abolishment of the existing milk quota system already in 1989, elimination of internal market regulations, abolishment of export subsidies, end of semi-annual price reviews, maintaining of the level of border protection, temporary compensations to farmers for an expected decline of prices due to reform on a per acreage basis.*

The reform was much more fundamental than the 1992 CAP reforms that were to follow. The compensations to farmers were e. g. only temporary and rather modest when compared to the EU level. Market interventions and export subsidies were also eliminated in Sweden, but retained in the EU. Since the adjustments imposed by the domestic reform, when compared to those expected to follow from joining the Union, were substantially different, the reform process became increasingly difficult to sustain. In addition, a large number of complications were created, since regulations and institutions that had been removed by the 1990 reform would have to be reintroduced to meet CAP obligations. With EU membership, the agricultural policy was therefore once again changed towards a more regulated approach. Finally, the reforms implied that Sweden joined the EU with a strong commitment to a liberal agricultural policy and an ambition to reform the CAP.

New member states: One segment of the agricultural producers comprises some of the large cooperatives and factory farms that have remained in operation. While these are currently financially more viable, their production is highly polluting (especially that of intensive animal husbandry) and the IPPC directive to be implemented will pose difficulties for many of these installations. The land use structure of the new member states has been very much influenced by the agricultural sector, or by agricultural policies in force during the last decades.

Environmental issues

Agriculture both creates pressures on the environment and plays an important role in maintaining many cultural landscapes and semi-natural habitats. Some pressures, such as greenhouse gas emissions from farming, have declined in recent years. However, others have increased, such as the over exploitation of aquifers from increased use of water for irrigation. Awareness of the importance of certain issues, such as diffuse pollution of freshwater, is increasing. (IEEP 2000)

The most severe pressures tend to arise in the more intensively managed farmland, for example in horticulture and arable production, lowland dairying and other livestock housed indoors. Looking at intensive livestock "…..the key environmental aspect is that the animals metabolise feed and excrete nearly all the nutrients via manure. (e.g. manure of pigs contains 67% of the Protein in the feed). Ammonia has been given most attention as the key air pollutant as it is emitted in the highest quantities. Nearly all the information on the reduction of emissions from animal housing reported on the emission reduction of ammonia." (European Commission 2003b) But referring to climate change even CH_4 emissions should not be neglected.

In all sectors "agriculture is a significant user of water resources in Europe, accounting for around 30% of total water use. The scale and importance of irrigation is significantly greater in the southern Member States but far from negligible in most northern Member States. Among the Accession States, irrigation accounted historically for very little water demand in the Baltic States; it had some regional significance in Poland, the Czech Republic, Hungary and Slovakia, and it was particularly important in Bulgaria and Romania. However, since the collapse of the command economies in the last decade, the use of water for irrigation declined sharply in most countries and is only now beginning to creep back upwards." (IEEP 2000)

In contrast to these pressures low input systems, such as extensive grazing of cattle, sheep and other livestock as well as traditionally managed, long-established orchards and olive plantations are closely associated with valued cultural landscapes and high nature value farm-land.

Some of the benefits and harmful environmental processes of agriculture are summarised below:

Table 1: Processes and their impact on environment {European Commission, 2000 #2456

Relationship	Processes
Pollution of Environment	Build up of nitrate and other mineral residues, pesticide residues, salination, ammonia and methane emissions
Depletion of environmental resources	Inappropriate use of water and soil, destruction of semi-natural and natural land cover
Preservation and Enhancement of the environment	Creation/preservation of landscapes, habitats, land cover, preservation of genetic diversity in agriculture, production of renewable energy sources

Regarding the European strategy on sustainable development, environmental protection should be investigated against the background of sustainability. In the context of sustainable agriculture (including Clean Technologies) the OECD has set up environmental indicators for Agriculture (AEIs). The indicator system is based on a driving force-state-response model (DSR).

The state of the environment refers to changes in environmental conditions that may arise from various driving forces. The impact of agriculture can occur both on-farm and off-farm, for example the effects on biodiversity and climate change, and operate at various temporal and spatial scales from the field through to the global scale.

Responses refer to the reaction by groups in society and policy makers to the actual and perceived changes in the state of the environment in agriculture, the sustainability of agriculture and to market signals. The responses include:

- Farmer behaviour, by changes in input use, farm management practices, such as integrated pest management, and cooperative approaches between farmers and other stakeholders;
- Consumer reactions, through altering food consumption patterns, including preferences for “organically” produced foods;
- Responses by the agro-food chain, with changes in technology to produce less toxic pesticides and the voluntary adoption of better safety and quality standards by the food industry;
- Government actions, through changes in policy measures, including regulatory approaches, the use of economic instruments such as subsidies and taxes, training and information programmes, research and development, and agricultural policies.

From this very comprehensive framework an individual selection of important criteria for agri-environmental indicators is necessary. There are obviously a large number of potential indicators that could be developed to help quantifying the various components and linkages and the DSR framework. {OECD, 1997 #2452}

Selection of (bundle of) technologies and case studies

The aim of this chapter is to outline clean technology clusters in the agricultural sector which have a potential to solve problems relating to the environmental issues described in the last chapter. Every description concludes with the summary of a first assessment of these technology clusters according to their contribution to the objectives of clean technology and sustainable agriculture.

Environmental Technologies (Cleaner Technologies) can be defined as “all technologies whose use is less environmentally harmful than relevant alternatives”. (European Commission 2004). The term technology in this contribution includes processes systems and activities such as farm management practices.

The agricultural sector can be split into two main sectors the “Food” and the “Non-Food” sectors. On the basis of this classification the technologies found were broken down into:

a) technologies relevant for food and non-food production

b) technologies for the food sector in particular

c) technologies for the non-food sector

1.7 Technologies relevant for food and non-food production[11]

Technologies for sustainable agriculture cover the whole spectrum of farming systems. All environmental friendly measures, from intensive conventional farming to organic farming, have the potential to be locally sustainable, if social aspects are also considered in the development process. Whether they do so in practice depends on farmers adopting the appropriate technology and management practices in the specific agro-ecological environment within the right policy framework. There is no unique system that can be

[11] OECD 2001a

identified as sustainable and no single path to sustainability. There can be co-existence between more intensive farming systems and more extensive systems that overall provide environmental benefits while meeting demands for food. However, it is important to recognise that most sustainable farming systems – even extensive systems – require a high level of farming skills and management to operate.

