Some of the key messages raised in the 2nd SCAR-Foresight into priorities for building the agricultural research agenda of the coming years

The 1st SCAR foresighting exercise in 2006 aimed at describing possible future scenarios for European agriculture including the possible implications thereof. The 2nd foresight looked at new developments which had occured since 2006 to alert on new and emerging challenges which should be taken into account in research priority setting for the longer term. Therefore it was clear from the outset of the 2nd foresight, that work done by many from "knowledgeable groups" would be needed to think through what the identified interconnected challenges (see below) would mean for the future research agenda building in the agrofood sector.

The 2nd SCAR-Foresight identified four interlinked challenges of growing importance for the European farming sector by 2030 and beyond. These should be taken into account by research policy when setting research priorities to enable a sustainable and competitive future for the agriculture and food sector.

From their analysis of more than 100 relevant foresight studies published in the past three years the following interconnected challenges deserve specific attention in research policy:

1) Climate change is proceeding much faster than expected by many IPCC-experts.
2) Environmental degradation is building up and weakening the services and resilience capacity of ecosystems.
3) Growing energy demand and shrinking phosphate resources are expected to make agricultural production more expensive with consequences for world food security.
4) Ageing and declining populations in Europe will not only imply that Europe's share in world population will diminish from currently 12% to about 9% by 2025 but it will also impact on rural areas and the way of farming.

These major challenges are not isolated from each other. Instead they are interconnected through feedbacks resulting in systems dynamics which are difficult to comprehend. The complexity connected with these new challenges is closely associated with our limited understanding of the driving forces behind these processes. It is this lack of knowledge which contributes to the uncertainty about the future development of the agricultural sector and for food security.

In the light of these new and interconnected challenges, it is not sufficient to look at the various facets of food security (availability, access and utilization) alone. Future food security will be endangered by an increasing number of constraints such as shrinking water and land resources, increasing biodiversity losses and soil degradation, higher seed and fertilizer prices making food systems more vulnerable especially under global warming conditions. The situation is further exacerbated by the high dependence of the entire food production, processing and retailing chain on fossil fuels. As the oil output is expected to peak in the next ten to twenty years and to steadily decline thereafter while the energy demand is estimated to grow by 50% in 2030 it is foreseeable that this situation will have serious consequences on food supply and prices because all the prices for farm inputs will increase. In addition the projected population and economic growth and changing food habits will double current food demand by 2050 (FAO, 2008).

The foresight report raises the important question "how to reduce vulnerability of social, economic and ecological systems" which will become a key challenge of the policy agenda in the years to come. The authors point to the fact that a local food crisis may undermine social stability which in turn could lead to failing states and more global insecurity. A focus on

vulnerability should therefore take a systems perspective in order to pay full attention to the complexity of the various ramifications of the underlying processes. They highlight the importance of linking the broader approach of vulnerability with the concept of ecosystem services and sustainable development.

From the above it is clear that any future research agenda setting has to cast a wide net and must draw on expert discussions in groupings such as the ETPs and ERA-Nets in the KBBE domain including other EU-Projects and NGOs which have undertaken foresight analysis in this domain.

We therefore request that you re-examine your research priorities in light of the following conclusions and questions raised in four key areas of the foresight report. This process should help you to identify some new and urgent research gaps and needs in your area of interest and to develop a broadly agreed research agenda for the future. **SCAR also invites any contributions of assistance you may have on the identification of new research priorities arising from these new insights.**

1) **climate change**:
   There is now clear evidence (IPCC4[1]) about the possible impact of climate change on natural ecosystems and hence agriculture and the entire food system. The foresight report highlights the global warming issue and the difficulties we will have to hold global warming below a 2°C rise by 2050[2], while pointing to the various consequences of unabated climate change, with greenhouse gas emissions (GHG) accelerating three times faster than the IPCC4 authors anticipated in their worst case scenario just a few years ago. Other research indicates that emissions must be cut more quickly to prevent critical thresholds being crossed that could lead to runaway climate change (Lennton and Schellnhuber, 2007).

