



Adaptation to Climate Change in the Agricultural Sector AGRI-2006-G4-05

AEA Energy & Environment and
Universidad de Politécnica de Madrid

Executive summary

ED05334

Issue Number 1

December 2007



1 Executive summary

1.1 Study context and scope

Climate change is already happening. Regardless of international progress to reduce emissions of the greenhouse gases that cause climate change, the climate system will continue to adjust for the next few decades to past and present emissions. This will bring unavoidable impacts on natural and human systems, presenting the challenge of a second response to climate change - adaptation - to prepare for and cope with these impacts.

Climate change is a real concern for the sustainable development of agriculture, both globally and within the EU. Although agriculture is a complex and highly evolved sector, it is still directly dependent on climate, since heat, sunlight and water are the main drivers of crop growth. While some aspects of climate change such as longer growing seasons and warmer temperatures may bring benefits, there will also be a range of adverse impacts, including reduced water availability and more frequent extreme weather. These impacts may put agricultural activities, certainly at the level of individual land managers and farm estates, at significant risk.

The European Commission has recently adopted a Green Paper entitled 'Adapting to climate change in Europe – options for EU action' (COM(2007) 354). This sets out options to help the adaptation process and focuses on four priority areas, including early action to avoid damage and reduce overall costs. Adaptation efforts need to be stepped up at all levels and in all sectors, and need to be coordinated across the EU. The Commission will publish a White Paper containing more concrete policy proposals in 2008.

Climate change will add to the many economic and social challenges already being faced by European agriculture, with crop yields, livestock management and location of production likely to be affected. Adjustments to the Common Agricultural Policy (CAP) and the 'Health Check' of 2008 could provide opportunities to examine how to integrate adaptation into agriculture support programmes. Consideration might be given to the extent to which the CAP can promote good farming practices that are compatible with changing climatic conditions.

This study on 'Adaptation to Climate Change in the Agricultural Sector' aims to provide the European Commission with an improved understanding of the potential implications of climate change and adaptation options for European agriculture, covering the EU 27 Member States. It also aims to assist policy makers as they take up the adaptation challenge and develop measures to reduce the vulnerability of the sector to climate change.

The full report provides comprehensive technical analyses, together with background information and details of the methodology, literature sources and stakeholder interactions used in the study. This shorter summary presents a synopsis of the methodology approach and conclusions.

1.2 Structure of the report

The report is structured in nine chapters. This executive summary (Chapter 1) synthesises the methods and the key results and conclusions of the study. The introductory chapter (Chapter 2) defines the scope of the assessment and the objectives of the report. The background knowledge related to climate change and its impacts on agriculture is included in Chapter 3. The methodology for the study is presented in Chapter 4. The results of the specific objectives of the study are presented in Chapters 5 to 8 as follows:

- An assessment of the impacts and risks of climate change on farming activities based on current scientific research and knowledge on the physical impacts of climate change (Chapter 5).
- The potential adaptation options to increase the resilience of the agriculture sector in view of the projected impacts of climate change (Chapter 6).

- Identification of whether and how CAP instruments work towards adaptation, and potential options on how climate change adaptation issues can be integrated into the CAP (Chapter 7).

The results of the study were evaluated in a workshop and information on the evaluation is provided in Annex J. Finally, the conclusions of the study are presented in Chapter 8. The complete list of scientific and technical studies that provide background information, contribute to the discussion and support the evaluation provided in this report is included in Chapter 9. Ten Annexes (Annex A to Annex J) contain additional information to complement the results provided in the main chapters of the report.

1.3 Methodology

The study comprised a series of tasks representing a logical progression from an assessment of climate change impacts, through an analysis of risks and opportunities, and identification of adaptation options, to potential integration into the CAP.