A general approach for environmentally friendly agriculture is called agri-environmental options for crop production. Agri-environmental options are additional voluntary practices designed to have positive environmental impacts to counter long-term environmental problems. The following options were developed within a project of the European Commission. It involved the Netherlands, with the most intensive agriculture, the UK, representing the relatively intensive production typical of northern Europe, and Portugal, with mainly less intensive systems typical of southern Europe.

The Netherlands agri-environmental options are classified in two sections. Section A, flora and vegetation, includes: arable flora in rotating cereal crops without pesticides and fertiliser , arable flora in rotating cereals without pesticides and fertiliser in any year, arable flora in permanent cereal field (cereals five out of six years) without pesticides and low input of fertiliser, arable flora in cereal margins, and hedgerow management.

Section B, fauna, includes: fauna margin, fauna fields, red list vertebrate management, and integrated whole farm plan.

Proposed ***UK*** agri-environmental options are: organic farming, arable conversion to grass, large riparian buffer zones, reed bed nutrient sinks, conservation headlands, conservation headlands with no fertiliser, wild bird cover crops, under sowing, grass leys, field boundary vegetation, hedges and shelterbelts, beetle banks, uncropped wildflower strips, hedge maintenance, stone walls and ditches, individual tree planting and integrated whole farm plans.

Agri-environmental options proposed for ***Portugal*** include: restricted harvest dates, triticale erosion control, arable conversion to trees, extensive arable systems, montado, organic farming, poly-culture, water points, wildlife crops, game management, shrub habitats and integrated whole farm plan, issues and measures relating to afforestation of arable land.

Costs and benefits of agri-environmental measures depend strongly on the combination of different strategies.[12] Opportunities exist, especially in the longer term, for offsetting costs of support for environmental measures by exploiting marketing opportunities such as premia for ‘regional’ products and food from environmentally benign production systems.[13] (European Commission DG Environment 1999)

1.7.1 Organic farming

“Organic farming can be seen as an approach to agriculture where the aim is to create integrated, humane, environmentally and economically sustainable agricultural production systems. The term 'organic' is best thought of as referring not to the type of inputs used, but to the concept of the farm as an organism, in which all the components - the soil minerals, organic matter, micro-organisms, insects, plants, animals and humans - interact to create a coherent, self-regulating and stable whole. Reliance on external inputs, whether chemical or organic, is reduced as far as possible. In many European countries, organic agriculture is known as ecological or biological agriculture, reflecting the reliance on ecosystem

[12] For example increasing of costs of milk production due to manure management could be compensated through decreasing of costs of wastewater-treatment in the farm.

[13] For example, Serpa sheep cheese is produced in the predominantly arable Alentejo region of Portugal. Iberian pigs and the production of ham and other regional pork products are directly linked to holm oak montados. Promotion of sylvicultural products such as cork and charcoal could also be encouraged within Alentejo arable systems.

management rather than external inputs. Detailed descriptions of the principles and practices of organic farming can be found in the many books on the subject published around the world in recent years." (Lampkin et al. 1999)

Organic farming management relies on developing biological diversity in the field to disrupt habitat for pest organisms, and the purposeful maintenance and replenishment of soil fertility. Organic farmers are not allowed to use synthetic pesticides or fertilizers. Some of the essential characteristics of organic systems include: design and implementation of an "organic system plan" that describes the practices used in producing crops and livestock products; a detailed recordkeeping system that tracks all products from the field to point of sale; and maintenance of buffer zones to prevent inadvertent contamination from adjacent conventional fields.[14]

In contrast to other parts of European agriculture, ***organic farming*** is a growth sector[15]. "Although organic products are increasing in supply volume, their share of total production in the EU remained low, ranging from 0.2 % for organic pork up to 2.3% for organic fruit. Concerning organic consumption Denmark and Austria were the leading countries in terms of overall average market share by volume, when all product groups are considered. The CAP reform has for several reasons increased the relative competitiveness of organic farming. Price reductions for organic products due to the increase of supply did not take place to degree feared; quite the contrary, in some countries a positive development on the market for organic products was observed as a result of the increase in supply which facilitated more efficient processing and marketing structures. "However, "-aside the compensatory payments, decoupling the support level form the output level, had on average a positive impact on the relative profitability. An important aspect of the profitability of organic farms is the opportunity of receiving higher farm gate prices for organically produced goods than for conventionally produced ones. Prices vary considerably between the different marketing channels.[16] [17] The analysis of the economic situation of organic farms in Europe shows that on average profits are similar to those of comparable conventional farms. (within a range of +-20%) Profitability varies between the countries surveyed, and between different farm types." (Offermann et al. 2000)

1.7.2 Integrated Crop Management (ICM)

The concept is to integrate the management of individual crops in order to benefit from the interactions between them. In many respects integrating crop production strategies to provide benefits such as pest control, maintain soil fertility, etc. is an ancient technique. However, ICM also takes advantage of modern technology to improve on the system.

A wide range of fairly similar 'working definitions' are used by various institutions throughout the EU. Eight of these definitions were examined and '***environmental sensitivity***' emerged as the key component of ICM systems. This is closely followed by '***economic viability'***. '***Modern techniques***' is an important component and this reflects a key point of difference in comparison to organic farming which can be thought of, at least in principle if not always in practice, as rejecting modern techniques such as artificial inputs.

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[14] http://www.ofrf.org/general/about_organic/

[15] In statistical terms, agriculture is not a major economic sector – it contributes about 1.8% of GDP and accounts for a small, and a declining, proportion of EU employment – currently around 4.5%, although the figure varies considerably between regions. However, more than three-quarters of the territory of the EU is agricultural or wooded land, and agriculture's share is over 50% in many Member States. IEEP 2002

[16] Currently, premium prices are very high for most crop products. In nearly all Countries, average from gate prices for organically produced wheat were 50 –200 % higher than for conventionally produced wheat (other examples: Potatoes 50% - 500%, milk 8 – 36%, pork 20% - 70%)