   These changes in climate are expected to greatly affect all components of the European agricultural ecosystems but in very different ways depending on the specific conditions in a certain region. But agricultural systems are not only sensitive to climate change, they are also contributing to GHG emissions (primarily CO_2, methane (CH_4) and nitrous oxides (N_2O)). Currently, agricultural activities contribute some 9% to GHG emissions, with wide variations between Member States. Thus agricultural research will have to look at both, adaptation and mitigations strategies.

   a) Research gaps/needs in adaptation to climate change
   As climate in Europe is forecast to become warmer and weather conditions less reliable, a first priority is the development and implementation of adaptation strategies (page 53 of the report). This often implies changes in agricultural land use, but crop production and protection, soil processes and livestock are also affected by more extreme events. The main challenge for agriculture and the whole food sector is to find the right responses and strategies to the challenge of a much faster rate of climate change.

   From the discussions held in your expert group (ETP, ERA-Net, others): what are the 5 most important research gaps for an effective adaptation strategy to the expected much faster rate of climate change? It is suggested that you consider in your reflections the shrinking resource base and the rising energy costs of farming as well.

[1] Intergovernental Panel On Climate Change
[2] In the light of more recent research results it seems clear that Green House Gas emissions have already committed a global warming of 2.4°C (Ramanathan and Feng, 2008)

Unconventional ideas offering new opportunities in support of multifunctional farming are also welcome.

b) Research gaps/needs for mitigation measures in agriculture to climate change
The design of future agricultural production systems and agricultural policies have to consider the need for reductions in GHG emission from agriculture and livestock production as well as the win-win opportunities that mitigation in agriculture offers for Copenhagen and beyond. The more we delay reducing GHG emissions, the larger the inevitable magnitude of climate change will be, and the more drastic reductions will be required later on to avoid dangerous levels of climate change. There are a number of options described in the report (page 54) to reduce or even reverse the emissions of GHG from agriculture and livestock in addition to a reduction in direct and indirect energy use in the whole food chain and changes in consumption behaviour. In general most of these mitigation methods and technologies need to be further developed (e.g. biochar), if they are to be applied in a cost effective manner.

From the discussions held in your expert group (ETP, ERA-Net, others): what are the 5 most important research gaps for an effective mitigation strategy to the expected much faster rate of climate change? It is suggested that you consider in your reflections the shrinking resource base and the rising energy costs of farming as well. Unconventional ideas offering new opportunities in the sense of multifunctional farming are also welcome.

2) **Environmental degradation:**
Worldwide changes of natural ecosystems to farmland, pastures, transport or urban infrastructures have expanded tremendously in recent decades. Such changes have enabled humans to appropriate an increasing share of the planet's natural resources potentially undermining the capacity of ecosystems to sustain food production, to maintain freshwater and forest resources or to regulate climate. Particularly declining water supplies in many parts of the world where population growth is high and the expected impact of climate change is large raise chilling questions about where and how farmers will produce the food needed in 10-20 years from now. We are facing the challenge of managing trade-offs between our immediate needs and the capacity of the biosphere to provide goods and services in the long run.

The report stresses the point that a number of important natural resources for agricultural and food systems, such as soil, water, and biodiversity have been deteriorating over many years, slowly but steadily undermining ecosystem services and the resilience of agro-ecosystems. The authors highlight the fact that the role of biodiversity and ecosystem services in both climate change mitigation and adaptation is rarely appreciated or understood and that the value of ecosystem services for society and the entire economy is rarely acknowledged. On a global scale the report points to the challenge of sustainably managing ecosystems in order to meet the demand of a still growing world population and to reduce the vulnerability of those regions expected to be most affected by climate change.

A number of examples are given in the report which point to the unsustainability of conventional farming and food systems due to their high energy dependence, their high water demand or their adverse environmental footprint. In addition it is important to note that our food base is extremely narrow and hence vulnerable to climate change. Only four crops provide about 60% of the global food. And in the livestock sector the FAO (2007)

has recently alluded to the fact, that the rates of livestock breed extinctions are "alarming".

The report questions the sustainability of the pre-dominant, retail driven food model in Europe which neglects the ecological footprint, the many unpaid environmental costs of the food supply, and the overall social impacts. It highlights the importance of lowering the total GHG emissions per kg of product, the need for restoring the soil organic carbon as well as diversifying landscapes, farms and fields to improve the resilience of agro-food systems towards external shocks. However without a clear policy framework and support measures environmentally benign land use systems may fail. And without healthy and resilient ecosystems it will not be possible to stabilise the climate system or to adapt to the unavoidable impacts of climate change. Therefore, new ways of sustainable landscape management will be increasingly important to ensure the vitality and multi-functionality of rural areas.

