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WHITE PAPER

Adapting to climate change: Towards a European framework for action

Adapting to climate change: the challenge for European agriculture and rural areas

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COMMISSION STAFF WORKING DOCUMENT

Adapting to climate change: the challenge for European agriculture and rural areas

1. INTRODUCTION

Over the coming decades agriculture will be influenced by climate change both globally and within the EU. Even though EU agriculture is technologically developed, its capacity to deliver food and to contribute to ecosystem services for the European society is directly dependent on climatic conditions. European farmers will need to define their strategies for production, farm management and investment in face of increasing uncertainty.

Climate change is one of the many drivers that shape European agriculture and rural areas. Socio-economic factors, international competition, technological development, as well as policy choices will determine the impact that agro-climatic changes will have on the EU agricultural sector. As farmers manage the majority of land in the EU, the Common Agricultural Policy (CAP) has a role to play in facilitating adaptation to the changing conditions by helping farmers to adapt their production to the changing climatic situation and to provide wider ecosystem services dependent on land management.

The White Paper 'Adapting to climate change'[1] lays out a European framework for action to improve Europe's resilience to climate change, emphasising the need to integrate adaptation into all key European policies and enhance co-operation at all levels of governance.

Complementing the White Paper, this document summarises the main impacts of climate change on EU agriculture, examines adaptation needs, describes the implications for the CAP and explores possible orientations for future action. It aims at further engaging Member States and the farming community into a debate and action on adaptation needs that result from climate pressures.

2. CLIMATE CHANGE: KEY CONCERNS FOR EU AGRICULTURE

2.1. Impacts on agricultural production

Climatic changes will have complex effects on the bio-physical processes that underpin agricultural systems, with both negative and positive consequences in different EU regions. Rising atmospheric CO_2 concentration, higher temperatures, changes in annual and seasonal precipitation patterns and in the frequency of extreme events will affect the volume, quality and stability of food production and the natural environment in which agriculture takes place. Climatic variations will have consequences for the availability of water resources, pests and diseases and soils, leading to significant changes in the conditions for agriculture and livestock production. In extreme cases, the degradation of agricultural ecosystems could mean desertification, resulting in a total loss of the productive capacity of the land in question.

[1] COM(2009) 147.

In the short term the frequency and intensity of extreme weather events and seasonal variations in precipitation patterns are the factors likely to have the most serious consequences for agriculture. There are wide geographical variations in the expected climatic conditions over the twenty-first century. Some areas will have simultaneous negative and positive effects with unknown net results, as the crop responses to climatic variations are still not well understood. Although climate change is a global process, its local impacts are diverse. Overall net effects on farm activities will vary across the EU and between farm types within the same region.

Annex 1 summarises the main aspects and impacts of climatic changes in different EU regions.

Crops

Some aspects of climate change such as warmer temperatures, enhanced photosynthesis due to more CO_2 in the air and longer growing seasons can have moderately positive effects on the productivity of arable crops in some areas, at least until mid-century. In northern regions yields may increase and the range of possible crops may become wider, but these benefits will only emerge from a low level of temperature increase, and are highly uncertain. Further warming will be increasingly detrimental because plant growth and yields are conditioned by temperature thresholds linked to the key reproductive stages. The acceleration of the vegetative cycle can have negative effects on grain filling and quality.

A range of adverse impacts can be expected from the increased inter-annual and seasonal variability of rainfall, with an expected reduction of summer rainfall in southern EU and a rise in the intensity of winter rainfall in central and northern EU. Extreme weather conditions, such as heat waves and droughts may severely disrupt production, in particular during critical phases of crop growth.

The production of vegetables is highly sensitive to water availability and to even minor stress related to temperature outside the optimal range, making this type of production highly vulnerable to climatic changes.

For perennial crops extreme events represent a serious risk as they can affect production capacity over several years. Perennial cultivations are also affected by the move forward in time of the phenological phases, while having fewer possibilities than arable crops to adapt by changing the calendar of farming operations.