1.3.1 Assessment of climate impacts, risks and opportunities

A wide-ranging review of the available literature covering climate change projections, agricultural modelling and impacts assessments, and other material relevant to European agriculture in the 21st Century (such as socio-economic, policy and other sectoral drivers) formed the basis of the assessment of climate impacts. From reports published since 1995, 271 relevant recent studies were selected and impacts data categorised into groups according to key issues, risks and regions. Risks and opportunities were identified in relation to projected impacts. Climate change and socio-economic projections were used to define a number of European agro-climatic zones, which served to distinguish the priority risks and opportunities (and later, adaptation options).

By prioritising the risks and opportunities arising from climate change impacts, the approach identified those that need be addressed most urgently and provided a rationale for focusing the adaptation assessment on key issues. This prioritisation was carried out in a three-stage process. First, the risks and opportunities were categorised according to agro-climatic zones. Then a semi-quantitative approach was used to assess the magnitude and likelihood of risks and opportunities. Finally, risks and opportunities were prioritised according to their combined magnitude-likelihood scores. The analysis provides some indication of the overall impact of climate change on farming across agro-climatic zones. It does not, however, provide a means for identifying the risks/opportunities that affect the most vulnerable farmers; as in many cases the literature did not provide sufficiently detailed information.

The analysis refers to a time-frame of 2050 to 2080, therefore the suggested adaptation options are relevant to projected risks and opportunities within this period. Nevertheless, due to the lack of quantified information on uncertainty in climate change scenarios, a detailed time-frame analysis is not considered in this study.

1.3.2 Evaluation of adaptation measures

The process of identifying potential adaptation measures involved three main stages:

- Analysis of relevant literature and ongoing studies to characterise adaptation measures relating to the risks and opportunities identified in the impacts assessment.
- A review of national adaptation frameworks to highlight ongoing work across the EU-27 to prepare national adaptation strategies.
- A stakeholder consultation exercise to obtain practical information on adaptation measures; this took the form of a questionnaire targeted at representatives in each of the EU-27 Member States.

For the priority risks identified at sector and farm level in the assessment of impacts, a number of possible adaptation responses (at both sector/policy level and farm level) were evaluated with respect to the following issues: technical feasibility, potential costs of implementation, cost-effectiveness, ancillary benefits, and cross-sectoral implications (e.g. water, tourism, energy). Adaptation measures were further categorised as technical (e.g. introduction of new cultivars), management (e.g. changes

in cropping patterns, soil, landscape, water), or infrastructural (e.g. changes in drainage, irrigation systems, access, buildings).

1.3.3 Examination of the role of CAP

This section aimed to analyse the potential contribution (and constraints) of the Common Agricultural Policy (CAP) and to identify policy measures that can support farmers and rural communities to tackle and facilitate adaptation. A SWOT analysis (Strengths/Weaknesses, Opportunities/Threats) was carried out on the main CAP instruments covering both direct income support payments and Rural Development measures.

1.4 Impacts, risks and opportunities of climate change on agriculture in Europe

1.4.1 Evolution of climate

- Temperatures will rise across Europe, especially during winter.
- Annual total precipitation may increase, but so will inter-season variability and evapo-transpiration. Summer rainfall is likely to be lower throughout much of Europe, with periods of intense rainfall becoming more common and less winter precipitation falling as snow.
- Although difficult to forecast, the incidences of extreme weather events is likely to rise in a warmer climate. This will mean more flooding, higher winds, destructive precipitation events and longer periods of drought.
- Sea level is predicted to rise by as much as 5m. One effect of this is likely to be the salinisation of water resources in coastal areas.
- Atmospheric levels of CO₂ and ozone will rise.

1.4.2 Evaluation of climate change impacts and risks: general trends

The combination of long-term changes and the greater frequency of extreme weather events is likely to have adverse impacts on the agricultural sector. Changes in hydrological regimes will directly impact agricultural production and production methods. Reductions in crop yield and quality as the result of reduced water availability and precipitation variability could result in a loss of rural income. This loss of income will be further exacerbated by the need for increased spending as a result of damage caused by extreme weather events.