[17] Compare Hamm, et al. 2002

Even the concept of '***whole farm approach***' is fairly prominent. In terms of two of the three least prevalent concepts, '***long term strategy***', as a reflection of the importance of the use of rotations in minimising weed and pest problems. ***'Efficiency of input use***' is not implied in the same manner, although it could be argued that rational producers would seek efficient input use in any case. Based on the above, one might summarise the main aspects of current ICM definitions by saying that it is an environmentally sensitive and economically viable production system or process which uses the latest available techniques to produce high quality food in an efficient manner.[18] It seems highly likely that ICM systems reduce the incidence of pesticide leaching. This evidence also suggests that ICM systems generally result in a reduction in the risk of nitrate leaching. Further it is likely that ICM does generally contribute to reductions in application through fertiliser rationalisation/reduction strategies. Having a look on profitability it is said to be the same as conventional farming systems as a result of lower yields and hence revenue being balanced out by reductions in production costs. (Bradely et al. 2002)

1.7.3 Measures to manage irrigation in the European Union

In an increasing number of regions in both north and south, irrigation by sprinklers using pressure, often drawing water from subterranean aquifers, is the most common practice. It is often in these areas where the quantities of water used, and thus the impact on the environment, can be most severe. A variety of measures is available for mitigating the negative impacts of irrigation and enhancing environmental benefits where these are achievable. Some of these are technical or site specific but many could also involve policy changes and adjustments to the institutional management of water at national and regional levels. An example would be a switch from spray irrigation to drip irrigation, which involves lower water losses and reduced impact upon soil surfaces. However, there may be no environmental gains if more efficient use does not result in lower overall water use, but simply allows an increase in irrigated area. (IEEP 2000)

1.7.3.1 Modern drip systems

"The effectiveness of irrigation (defined as the ratio between the water abstracted and the water actually consumed by the plant) varies according to soil characteristics, differences in altitude, irrigation practices and techniques and water distribution method. Irrigation practices and techniques are border and furrow or drip method, water distribution can be realized by gravity or under pressure. For example the effectiveness of conventional irrigation practice varies between 50 and 70% in the gravitational systems of the Ebro basin in Spain, but can rise to over 95% in modern drip systems. Nevertheless, the water ´lost´ by the irrigator and by the irrigated system is not necessarily lost for the catchment-basin. Indeed, the lost waters joining water-courses or ground water can be re-used by other users who are located further downstream from the water-course or who pump from the ground waters concerned. However, in absence of water accounts at catchment-basin level, the real losses (i.e. the quantities of water returning to the sea surplus to the quantities necessary for ecosystems to function properly and for economic activities) connected with ineffective irrigation cannot be assessed.

Techniques like border and furrow or drip method, water distribution by gravity or under pressure reduce the volume of water abstracted for irrigation and decrease the investment in infrastructure for storing and gathering new water resources. They also reduce the problems associated with soil erosion and the salinisation of ground water in coastal areas. In the case

[18] Case studies in the EU were : **France:** Boigneville project and Champagne production. **Germany:** the Lautenbach project and the AKIL project. **Italy:** the CAMAR project and Chianti production. **Spain:** citrus production in Valencia and pome fruit production in Cataluña. **UK:** Less Intensive Farming and the Environment (LIFE) and Focus on Farming Practice (FOFP)

of soils with high salinity levels or of subsoil irrigation waters with high salt content, the lower water output of these techniques does not, however, allow the quality of the soil to be restored and/or excess salts to be leached." (Strosser et al. 1999)

In a case study in Spain cost analysis showed that the water transfer is not economically sustainable, because the costs of the diverted water are higher than the current marginal value of water in agriculture, and crop profitability is insufficient to pay for the whole volume of transferred water.(Albiac et al. 2003)

1.8 Technologies for the food sector in particular

As all technologies for crops are relevant for both the food sector and the non-food sector this section is limited to the description of livestock-technologies.

1.8.1 Best Available Techniques for Intensive Rearing of Poultry and Pigs

(European Commission 2003b)[19]: Intensive livestock farming coincides with high animal densities. The central environmental issue in intensive livestock farming is manure. Other environmental issues are waste, energy, water and waste water, noise (and even odour). Ammonium is the key air pollutant as it is emitted in the highest quantities. As a solution is nutritional management suggested. Reducing the excretion of nutrients (N,P) in manure can reduce emissions. Nutritional management covers all techniques to achieve this reduction.[20] [21]Assessing the costs and benefits of nutritional measures aimed at reducing emissions from intensive livestock farming is complex. The potential economic and environmental benefits of such management measures in reducing nitrogen pollution have been evaluated in a recent report by Dutch Agricultural Economics Research Institute[22] It evaluates the effect of current and future European policy changes on nitrogen pollution levels at national, regional and farm level using different predictive models and comparing similar approaches. It draws attention to the fact that, where dietary protein levels decrease with increasing cereal used in feed, then the changes in cereal price are important for the sustainability of the nutritional management measures. In that respect much is expected of the effects of the CAP reforms. However, the EU-determined cereal price is not independent, but has a price relationship with Soya, the price of which is set on the world market. These costs levels affect the economic viability of the nutritional management measures, such that low Soya prices can lead to high dietary protein levels. With successive CAP-reforms, the inclusion of higher levels of cereals has been favoured and the cost of implementing reduced protein diets compared with current norms has decreased accordingly. It can be concluded that Applying preventive nutritional management as a mean of reducing nitrogen output at the farm level is economically competitive with the downstream processing of excess manure.

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[19] The Intensive Rearing of Poultry and Pigs (ILF) BREF (Best Available Techniques reference document) reflects an information exchange carried out under Article 16(2) of Council Directive 96/61/EC. The scope of the BREF for intensive livestock is based on Section 6.6 of Annex I of the IPPC Directive 96/61/EC as "Installations for the intensive rearing of poultry or pigs with more than: 40.000 places for poultry, 2.000 places for production pigs (over 30 kg), or, 750 places for sows.

[20] Achieved environmental benefits: Both, in pig and poultry a 1%-point protein reduction, e.g. from 18 to 17% leads to a 10% reduction in nitrogen output and ammonia production.

[21] Other issues in the context of intensive livestock farming are (compare BAT): water and energy usage, waste arising and field applications of inorganic fertiliser and manure, emergency procedures to deal with unplanned emissions and incidents, and therefore education and training programmes for farmer stuff and repair and maintenance programmes to ensure that structures and equipment are in good working order and that facilities are kept clean.

[22] <77,LEI, 1999>

1.9 Technologies for the non-food sector

The following chapter is on technologies for the non-food sector. This means technologies which have an interface to the industry sector with agricultural products or by-products which are not used directly as food themselves or for food production, but processed to inraw material and intermediate products for different industry sectors. The first steps of processing such as fermentation are accomplished within the agricultural sector. Technologies such as potato production for starch, do not differ from other crop production systems and are not mentioned here.