Many fruit trees are susceptible to spring frosts during the flowering period and winter temperature plays a significant role in productivity. As warmer temperatures will advance both the date of the last spring frosts and the date of flowering, the risk of damage is likely to remain largely unchanged. The risk of damage caused by early autumn frosts is likely to decrease, while water need is likely to rise. Difficulties related to pests and diseases are expected to increase.

Impacts on the wine sector include a higher risk of frost, a shortening of the ripening period, water stress, which can be highly damaging at the maturity stage, and changes in pest and disease patterns. The European area suitable for wine and olive production may expand north and eastwards. In the current production areas the variability of fruit production is likely to become higher.

Livestock

Dryer conditions and rising temperatures will affect livestock activities in different ways, including implications for animal health and welfare. Climate change has a complex influence on the livestock sector due to the great diversity of production systems in the EU.

Warming and extreme events, such as heat spells, will have direct impacts on animal health, growth and output, as well as on reproduction. There will also be indirect effects through changes in the productivity of pastures and forage crops, and in the distribution of animal diseases.

Highly adverse impacts are likely to be felt in extensive grazing systems which are directly dependent on climate conditions for the provision of feed and shelter. In Mediterranean areas warmer temperatures and summer precipitation deficits will shorten the grazing period and decrease forage production and its quality. In the North-Western humid areas moderate warming can, however, be beneficial to livestock activities in the short to medium term because of the productivity increase of pastures.

2.2. Economic effects of climate-related risks

At EU level, no correlation has been established between the warming of the last decades and the level of crop yields, which have generally increased. The effects of technology and farm management improvements and continuous adaptation of farming practices have so far largely outweighed the impact of climate change. However, the variability of crop yields has increased since the beginning of the century as a consequence of extreme climatic events, such as the drought and summer heat of 2003 and the spring drought of 2007.

Most assessments anticipate that at the overall EU level the expected changes in mean climatic variables will be beneficial for agricultural production for the next three decades. Increasingly negative impacts can, nevertheless, be expected earlier than mid-century from extreme events. In addition to disrupting annual production, climate extremes can severely affect farm infrastructure causing major economic losses.

Although forecasts of climate change impacts on agricultural productivity and prices are uncertain, it is expected that the increase in extreme events will have consequences on the volatility of agricultural production because of weather-related supply shortfalls. Even though the ultimate impacts on farm income depend on the interplay of many factors such as the global market and policy support, the higher likelihood of failures in production may lead to increasing instability in the economic situation of farmers affected by extreme climate events.

2.3. Wider climatic risks for rural areas

Rural areas are exposed to a wide range of impacts from climatic variations, beyond those directly affecting agriculture. These include increased risk of flooding, particularly in Central and Northern regions, and risks for damage to infrastructure due to other extreme events. Increasing competition for water between different uses will also concern rural population and economies.

Forest ecosystems and forestry are important in many rural areas. Climatic changes will lead to increased risk of disturbances through storms, fire, and outbreaks of pests and diseases with implications for forest growth and production. This will affect economic viability of forestry,

mainly in southern areas, and the capacity of forests to provide environmental services, including the carbon sink function.

The trend towards reduction of snow cover in mountainous areas will have negative consequences for winter tourism and on rural economies dependent on income from tourism. This can also be the case for areas facing water shortages, while a warmer climate can bring new tourism opportunities for rural areas in other parts of the EU.

2.4. Adaptive capacity, vulnerability, and regional differences

Adaptation to weather conditions has always been part of farm management and to some extent adaptation to climate change follows the same principles as adaptation to short-term oscillations. Adaptation of agronomic techniques and farm strategies is already happening. In the coming decades, however, the magnitude of climatic changes may exceed the adaptation capacity of many farmers.