Too much water

Heavier winter rain and the decreased proportion of winter precipitation falling and being stored as snow will increase the occurrence of floods, damaging crops at vulnerable stages of development and disrupting farm activity.

Excessively wet years may cause declining yields as a result of waterlogging and increased pest and disease problems.

Intense rain and hail-storms can affect yield and quality of vulnerable crops, such as soft fruits.

Sea level rise will directly impact some agricultural land, contribute to greater pressures via changes to land use around urban areas and increase the salinity of some water resources.

Too little water

Reduced water availability may lead to insufficient water available for irrigation, crops suffering from heat and drought stress, and increased competition for water resources may result in higher prices and regulatory pressure.

Increased manure and fertiliser applications (as a response to reduced nutrient uptake), may lead to a reduction in water quality as nutrients and other leachates are not sufficiently diluted by rainfall.

Drought will lead to soil degradation, which is a major threat to the sustainability of Europe's land resources and may impair the ability of European agriculture to successfully adapt to climate change.

Increased salinity may result in land abandonment as it becomes unsuitable for cropping.

The challenge to adapt

Varying seasonality and inter-annual variability will affect crop cycles and farm management, affecting yields and rural economies.

Temperatures are expected to rise beyond the optimum growing conditions for many common crop species.

Increased concentrations of tropospheric ozone are expected to reduce crop yields.

The delineation of agro-climatic zones is likely to change, leading to the loss of some indigenous crop varieties, regional shifts in farming practices and to shifts in optimal conditions for pest species and disease types.

Potential advantages

In some regions a positive relationship between temperature and crop yield is forecast, with higher temperatures and increased CO₂ concentrations producing greater yields. However, an insufficient supply of water or nutrients, coupled with increased weed competition is expected to frequently negate the fertilizing impact of higher CO₂ levels.

New crops such as soya could be grown in future conditions to produce livestock feed. However, warmer and drier climatic conditions may also reduce forage production leading to changes in optimal farming systems and a loss of income in areas dependent on grazing agriculture.

1.4.3 Risks and opportunities in Europe's agro-climatic zones

In the **Alpine, Boreal, Atlantic north** and **central** and **Continental north** zones, risks relate mainly to potential changes in precipitation patterns, with projected increases in winter rainfall and decreases in water availability in summer. Hence strategies are needed to reduce the effects of winter flooding, water logging and reduced water quality, while implementing measures for capturing and storing water to ensure adequate supply during the summer.

Mountain **Alpine** regions are particularly vulnerable as temperature increases are expected to be above average and other climate change impacts, such as decreased snow cover and glacial retreat, may have further impacts on hydrological cycles in many river basins.

In the **Alpine, Boreal, Atlantic**, and **Continental north** agro-climatic zones, a lengthened growing season and an extension of the frost-free period may increase the productivity of some crops and enhance the suitability of these zones for the growth of other crops. However, these changes will only be possible if there is sufficient water available.

Rising sea levels are a particular risk in the **Atlantic central** zone, requiring either improved defences or the abandonment of land due to inundation and saline intrusion. Hard defences are extremely expensive and not necessarily cost-effective, so farm-level measures should be considered in the context of wider Integrated Coastal Zone Management plans.

Whilst influxes of new pests and diseases present a high risk in the **Boreal, Atlantic central**, and **Continental north** zones, there is likely to be considerable opportunity in these zones for increased

agricultural production. The yields of current crops are set to increase, together with the area of potentially productive land. There are also opportunities for the introduction of new crops types, and may be potential for increased livestock production in some zones. However, there is also a possibility that optimal growing conditions may shift from areas that have a large proportion of fertile soils towards those where soils are less fertile and, therefore, less able to produce higher yields.