1.9.1 Bioenergy

"Biomass use for energy and materials will increase from 250 Mt in the base case to 600 Mt in case of 75 % emission reduction in 2030" for Western Europe. Based on.….modelling results it is recommended to apply generic pricing instruments provide a long-term policy target to all market parties and avoid premature technology selection. The results show that the selection of appropriate policy instruments is a decisive factor with regard to the development of future biomass strategies. Pricing instruments seem more appropriate than specific regulations, given the flexibility but uncertainties with regard to optimal technology selection and biomass availability. Significant costs can be saved and significant efficiency gains are possible in case the appropriate approach is selected." (Gielen et al. 2000)

Agriculture and forestry constitute a very important element in the existing Western European economy, especially if the flows are expressed in weight or energy units. Total annual commercial plant biomass production amounts to approx. 1200 Mt (dm) which equals 15-20 EJ. This is equivalent to 25-30% of the total Western European primary energy use (but this sustainable resource is largely not utilised for energy purposes, and is therefore not reflected in energy statistics). The bulk of this biomass is used for non-energy purposes: food and materials. Some goes to waste or, in the case of straw, is often ploughed back in as a soil conditioner. Thus, there is considerable potential even within existing cultivation systems, although ultimately the supply of biomass for energy and materials is constrained by physical supply constraints: land availability and biomass yield per ha of land. The transportation market is the second most important bioenergy market following electricity. It represents approximately one third of the total bioenergy market (expressed in primary biomass equivalents). "However, it is still as yet a very small proportion of even the road transport fuel market. (Gielen et al. 2000) (IEEP 2004)

1.9.1.1 Biofuels

Currently liquid biofuels are typically produced from arable crops – biodiesel mainly from oil seeds such as rape or sunflower, and ethanol from starch or sugar crops (eg wheat, sugarbeet). In the longer term, however, it should be possible to produce ethanol from a range of lignocellulosic materials including straw from conventional crops or novel crops such as grasses (eg miscanthus) or wood crops (such as coppiced willow). The latter can be achieved by coupling hydrolysis process before fermentation, or in the future, gasification of a range of biomass may be available to produce a broader range of fuels.(IEEP 2004) The EC suggests the use of liquid biofuels as a tool to secure and diversify the energy supply, as well as to decrease the CO_2 emissions from road transport in the EU.

"In Europe, the predominant feedstock is rapeseed oil, the major oilseed crop raised there. While making bio diesel from a wide variety of fat products is possible, the technology for processing soybean oil has received the most attention in the U. S. Animal or recycled fats cost considerably less than soybean oil and therefore present an attractive option to increase the supply of bio diesel[23]. For instance, the efficiency of a large multiple product-processing

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[23] An example from USA shows that: "Yellow grease is about half the cost of soybean oil… Commercially manufactured bio diesel from yellow grease currently meets industry specifications and yellow grease bio diesel

facility relies in part on uniform inputs, quality-controlled outputs and a carefully controlled process that operates around the clock. These factors, combined with quantity purchases and large labour, management and resource pools, may reduce the overall production costs suggested by a comparison of the spot prices of various process inputs. In other words, it may be more profitable for large industrial facilities to use more expensive commodity oils than the current low-cost options such as the various waste/recycled grease products. " (Groschen 2002)

Biofuels in New Member States

Based on a summary of national forecasts, the potential contribution of New Member States to the enlarged EU biofuel production is estimated to be up to around 1% substitution rate simultaneously for fossil diesel and gasoline consumption as a maximum. Based on optimal technically feasible estimates, the potential contribution of New Member States reaches maximum substitution rates of around 2% of fossil diesel consumption (bio diesel) and around 3% of gasoline consumption (bio ethanol) simultaneously. The bio ethanol production potential appears larger than the bio diesel potential, due to a higher biofuel yield per ha and a larger potential to increase the sown area.

"New Member States differ from EU-15 by having lower transport energy consumption and lower population densities. In addition, New Member States have larger reserves of idle land and labour at lower cost. Therefore, it is sometimes assumed that New Member States have relatively large production potential for biofuels. The production costs of biofuels in New Member States appear to be similar to the biofuel production costs in EU-15. This is primarily due to the fact that lower factor costs are balanced by lower yields. External support to improve yields will bring costs to higher levels. Therefore, New Member States do not constitute a large reserve of cheap biofuel supply. On energy content comparison basis, bio diesel production costs are generally lower than bio ethanol production costs. The final net production costs of biofuels are strongly influenced by the revenue from by-products. This impact is more pronounced for bio diesel than for bio ethanol, because the value of by-products represents a larger share of gross production value and the market liquidity of bio diesel by-products is more uncertain. Cultivation costs of biofuel corps constitute around 80% of final production cost of biofuels in New Member States on average. Therefore, the main strategies to decrease the overall production costs of biofuels are tied to improving cultivation and increasing yields per hectare. "(Kavalov et al. 2003)

FAO[24] and Biofuels:

Production and use of biofuels as an energy source are linked to a host of issues, such as agriculture and food security, land use and rural development, sustainable forest management and biodiversity conservation, and mitigation of climate change. The FAO stresses the potential of biofuels as locally available, renewable sources of energy. This refers particularly to rural areas in developing countries, where they have been the mainstay of energy generation. The FAO recognizes the importance of new technologies for utilization of bioenergy as an industrial energy source at competitive market prices. (FAO 2000)

1.9.1.2 Biogas

Biogas generated by the means of corn, rapeseed meal and liquid manure was weighed against a number of liquid and solid biofuels. By comparison biogas has got a large potential for reducing green house gas emissions depending on the bioenergy carrier used. Biogas

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performed well in heavy duty snowplow vehicles in a Minnesota demonstration …. " ." However the production of bio diesel from grease can be expected to benefit from a raw material cost advantage and eventually from improved technology. … it will help reduce overall bio diesel cost and add to the diversity of raw materials used for the production of bio diesel. " Groschen, p. ii

[24] Food and Agriculture Organisation of the United Nations

from corn for instance performs much better than liquid biofuels, reaching almost the results of best solid bioenergy carriers. However, like other biofuels as well, the use of biogas affects the environment regarding acidification, eutrophication, photo smog, and ozone depletion. (Braschkat et al. 2003)