The vulnerability of farming varies across the EU depending on the exposure to adverse climate impacts and on the socio-economic context. Existing agro-ecological conditions and the experience in dealing with changing conditions influence farmers' adaptive capacity. Socio-economic factors defining **resilience** include:

– Farm characteristics such as production type, size of the farm, level of intensity;

– Diversity of cropping and livestock systems, and the presence of other income sources apart from agriculture;

– Access to relevant information, skills and knowledge about climate trends and adaptive solutions; the role played by advisory services in facilitating adaptation;

– General socio-economic situation, farmers with limited resources or living in remote rural areas being most vulnerable;

– Access to available technology and infrastructure capacity.

The uneven effects of climatic changes are expected to amplify regional differences and exacerbate economic disparities between European rural areas. In the long run, climatic pressures may lead to further marginalisation of agriculture or even to the abandonment of agricultural land in some parts of the EU, while others could see an improvement in agricultural conditions and farm incomes. This could significantly affect landscapes and biodiversity and influence the overall development of European regions.

2.5. Global impacts on agriculture and food security

Climate change brings an additional perspective to the global challenge of increasing agricultural production to keep pace with projected population increase, guaranteeing food security and rural livelihoods while keeping high standards of environmental protection across the world.

In low-latitude world regions, where most developing countries are situated, even limited additional warming will reduce crop yields and trigger higher yield variability with serious local consequences for food security. Negative effects on agricultural yields will be

exacerbated by more frequent extreme weather events. This is likely to increase the dependence on food imports and the number of people at risk of famine.

At higher latitudes increasing productivity is expected to be predominant in the next few decades. Despite the regional changes in production, overall global food production in the coming two or three decades will not be threatened and is expected to keep pace with the increasing food demand of the growing world population. However, existing projections do not always fully account for some of the risks of extreme climate events and outbreaks of pests and diseases, which could worsen the current picture regarding climate impacts on productivity in both developed and developing countries. Furthermore, by the second half of this century global agricultural productivity may start to decrease.

The combination of changes in the agricultural production potential in different world regions and increased incidence of extreme events could lead to greater variability of production, contributing to increased volatility of prices and changes in trade flows.

3. ADAPTATION OF EU AGRICULTURE TO CLIMATIC CHANGES

Adaptive measures in agriculture range from technological solutions to adjustments in farm management or structures, and to political changes, such as adaptation plans. In the short-term autonomous farm level adaptation may be sufficient, but in the longer run adaptation in the form of technological and structural changes will become necessary. This will require planned strategies based on analysis of local and regional conditions.

3.1. Farm-level adaptation

Constant evolution of crop patterns, farm management practices and land use are observed across the EU, partly in response to climatic variation. Such farm-level adaptations aim at increasing productivity and dealing with existing climatic conditions, and draw on farmers' current knowledge and experience. Over the next decades, adaptation may need to go beyond mere adjustments of current practice. Possible short to medium term **adaptive solutions** include:

– Adjusting the timing of farm operations, such as planting or sowing dates and treatments;

– Technical solutions, such as protecting orchards from frost damage or improving ventilation and cooling systems in animal shelters;

– Choosing crops and varieties better adapted to the expected length of the growing season and water availability, and more resistant to new conditions of temperature and humidity;

– Adapting crops with the help of existing genetic diversity and new possibilities offered by biotechnology;

– Improving the effectiveness of pest and disease control through for instance better monitoring, diversified crop rotations, or integrated pest management methods;

– Using water more efficiently by reducing water losses, improving irrigation practices, and recycling or storing water;

– Improving soil management by increasing water retention to conserve soil moisture, and landscape management, such as maintaining landscape features providing shelter to livestock;

– Introducing more heat-tolerant livestock breeds and adapting diet patterns of animals under heat stress conditions.

Individually or in combination these solutions have substantial potential to counterbalance adverse climatic changes and to take advantage of positive ones. Many of these adaptation options can be implemented by farmers today or in the near future, provided that they have sufficient knowledge and guidelines. However, climate risks are only one aspect influencing farmers' decisions, which involve many other socio-economic and market considerations.