In the **Atlantic south**, **Continental south** and **Mediterranean** zones, the greatest risks could derive from reduced crop yields and conflicts over reduced water supply. Strategies need to be developed to adopt cultivars or crops better suited to water- and heat-stress. Problems from new pests and diseases are also considered a high risk in these zones. There are few opportunities, although in parts of the **Continental south** zone (for example, Hungary or Romania), there may be some scope for the introduction of new crops.

Climatic changes, in general, are likely to shift the zones of optimal production areas for specific crops in the EU and altered carbon and nitrogen cycles may have significant implications for soil erosion and water quality in all zones. Temperature increases tend to speed the maturation of annual crops, therefore reducing their total yield potential. In turn, such changes in productivity and zonation may affect the total agricultural output of the EU and its share of international commodity trading.

Table A below summarises the risks and opportunities according to the current distribution of the defined agro-climatic zones.

Table A. Summary of risk and opportunity prioritisation by agro-climatic zone

Description	Bor	Atl N	Atl C	Atl S	Cnt N	Cnt S	Alp	Md N	Md S
Risks									
Crop area changes due to decrease in optimal farming conditions		M	M	M	M	M	M	M	H
Crop productivity decrease		M	M	M	M	M	M	M	M
Increased risk of agricultural pests, diseases, weeds	H	M	H	H	H	H	M	H	H
Crop quality decrease			M	M	M	M		M	H
Increased risk of floods	H		H		H		H		
Increased risk of drought and water scarcity		H	H	H	H	H	H	H	H
Increased irrigation requirements				M		H		H	H
Water quality deterioration	H	H	H		H		H		
Soil erosion, salinisation, desertification	H			M		H	H	H	H
Loss of glaciers and alteration of permafrost	M						H		
Deterioration of conditions for livestock production	H	H	H	L	H	L	H	L	M
Sea level rise	H	H	H	H	H			H	H
Opportunities									
Crop distribution changes leading to increase in optimal farming conditions	H	H	H	M	H	H	H	M	
Crop productivity increase	M	H	M	M	M		H		
Water availability	H	M	H	H	H		M		
Lower energy costs for glasshouses	M			M	M	M		M	
Improvement in livestock productivity	H	H	H		H		H		

H=High M=Medium L=Low

1.5 Options for adaptation in European agriculture

The different agro-climatic zones not only face different impacts, risks and opportunities, but will also have different adaptation options for the same risks because of inherent socio-economic constraints and adaptive capacity.

The review of national adaptation strategies highlights the current policy focus on reducing the risk of flooding, either from sea level rise or from increased runoff. There are also proposals, mainly from southern member states, to increase capture and storage of water to ensure adequate supplies. While some mention is made of such measures in northern states, it is important that these are promoted more widely as the prospect of drought may be viewed with some scepticism, particularly in those member states accustomed to receiving a large proportion of their annual precipitation in summer. However, as precipitation patterns change, limited capacity for water storage may need to be increased to capture a greater proportion of winter rainfall.

The stakeholder survey results revealed reasonable consistency across all nine agro-climatic zones. The responses differed in terms of projected impacts, however. For example, there is a higher likelihood of drought in the southern Mediterranean zone as opposed to the north, with a corresponding difference in the need for irrigation. In general, there was a greater awareness and greater adoption and/or consideration of adaptive measures in the southern agro-climatic zones than in the north. This reflects a greater likelihood of adverse impacts on crop production in these zones and hence a greater urgency to take adaptive action, insofar as is possible, or to seek alternative modes of production.

Despite the apparent lower appetite for adaptation in northern regions, measures clearly need to be implemented to lessen the negative impacts of climatic changes. Furthermore, there are likely to be opportunities for increased agricultural production. If these potential increases are to be realised, a more active approach to identifying and promoting adaptation measures may be needed.

1.6 Potential role for the Common Agricultural Policy in adaptation

The contribution of current CAP measures towards adaptation was evaluated in order to consider how existing policy instruments may be continued or extended to facilitate adaptation. The analysis also aimed to reveal where policies may present a barrier to adaptation or lead to 'mal-adaptation'.