From the discussions held in your expert group (ETP, ERA-Net, others): what are the 5 most important research gaps for a strategy to halt or even revert the accelerating degradation of the environment and ecosystem services? It is suggested that you consider in your reflections the importance of climate change and the rising energy costs of farming as well. Unconventional ideas offering new opportunities in support of multifunctional farming are also welcome.

3) **Rising energy costs and shrinking phosphate resources and its consequences for world food security:**

The entire food production, processing and retailing chain is highly dependent on cheap energy from fossil fuels and gas. The report highlights what is known for quite some time now, that the growing food demand alongside increasing economic and resource pressure, in combination with climate change, is a tremendous challenge for research.

Previous energy transitions from wood to coal and from coal to oil were gradual, while decreasing oil production in combination with surging demand is expected to result in large price increases. If the warnings of peaking oil production become reality, massive disruptions may affect all sectors of the economy, including modern agricultural production and food systems which are highly dependent on oil.

Phosphorus, an essential fertilizer for agriculture seems to have reached the peak already. From that point onward, the resource becomes more difficult to extract and more expensive. Western Europe is totally dependent on phosphate imports. Phosphate is an essential nutrient for agriculture for which there is no substitute.

In addition, the structure of the food system has changed with the growing power of international corporations and food production and purchasing occurring nowadays in an entirely global context. This makes our food economy highly vulnerable to any disruption or market distortion. The extraordinary increases in the global prices of basic foods in 2007/8 were caused by a combination of factors, amongst others surging oil prices that further heightened the costs of fertilizers, and food transport; a rise in demand for animal feed from changes in food habits in emerging economies; the use of more land and agricultural produce for bio-fuels; and climate change. The food crisis created political and economical instability and social unrest in both poor and developed nations and gave a foretaste of what may happen more frequently in the near future. It has made clear that

food security is a matter both for the North and for the South which cannot be dealt with effectively by approaching it under a national perspective only.

According to the authors of the report, it has made food security a key issue on the global policy agenda. The perception that market liberalization has failed to provide food security even in rich nations has brought about a general agreement on the importance of searching for different models of agriculture and food provisioning. Research urgently needs to deliver more resilient systems that are able to meet simultaneously the growing demand for food, bio-energy and bio-fuel in a world of a shrinking resource base and accelerating climate change all impacting on land productivity. This has to include as well a better understanding of the possible long-term consequences of unsustainable consumption styles and alternative options.

From the discussions held in your expert group (ETP, ERA-Net, others): what are the 5 most important research gaps for a strategy to meet this triple challenge mentioned above? Especially integrated approaches offering new opportunities for farming are welcome.

4) **Demographic change in Europe and its possible implications for rural areas:**
In the 20th Century, Europe has entered a period of relative decline when it comes to demography, ageing competitiveness or innovation. Europe will not only be subject to a continuing demographic marginalisation on the World scene but also with a relatively aged population, with the largest cohort being between 65-69 years old by 2050. This gives rise to the more fundamental question who will replace the rural population that will retire during the coming decades? It is expected that the trend of farms to close down will continue in the near future, resulting not only in an increasing unemployment in rural areas but also pertinent questions, who will farm Europe's agricultural regions in future and maintain the scenic landscape that most city dwellers enjoy? Implied is the question of incentive structures to maintain certain land use types and ecosystem functions and who should pay for these?

On the other hand, the larger farmers no longer find adequately skilled personnel because the hard and dirty work in agriculture is unattractive to better educated and skilled persons.

In addition, complex patterns of mobility and migration are causing rapid changes in the agricultural workforce (e.g. workers from Africa in Spain or from the new Member States in Germany). These could be further exacerbated by tensions between immigrants and residents, but also between young and old or between traditional farming and other land use options. The diversity of systems, contexts and challenges of the EU-25 agro-economy is set to increase with further enlargements and the onset of varying impacts of climate change on agricultural ecosystems and the vulnerability of certain regions. It is a formidable research task to develop alternatives for maintaining attractive and productive rural areas that are sustainable and competitive as well.

From the discussions held in your expert group (ETP, ERA-Net, others): what are the 5 most important research needs in the light of the expected demographic trends for developing a strategy that enables sustainable land use systems in the rural areas of Europe which are competitive in a global perspective as well?