1.9.2 Green biorefinery

Today, petroleum refineries efficiently produce a multitude of products from crude oil on a very large scale. The development of comparable technologies will be essential to make many bio-based products competitive with their fossil-based equivalents. A biorefinery is "a processing and conversion facility that (1) efficiently separates its biomass raw material into individual components and (2) converts these components into marketable products" (US-DOE 2002a). Bio refineries are regarded as an essential contribution to the transition from a currently hydrocarbon-based economy (fossil oil, coal, natural gas) towards a carbohydrate-based economy (renewable bio-based feed stocks). Bio refineries will process bio-based feedstock into multiple value-added products, e.g.:

- chemical intermediates (e.g. lactic, acetic, citric acids);
- solvents (e.g. ethanol, acetone, butanol, esters);
- fuels, adhesives, industrial enzymes, fermentation feedstocks;
- materials: biodegradable plastics, bio composites, construction materials, new fibres.

Green bio refineries utilize green biomass as primary resource (e.g. grass, clover, green agricultural crops, etc.). However, in this case the storage-problem has to be solved, i.e. green biomass has to be preserved so that it is available for longer periods of time in order to allow continuous year-round operation of the plant. Developing sustainable green biorefinery systems requires a combination of central and decentralized / localized units, i.e. large scale conversion and processing plants that take advantage of economies of scale must be combined with smaller and localized units as close to biomass feedstock as possible, resulting in improvements to rural economies and a reduction of the environmental impacts of transportation.[25]

In ***The Netherlands*** big efforts are being made with respect to whole crop utilization of green biomass (Ketelaars 2001) with a pilot plant opened in 2002 (Hulst 2002).

In ***Germany***, in 1996 a research group (Kamm et al. 1999) started to use different juices for lactic acid fermentation. As green biomass is rich in the bulk components free carbohydrates, proteins and fibres, these components should serve for the basic exploitation. "Low-volume, High-price" specialty chemicals like bioactive substances (carotenoids, isoflavonoids, etc.) are expected to increase the viability of such green biorefineries systems.

During the last four years a holistic concept for an Austrian green biorefinery has been developed in **Austria** (Kromus 2002). This concept is based on a decentralized system to take account of the small-scale agriculture. However, the system is built around grass silage fermentation and the production of lactic acid and amino acids (hydrolyzed proteins). Therefore, the main focus of green bio refineries is directed to products such as lactic acid, other organic acids, proteins, amino acids, carotenoids, other pigments, monosaccharides and fibers and the resulting applications. Beside raw material and technology aspects, biorefinery concepts are particularly characterized by the approach of considering and paying attention to sustainability criteria and the incorporation of technologies in regional structures summarized under the key word "sustainable regional development".

[25] In the United States just recently a "Roadmap for Biomass Technologies in the United States" was published, in which development and implementation of biorefineries is attributed as an essential contribution to a transistion from the fossil-oil based economy towards an economy based on renewable resoureces (biobased products) US-DOE 2002a, US-DOE 2002b

Following the basic elaboration of different integrated systems (centralised and decentralised) systems in Europe, research is currently focused on intensifying the conversion processes and the search for high yield strategies in optimised cradle-to-grave system setups. The aim of this project is to continue the research on environmentally friendly process intensification in a European dimension to foster the profitable bio-industry with a long term perspective in Europe. Therefore, all relevant European players are involved. Due to some decentralised approaches a special focus is put on the integration of SMEs.

1.10 Selection of the case studies

A first assessment of the technology clusters described above is carried out according to their policy, environmental, economic, technical and social rank for selection of two appropriate examples for case studies in Work Package Two.

The criteria used for the ranking of technology clusters in the agricultural sector are a modified list of criteria selected by ISI for industry sector. The list for criteria for agricultural sector is presented below:

A Political rank

Priority issue of ETAP (climate change, water supply and sanitation technology, industrial processes, soil protection), contribution to climate policy incl. emission trading scheme, contribution to water regulation, contribution to manure management/ and plant and harvest residues and contribution to cultural landscape conservation.

B Environmental rank

Energy conservation, control / abatement of greenhouse gas emissions, control / abatement of air pollution, control / abatement of water pollution, abatement of raw material depletion, sustainable waste management, sustainable management of water bodies and soil protection.

C Economic rank

Potential for European lead market, high market potential, cost effectiveness, costs (including opportunity costs,…)/environmental benefits, low present or hindered dissemination, high dissemination potential and participation of SME and crofters.

D Technical rank

Leading edge technology, shaping the technological future, proved technical feasibility of technologies or components and strong traditional position of European vendors.

E Social rank

Creation of jobs, improvement of employment conditions, health protection, consumer protection, availability / accessibility for different societal groups (aspects of social exclusion), relevance for different age-groups (aspects of an ageing society) and contribution to rural development.

D Geographical rank

Importance for the majority of the 10 New Member States and importance for the majority of the present EU-15 countries.

The detailed results of the assessment are presented in Annex I to this paper. The results are based on desk research and expert judgement by the ITA team. For the evaluation of biofuel we also considered an assessment of IEEP.

Technology clusters with the highest average points are: biorefinery combined with biogas (20,69 points), biofuels (18,38 points) and organic farming (16,61 points).

Review of barriers and drivers

In this chapter we present an overview of the research results on barriers and drivers for technology clusters in the last chapter. Barriers and drivers are broken down into policy, economic, market, communication, attitudes and social values, technological and organisational categories in order to be comparable with the classification of diffusion factors in the contribution of TNO to the ESTO/IPTS project: Diffusion of Industrial Clean Technologies. The detailed descriptions and citations for barriers and drivers are documented in Annex 1. In addition, the result of review of factors in the contribution of TNO together with some general barriers and drivers for development and implementation of cleaner technologies in agricultural sector is available in table 8 of Annex I to this report.