Using the CAP

Supplementing current **Statutory Management Requirements** with new legislation that addresses climate-related impacts would create stronger incentives for Single Payment Scheme claimants to adapt.

The flexibility that Member States can exercise in determining **Good Agricultural and Environmental Condition** standards allows for highly appropriate and localised management practices that assist with adaptation. The potential of GAEC's would be maximised by requiring member states to identify major environmental pressures, which may include climate impacts, and justify the inclusion or exclusion of corresponding standards.

Member States should be required to make provision for training farmers on climate change issues, particularly new entrants such as young farmers. Developing the role and scope of the **Farm Advisory System** would be a feasible option for effective knowledge transfer.

The Rural Development Programmes have the potential to benefit further by guiding or placing an obligation on member states to meet or consider the impacts of future climate change across all axes.

- **Agri-environment schemes** have the potential to support many adaptation initiatives.

- To ensure investments made through Axis 1 and 3 bring benefits in terms of adaptation, **linking funding to cross compliance** should be explored
- Mitigation to climate change is explicitly mentioned throughout the Rural Development regulations. This could be expanded to include adaptation.
- Adaptation to climate change will be needed at all spatial levels. The Rural Development measures can do this through careful **co-ordination from the grassroots** Leader programme all the way up to integration with river basins through the Water Framework Directive.
- Adjusting the **criteria** for those eligible for rural development support for areas with high vulnerability to climate change may be an option to facilitate their adaptation.

In addition to existing CAP instruments, **insurance** needs to be considered and encouraged to allow farmers to increase their resilience to climate change. This may provide further incentives for farmers to adapt their business and buildings in order to reduce their premiums.

1.7 Conclusions

Summary of risks and opportunities across the agro-climatic regions

- In the Alpine, Boreal, Atlantic north and central, and Continental north zones, risks relate mainly to potential changes in precipitation patterns, with projected increases in winter rainfall and decreases in water availability in summer.
- Whilst influxes of new pests and diseases present a high risk in the Boreal, Atlantic central, and Continental north zones, there is likely to be considerable opportunity in these zones for increased agricultural production.
- In the Atlantic south, Continental south and Mediterranean zones, the greatest risks are reduced crop yields and conflicts over reduced water supply.

Adaptation options

Farmers have always adapted to changes in climate. The challenge now is to adapt within very short periods of time to potentially extreme impacts and new risks and opportunities. This will be achieved through a combination of managerial, infrastructural and technical measures.

In general, there seems to be greater awareness and greater adoption and/or consideration of adaptation measures in the southern agro-climatic zones than in the north, which is likely to be due to the higher prevalence of negative risks in southern areas.

Measures to adapt crop and livestock production, in particular to take advantage of the potential gains in productivity forecast for northern regions, need to be given greater attention. Simultaneously, there is a need for EU measures to help farmers cope with the forecasted loss of agricultural production in southern regions. While in a global economy it might be argued that the market should be left to resolve such issues, it must also be remembered that social and environmental issues are closely imbedded in this issue, which may falter without any support.

Many of the possible adaptation measures to address the risks and opportunities identified in the nine agro-climatic zones can be applied at farm level, with a significant proportion being management-related. However, before many of these adaptation initiatives can be implemented, short-term measures involving policy development, knowledge transfer, assessing adaptation costs and establishing relevant partnerships must first be put in place. Existing CAP mechanisms can be used to stimulate and facilitate adaptation and other mechanisms must also be utilised, such as insurance, capacity building, networks and partnerships.

The Gemini Building
Fermi Avenue
Harwell International Business Centre
Didcot
Oxfordshire
OX11 0QR

Tel: 0845 345 3858
Fax: 0870 190 6318

E-mail: info@aeat.co.uk

www.aea-energy-and-environment.co.uk

 **AEA Energy & Environment**
From the AEA group