Coping with the increasing climatic variability will be more difficult than adjusting to gradual changes in mean climatic variables. This may require greater attention to ensuring stability and resilience of agricultural production and farm incomes in vulnerable regions. Diversifying farm activities and income sources, with fundamental changes in farm structures and in some cases, additional investments, may become necessary.

3.2. Sectoral-level adaptation

Autonomous farm level adaptation may find its limits as climate change impacts gradually become more drastic. Sector-wide responses tailored to the diversity of regional and local agriculture and steered by public authorities may be needed to facilitate a broader range and better coordinated adaptive action, and to help avoid maladaptation, which could have serious environmental and economic consequences.

National and regional adaptation strategies can provide a coherent framework for enabling adaptation. EU Member States are at different stages of preparing and developing national adaptation strategies, including for the agricultural sector. Adaptation strategies can enhance farmers' awareness of the projected changes, encourage early action and facilitate appropriate responses and solutions with long temporal viability. The social partners in agriculture can be conducive to such adaptation strategies and should be involved in this process.

Sectoral-level adaptation action may include:

– Identification of vulnerable areas and sectors and assessment of needs and opportunities for changing crops and varieties in response to climate trends,

– Support to agricultural research and to experimental production aiming at crop selection and development of varieties best suited to new conditions,

– Building adaptive capacity by awareness raising and provision of salient information and advice on farm management,

– Enhancing investment in improved efficiency of irrigation infrastructure and water use technologies, as well as management of water resources,

– Developing irrigation plans based on thorough assessments of their impacts, future water availability and water needs of different users, taking account of the balance between demand and supply

– Developing risk and crisis management instruments to cope with the economic consequences of climate-driven events.

Sector-wide planning and advice are needed because some of the measures for adjusting to new climatic conditions are likely to be costly and need significant investments by farmers. Also, some adaptation measures may help to maintain farmers' income in the long term, but entail a higher risk in the short term. For instance the use of new varieties or new crops may require specific technologies or marketing, which will need time to develop successfully.

Adaptation planning is challenging because of uncertainties in climatic developments and their locally specific impacts, which makes it difficult to identify the optimal changes in agricultural systems. To be successful adaptation planning must start early and be flexible to deal with the uncertainties.

4. CAP – CONTRIBUTING TO ADAPTATION

Projected climatic developments may affect the achievement of CAP objectives of ensuring availability of sufficient food at reasonable prices, contributing to the viability of farming and rural areas, and promoting environmentally-friendly farming practices. The key objectives of adaptation for EU agriculture are to ensure resilience to climatic variations, socio-economic viability of agriculture and rural areas, and coherence with environmental protection objectives.

The present CAP provides a basic level of income security to farmers as well as a framework for sustainable management of the natural environment in which agricultural activity takes place. The shift from support linked to production to decoupled aid enables farmers to respond to external requirements, to market signals as well as to developments resulting from climate change. Rural development policy offers the Member States a range of measures through which they can provide targeted support to activities that contribute to adaptation to climatic changes.

The CAP "Health Check" represents a further step in the direction of sustainable agriculture with specific emphasis on climate change mitigation and adaptation, water and biodiversity protection, for which further rural development funding has been agreed. The challenge and opportunity for the EU and its Member States in the period up to the end of 2013 is to make the best possible use of the CAP tools available to support adaptation.

5. ORIENTATIONS FOR AN ADAPTATION STRATEGY IN AGRICULTURE

5.1. Prioritising "no regret" measures

In face of the inherent uncertainties, prioritising "no regret" options for adaptive action will ensure the most cost-effective approach. These are choices which help cope with a broad range of plausible changes and induce socio-economic or environmental co-benefits. In the agricultural sector this means enhancing resilience of the agricultural ecosystems by more sustainable use of natural resources, in particular water and soils. By protecting the natural resource base on which agriculture depends the sector can better build resilience to climatic changes. Such responses will ensure that management decisions implemented over the next decades do not undermine the ability to cope with potential larger impacts later in the century.