1.11 General barriers and drivers for environmental technologies in agriculture (Table 2)

General barriers and drivers for environmental technologies in agriculture								
	Policy	**Economic**	**Economic/communities**	**Market**	**Attitudes and social values**	**Technological**	**Organisational**	**Organisational economic**
barriers		perception of risk associated with many new technologies	replacement of labour by capital (unfavourable for small scale family farms)	incomplete markets for „sustainable" products	lower environmental awareness in the New Member States	heterogeneity of the natural resource base	structural barrier to decision making	lack of complete property rights of information for innovators
		financially weak fragmented small farms after the re-privatisation in the New Member States		lack of market prices for wildlife or landscape (external costs)				
		lower eligibility of farmers in the New Member States for subsidies (compared to former subsidies in EU15)						

General barriers and drivers for environmental technologies in agriculture								
	Policy	**Economic**	**Economic/communities**	**Market**	**Attitudes and social values**	**Technological**	**Organisational**	**Organisational economic**
		inadequate funding, resistance to long-term obligations and reluctance to abandon traditional practices						
drivers	regional policy							
	EU structural funds.							
	CAP							
	new land-use functions in the New Member States							
	reduction of variable costs as an indirect effect of lower cereal prices							
	premium for regional products}							

1.12 Barriers and drivers for organic farming (Table 3)

Organic farming					
	Policy/market	**Economic**	**Market**	**Technological/ organisational**	**Attitudes and social values**
barriers		economical and technical co-evolution	lack of coordinated action for organic food	physical and chemical problems of transformation	
		lower yields	missing data		
		financial problems during transformation	long term supply reaction and highly volatile demand		
			dumping organic products by trade organisations		
drivers	binding organic standards		organic food sold in general food shops		aversion against conventional farming
	labels, consumer recognition and transparency		efficient market - demand driven market-pull strategy		strong belief in the future of organic farming
	subsidies		appropriate marketing channels		
	voluntary agreements				

1.13 Barriers and drivers for Integrated Crop Management (Table 4)

Integrated Crop Management							
	Policy	**Policy/ Economic**	**Economic**	**Market**	**Attitudes and social values**	**Technological**	**Organisational**
barriers		lack of standards	lower yields		controversial discussion of chemical fertilizers and manure	diffuse boundaries between ICM and conventional arable farming	ICM as a total package (holistic approach)
		lack of financial incentives	lack of visibility of profits				lack of reference projects on farms
			impractical mechanical weed control for winter wheat				lack of adopting knowledge
drivers	food safety		lower variable production costs	marketing advantage for multiple retail outlets			network
	training and information exchange						flexibility in adoption
	support for farmers and growers by well-trained staff						
	funds						
	voluntary agreements						

1.14 Barriers and drivers for measures to prevent negative impacts of irrigation in the European Union (Table 5)

Irrigation in EU				
	Organisational/Policy	**Economic**	**Policy/Market**	**Technological**
barriers	lack of consistent regulation	costs		
		low water prices		
		additional costs for replacement of labour by capital		
drivers			public sector involvement	technical possibilities
			economic and regulatory policies	pricing water/water markets
			voluntary agreements	
			water price increase	

1.15 Drivers for Best Available Techniques for Intensive Rearing of Poultry and Pigs (example nutritional management) (Table 6)

Intensive Rearing of Poultry and Pigs (example nutritional management)	
	Policy/Market/Economic/Technical
drivers	cost savings
	decreasing price of functional feed
	local commodity supply
	local land availability for spreading manure

1.16 General barriers and drivers for non-food clean technologies (Table 7)

General barriers and drivers for non-food technologies			
	Policy/ Economic	**Technological**	**Organisational**
barriers	lack of regulation for non-food land use	problems due to mass production	
		land availability for agricultural products for non-food sector is limited	
		temporal availability	
drivers		GMO research for non-food sector	diversity in agriculture is required
		need for technological developments in the context of the Kyoto Treaty	developments in food sector
			more area for agricultural production in the New Member States than eligible for agricultural subsidy

1.17 Special barriers and drivers for bioenergy/biofuels (Table 8)

Bio-energy/Biofuels						
	Policy	**Economic**	**Market**	**Attitudes and social values**	**Technological**	**Organisational**
barriers		lack of economic instruments				
		competition between resources and strategies				
		competition with other energy forms				
drivers	appropriate policy instruments and pricing instruments	new income sources for farmers	scale effects	local opinion	knowledge to reduce environmental damages	positive complementary effects of cooperation with the petrochemical industry
	national policy		competition within bioenergy sector			
	local policy and opinion		competition with other business			

1.18 Special barriers and drivers for biorefinery (Table 9)

Bio-refineries					
	Economic	**Economic/ Technological/Market**	**Technological/ Organisational**	**Technological**	**Organisational**
barriers	higher price of renewable raw materials			medium stage of technology-development	lack of appropriate logistic
	new income sources for farmers				
drivers	bio refineries as multi-product plants	development of key-technology in the bio-industry field	innovative solutions		
	creation/maintenance of jobs	high market potential for lactic acid	solution for using grassland		
	market potential		improvement/maintenance of cultural landscapes		

Analysis of sector development

Over the coming years, Europe's agricultural sector will face new realities in terms of market developments, international trade rules, consumer preferences, in addition to the new situation arising as a result of enlargement which will affect both agricultural markets and rural economies.

Technology, policy, cultural and organisational developments could be considered as interdependent activities of society and will influence the development of the agricultural sector. It is important that the investigation of interfaces between these different activities is able to use positive synergy effects and avoid negative rebound effects of interactions. Rebound effects are disincentives caused by incentives. As an example, the increase of water prices seems to be a solution for the improvement of irrigation systems. The higher efficiency permits saving of natural resources, but it is only the trade off between labour and cost that is relevant to farmers when resources have almost zero value. However, a high increase of water prices to achieve better water management could prevent farmers investigating innovative irrigation methods. Another driving force with critical impacts is the subsidies for biomass production for energy use which could be a serious barrier to the development of biomass production for other non-food products.

The shaded fields in figure 2 show that Field A and D for cleaner production policy and sustainable strategies for agriculture evolve in an interface between technology and policy development. These activities interact with general agricultural policy. In the past, agricultural and trade policies in many cases have caused environmental harm and disincentives for the diffusion of clean technologies in this sector by distorting price signals through, for example, linking support to agricultural commodities, encouraging farming on environmentally fragile land and lowering the costs of inputs such as energy and water. The impact of Field C referring to technology development for agro-chemicals and other innovations in the agricultural sector with marginal or no consideration of environmental or social factors has also to be considered.

The intensity and dynamics of the interactions vary in different countries. As an example, voluntary agri-environmental measures in the agricultural sector of new member states may slow down the dynamics of development and implementation of cleaner technologies in these countries more than in other European countries. Voluntary agreements could be used at this stage to compensate, based on quality of products, those farmers who voluntarily agree to fulfil strict environmental conditions going beyond good farming practice. Supports by means of hectarage payments are a strong incentive for establishing big farms.