As indicated in the White Paper "Adapting to Climate change: Towards a European framework for action", it is also necessary to assess which requirements regarding water management should be further integrated into relevant CAP instruments. Adaptation measures concerning agriculture can also be integrated in the national implementation of the Water Framework Directive and the Floods Directive.

5.2. Strengthening the role of agriculture as a provider of ecosystem services

Taking into account the projected impacts of climate change on European hydrological systems, habitats and biodiversity, the maintenance of ecosystems through the management of agricultural land has a central role to play in contributing to overall resilience to climate change. Agriculture can, for example, assist in watershed management, protection of habitats and biodiversity as well as in the maintenance and restoration of multifunctional landscapes. Among other, migration of species can be facilitated by establishing networks of wildlife corridors on agricultural land, and the water holding capacity of grazing land can be used to reduce the risk of flooding. The potential role of agriculture in providing such "green infrastructure" could be recognized and further enhanced.

Current agri-environmental measures contribute to this objective, but may not always sufficiently enhance connectivity between areas protecting biodiversity. Inthis context, the applicability of rural development measures on a territorial scale beyond the level or individual farms could be considered to help successful adaptation.

5.3. Enhancing resilience of agricultural infrastructure

Agriculture as a production system is dependent on fixed assets (e.g., equipment, buildings, machinery) and infrastructure, which can be impacted by extreme events. The potential economic losses triggered by such events can become a serious concern to the sector, in particular because in agriculture the value of fixed assets tends to be significant compared to the average annual output and farm income. Therefore further developing preventive action and developing instruments tailored to regional characteristics to cope with potential damage is necessary.

5.4. Developing synergies between adaptation and mitigation

Agricultural activities are an important source of nitrous oxide and methane emissions, which contribute to global warming. In the EU, agriculture can contribute to climate change mitigation by reducing its emissions, by the production of renewable energies and bio-products, and by storing carbon in farmland soils.

To address the double challenge of reducing GHG emissions while at the same time coping with the changing climate, it will be necessary to ensure synergies between adaptation and mitigation as much as possible. Measures that provide co-benefits in terms of reducing emissions and increasing resilience of farming need to be identified and promoted. These include, among other, soil and tillage practices that help maintain and increase organic carbon in soils, and protection and management of pastures. Organic farming has potential for mitigation through its efficient nutrient cycles and soil management, and as it usually implies higher diversity and high level of knowledge of the functioning of the farm ecosystem, it is also likely to be more resilient to climate change.

Possible conflicts between objectives should be considered when deciding about appropriate measures, and trade-offs may in some cases be necessary. Member States may use rural development funds to implement these measures.

5.5. Improving the adaptive capacity of farmers

Enhancing the adaptive capacity of farmers is a necessary condition for sustaining adaptation in agriculture. Strengthening information and advisory support on climate-related matters to farmers and agricultural workers is key for motivation and preparedness to adapt. Various means are available such as dedicated courses, specialised press, use of communication technologies. It is also important to include climate change into educational systems for young farmers, farm workers and apprentices. Farm advisory services could be developed so that they can become an instrument for disseminating regionally-specific information and practical adaptive solutions enhancing farmers' skills to respond to future changes.

The measures adopted in the framework of the CAP "Health Check" provide additional possibilities, within the rural development policy, for funding dissemination and training programmes, and for using farm advisory services.

5.6. Facilitating co-operation between Member States

Development of national and sub-national programmes and policy thinking on climate change adaptation needs to be encouraged. Exchanging approaches, experience and best practices in adaptation options in the agricultural sector between the Member States can advance farming practices and production systems best adapted to expected climatic developments. A technical working group on agriculture, supporting the Steering Group on Impacts and Adaptation, proposed by the White Paper, will be set up by the end of 2009.

The Commission initiative to establish a Clearing House Mechanism to serve as a platform for information exchange on climate change impacts and vulnerabilities, will need to include a part specifically dedicated for sharing national developments, projects results and best practices in the agricultural sector.

5.7. Enhancing research on climate and agriculture

Adaptation planning in agriculture cannot only rely on knowledge about global climate patterns, but needs detailed information on regional impacts and meaningful assessment of the adaptive options and their feasibility at local and farm level. Improving and refining the spatial and time scales of the assessments of expected climatic impacts and vulnerability, and a better understanding of the interactions between agriculture and climate is essential. A recent Commission Communication on European agricultural research[2] elaborates on the needs and directions for EU climate change research and innovation, including those for the agriculture sector. Climate change was identified as a priority area by the Standing Committee on Agricultural Research (SCAR), which recognised a significant gap in the coordination of research at European level. A working group of national programme managers has been set up to consider how climate change affects agriculture, and how agriculture can suitably adapt to and mitigate these effects.

[2] COM(2008) 862 "Towards a coherent strategy for a European Agricultural Research Agenda".

In addition, as rural areas are exposed to wider climatic risks and as significant parts of rural Europe are characterised by economic multifunctionality, an integrated understanding of the impacts of climate change on rural economies and societies is important. Socio-economic research on the climate challenge and its impact on rural sustainability could thus be enhanced.

The climate challenge puts a renewed emphasis on the need for continuous agricultural research, at EU and national levels, for example on development of crops, varieties and herds better adapted to future conditions. Mitigation will also need to be supported by research efforts to further develop suitable and affordable technology and innovation. The forthcoming interim evaluation of the 7th Research Framework Programme provides an opportunity to review the balance among thematic priorities, addressing in that context the issue of support to climate and agricultural research.

A key challenge is also to integrate findings from the physical and agronomic sciences with local knowledge from farmers, so as to develop robust adaptation strategies, which, over a range of climate and socio-economic scenarios, can minimize the negative impacts of climate change. The Farm Advisory System can be an important tool also in this regard.

Equally important is to strengthen the capacity of regional institutions to use appropriate tools to address climatic changes. Partnerships between national and regional research institutions, advisory services and social partners in agriculture as well as setting up of regional networks providing information to farm communities will help to design adequate site-specific strategies.

5.8. Developing vulnerability indicators

Developing specific indicators for agriculture such as an index for adaptive capacity and vulnerability could be explored. The identification of vulnerability would need to be carried out at low spatial scale, on the basis of current sensibility to climate variability and natural hazards as well as scenarios of changes in weather patterns. Building a vulnerability indicator, including the aspect of adaptive capacity, will require a multi-dimensional approach combining climatic, environmental and socio-economic factors.

6. CONCLUSIONS

Climate change will require farmers to adapt while they are also called to reduce farm-level greenhouse emissions, and to improve agriculture's environmental performance. Developing a progressively evolving and comprehensive response to climate change is needed to maintain the resilience and competitiveness of EU agriculture so that it can continue to play its role as supplier of high quality food and environmental and landscape services, as well as contribute to the sustainable development of EU rural areas. Climate change also brings an additional perspective to the challenge of food security.

Adaptation is a long-term process which needs to evolve over the coming decades according to the climatic trends and by building on a growing body of knowledge and practical experience. In this process, it is important to further engage the farming community in the discussion on adaptation needs and in sharing good practices, as farm-level changes are a key component of adaptation.

In the context of the review of the Common Agricultural Policy after 2013 the need to ensure favourable conditions for the adaptation of agriculture and rural areas will need to be examined. Effective adaptation and adoption of new technologies, which contribute both to mitigation and the long term viability of farming, will require investments and planning efforts beyond the capacity of individual farms. Public authorities will have a role to play in supporting and facilitating climate change adaptation policies.