These examples show that although EU and national support schemes and the availability of financial resources are cited generally as an important factor for agri-environmental activities, the critical character of these drivers and possible disincentives has to be taken into account.

Other most cited driving forces for adoption of sustainable farm technologies for the food sector are a stronger food safety system, pressure from consumers, non-government organisations, the media and the public, the role of general food shops in promoting organic products, and the degree of coordinated actions by a range of actors. In addition the trade off between investments for efficient resource consumption or feeding measures and costs of resources, agro-chemicals and feed have an important impact on the implementation of clean technologies in the agricultural sector.

The key issues for the investigation of the non-food sector are competition between resources and strategies for biomass production, the role of price instruments in comparison to specific regulations, external effects of energy policy and interactions with the energy sector as well as the importance of landscape maintenance in Europe.

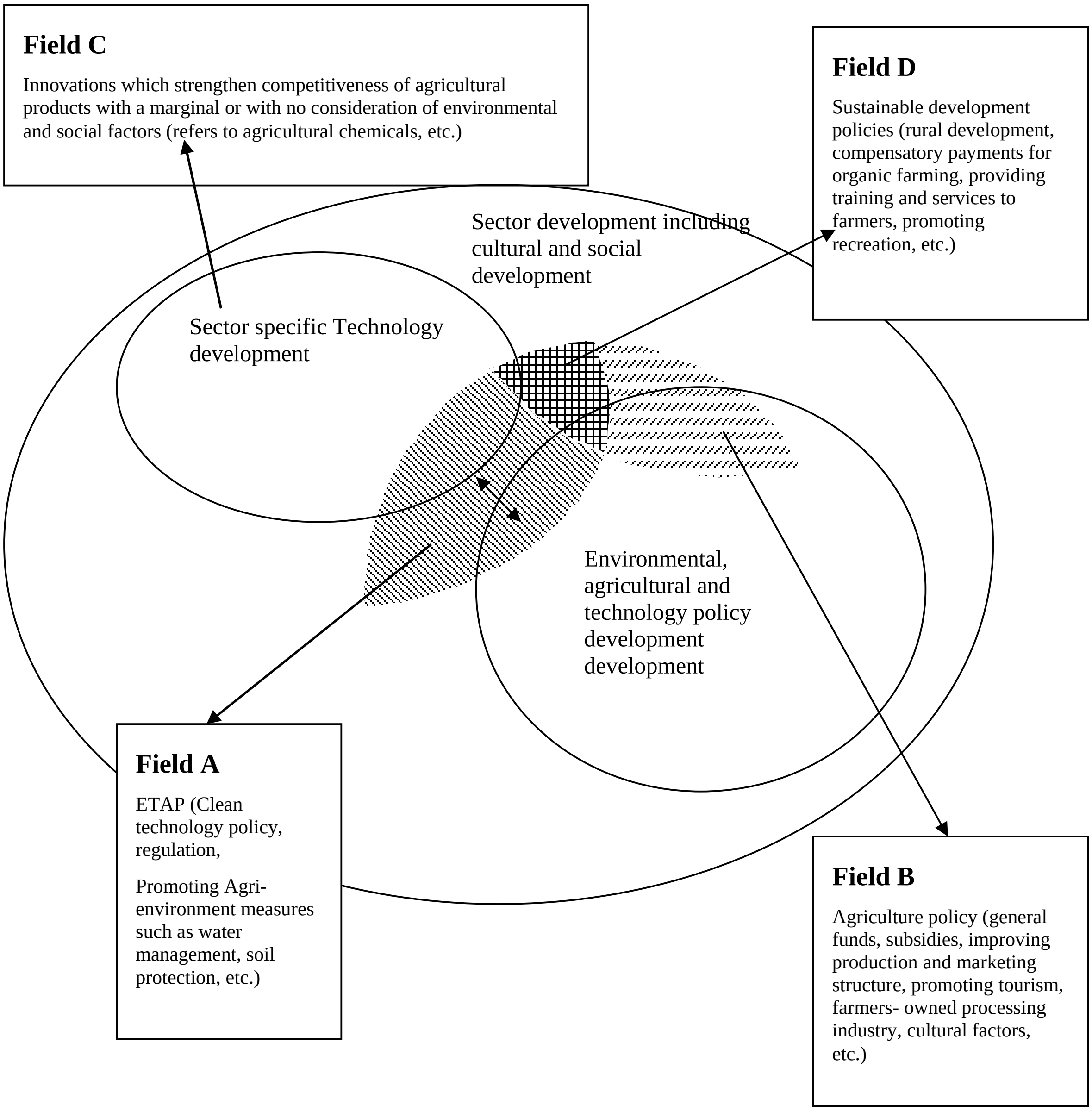

Figure 2: Interaction fields of sub-systems technology, sector and policy development in society

The shaded fields in figure 2 represent areas between different activities involving different actor groups. It is important to identify all relevant actors and investigate the expectations of these actors and their role on the development of clean technologies.

The next section contains some general and specific data and information on the agricultural sector.

1.19 Some general information on Agricultural sector in EU and OECD countries

"Agriculture's contribution to gross domestic product is under 4 % for most OECD countries (holds also for EU except for Greece about 9%, Hungary and Poland between 6-7%). The future expansion in Production may heighten the pressure on the environment through intensification and growth in farm output, particularly for exporting countries. Agricultural employment as a share of total employment is now less than 7 per cent for most OECD countries (holds also for EU except for Greece about 20%, Poland 19%, Ireland about 9% and Portugal 13%). Farm numbers have declined in most OECD countries with a corresponding increase in farm size, leading to the concentration of production in a small number of larger farms.

Support to OECD agriculture is high, but with wide variations in the level, composition and trends among countries and commodities. Agricultural support in OECD countries has been mainly delivered through higher market price support for commodities, direct payments to farmers and subsidised prices for inputs such as fertiliser, pesticides, water and energy as well as subsidised credit, structural investment and infrastructure development." (OECD 2001b)

1.20 Specific information on Spain, Germany, Netherlands, Austria, United Kingdom and Sweden

Spain: (E1 Unit-DG Agriculture 2002) There is an increased demand of Mediterranean quality food products (an expanding food industry in its turn requires a stable agricultural production). There is technological innovation in the sector of irrigation. There are new opportunities for diversification of the agricultural activities (within craft, processing and packaging of products, rural tourism, etc.). 67% of the total water demand in Spain is for irrigation. 3,3% million hectars are under irrigation, or 13% of the utilised agricultural area (UUA). A continuous work is carried out to reduce the negative effects (over-use of groundwater supplies, the water becoming salt by disturbed ground water levels or polluted by nutrients and pesticides, erosion of the soil and damage to wetlands and natural habitats) at European and national level.

Germany: (DG-Agriculture 2000d) The natural conditions for agriculture in Germany vary widely. The cultivated area stretches from the north German plain to the mountains in the south over 2000 high. The differences in soil quality and climate are just as pronounced. In the Länder of the former west Germany, small and medium-sized family-run farms dominate, and almost 60% are subsidiary earning holdings. The restructuring process in the new Länder, which began after unification, has almost been completed, with 28000 farms. More than 54% of the total surface area of Germany is utilised agricultural land (193 271 km2). The annual value of output of agricultural produce is around DEM 84 billion.

The Netherlands: (DG-Agriculture 2000c) Agriculture area in the Netherlands is set to decline further to meet the needs of urbanisation, nature reserves and recreation areas. Daring and horticulture are the largest sectors in terms of farm numbers, arable crops are found more in the north and intensive livestock in the south and east. Dutch producers are generally open to change and ready to invest in the future to make the most of scarce resources, but agricultural employment is declining and diversification is vital. New employment in the countryside and better access to services are needed to improve the quality of rural life. The intensive nature of much of Dutch agriculture has caused environmental damage, notably in terms of natural resources and water systems. The improvement is needed in water quality and management.

Austria: (DG-Agriculture 2000a) 8 million populations, 43% live in rural areas. Land area: 83 858 km2. 70% of usable agriculture area is classified as Less Favoured Area. 60% of land lies in the Alps. Austria's rural areas offer relatively low pollution and a traditional farmed landscape with a high proportion of forest, providing a strong basis for tourism. The majority of agricultural holdings are family run and small/medium size. 66% are part-time. Agricultural employment is relatively low (1997: 4.5%) and new opportunities are vital to the viability of remote communities. The natural handicaps to agriculture in much of Austria have caused environmental problems through either abandonment of land or over-intensive farming. The remoteness of some areas is a barrier to new economic developments and co-operative initiatives in marketing farm produce. The infrastructure costs of maintaining rural communities are high and making holding more competitive in particularly in this type of countryside.

United Kingdom: (DG-Agriculture 2000b) Land area: 130 410 km2 . Population: 49.3 million, of which around 255 live in rural areas and this percentage is growing. Approximately 20% of agricultural land is classed as Less Favoured Areas. The economic importance of agriculture has been steadily declining and now accounts for 1% of GDP. The fall in farm incomes has been particularly dramatic over the last three years (-60%), making diversification of farming activities all the more pressing. Agriculture, fishery and forestry employ around 430 000 people, of which between one quarter and one third are women, which is significant since it is often women who take the lead in farm diversification ventures. In 1997/98 nearly 25% of farmers received income from a source other than farming. Agricultural practices and urban and industrial development have led to loss of semi-natural habitats and biodiversity.

Sweden: (DG-Agriculture 2003) The scope for agricultural activities of various kinds differs a great deal between the north and south of the country (1572 km separating the extreme north from the extreme south). The prospects for farming are indeed less favourable in northern Sweden than the rest of the country. The farms are usually small in the northern parts of the country, whereas most of the large farms are located on the southern plains. Accordingly, the highest productivity is found in southernmost Sweden and in the plains of central Sweden.

Unlike farmers in many other European countries, the farmers of Sweden are involved, through their co-operative societies and associations, in the further processing and marketing of agricultural products. The farmer-owned processing industry is predominant in Sweden with for example farmers´ co-operatives holding 99% of the market in milk-processing and Swedish Meats carries out some 65% of all slaughtering in Sweden. On the dairy side, the predominance is virtually total, and also in the case of grain the farming co-operative movement is the market leader. Although nowadays less than 2% of Sweden´s labour force works in agriculture, agriculture is still an important sector of the Swedish economy.

In 1994, there were about 91,000 people economically active in farming, including people having other related businesses (forestry hunting, fishing, etc.). In 2000, this number fell to 77,000, or 1.9% of the total, 59,000 being active only in farming. In addition, approximately 60,000 people are employed in the food industry.

Nearly all Swedish farms are family businesses. Part-time farming, with income supplement by other employment, has become increasingly common. Structural developments in agriculture over the last few decades have led to fewer but larger farms.[26] Despite the sharp reduction in the number of farms and crop acreage, production has increased, and with the exception of a few products, Sweden is self-sufficient in agriculture. In pace with ever-bigger investments in machinery and equipment, farmers have tended to specialise in fields such as grain, milk production and pig rearing.

1.21 Specific information on the New Member States

After the re-privatisation process the average size of agricultural land has become very small, small-holders are struggling with financial problems not being able to buy the needed machinery formerly available in the cooperatives. This has caused land-abandonment of some time (causing problems like spreading of the allergenic common ragweed <Ambrosia artemisiifolia, L.>), and the fertiliser and pesticides use have also dropped significantly – a beneficial trend for the environment. Retailer price of agricultural products are relatively low despite the high consumer prices, which creates tensions.

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[26] In 2001, about 34% of farms covered less than 10 ha, 31% between 10 and 30 ha and 35% occupied more than 30 ha. Since 1996, the number of holdings covering less than 100 ha has decreased every year while holdings occupying more than 100 ha increased (nearly 8% were over 100 ha in 2001). The average arable land area of farms was 36,3 ha in 2001 against 31,1 in 1996.

Agriculture together with forestry generally takes the biggest parts of land from the area of each country. Taking Hungary as one example, according to the National Agri-environmental Programme and the background research aiming at developing a land-use zoning system taking into account agri-environmental considerations, the rationalization of the existing structure means a significant change in land use and intensity of farming over app. one quarter of the country territory. Such changes would affect approximately 1.5 million hectares of intensive arable land, out of which 6-700,000 should be afforested, 3-400,000 hectares turned into meadows and pastures, while on the remaining 500,000 hectares extensive farming methods should be applied.

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