FACCEJPI

Agriculture Food Security and Climate Change

Summary Report on the Stakeholder Consultation

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Introduction

The Joint Programming Initiative on Agriculture, Food Security and Climate Change (acronym: FACCE - JPI) evolved from the outputs of the Standing Committee on Agriculture Research (SCAR) foresight exercises through which Member and Associated States identified food security and climate change as two of the major key issues impacting on the future of European agriculture. In keeping with the definition of joint programming initiatives, the FACCE – JPI aims to pool national research efforts in order to make better use of Europe's precious public R&D resources and to tackle common European challenges more effectively in key areas. In Joint Programming, Member States are expected to coordinate national research activities, group resources, benefit from complementarities and develop common research agendas, to provide the long-term, stable research base that is needed to address major societal challenges. Today, the FACCE-JPI brings together 21 Member States and Associated Countries*[1].

In order to define the scope of this challenge and the key research questions, the FACCE – JPI Scientific Advisory Board (SAB)[2] has elaborated a Scientific Research Agenda (Annex 5). Following the publication of the Scientific Research Agenda, themes are elaborated in dedicated mapping meetings to provide further input towards the development of the Strategic Agenda. The foresight and mapping activity for strategic collaboration is part of the internal process towards the strategic agenda. Furthermore, a broad public stakeholder consultation was held.

The public consultation aimed to gather views and evidence from stakeholders on the key priorities and areas for research to contribute to the goals of food security and sustainable agriculture in the face of climate change.

Method

In order to gather the stakeholders views, a questionnaire (see Annex 6) was designed around the five core research themes of the FACCE – JPI Scientific Research Agenda. The questions were mostly open text format in order to receive the most accurate responses possible. This questionnaire was made available online from January 26 – March 30, 2012. The FACCE – JPI Secretariat sent an invitation to respond to the consultation to 162 European and international stakeholders. Members of the FACCE – JPI Governing Board were responsible for circulating an invitation to respond to their national stakeholders.

This summary report is based on the analysis of all the responses received. 132 responses (Annex 1 for list of all respondents) were received to the online questionnaire as well as 4 position papers

[1] Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Israel, Italy, The Netherlands, Norway, Poland, Romania, Spain, Sweden, Switzerland, Turkey, United Kingdom

[2] Prof. Elias Fereres, School of Agricultural and Forestry Engineering, University of Córdoba, Spain, Institute of Sustainable Agriculture, Scientific Research Council of Spain (IAS-CSIC); Prof. Stephen P. Long, University of Illinois, Urbana-Champaign, USA; Prof. Frits Mohren, Wageningen University, Netherlands; Prof. Bernd Müller-Röber, Potsdam University's Institute of Biochemistry and Biology, Max Planck Institute of Molecular Plant Physiology (Germany); Ms. Rajul Pandya-Lorch, International Food Policy Research Institute (IFPRI); Prof. Pirjo Peltonen-Sainio, MTT Agrifood Research, Finland; John R. Porter, University of Copenhagen, Denmark; Prof. Johan Rockström, Stockholm University, Sweden; Prof. Thomas Rosswall, CGIAR Challenge Program "Climate Change, Agriculture and Food Security"; Dr. Henning Steinfeld, Food and Agricultural Organisation; Dr. Jean-François Soussana, Institut National de la Recherche Agronomique (INRA), France; Prof. Joachim von Braun, Center for Development Research (ZEF), University of Bonn, Germany

(Annex 4). Additionally, a summary of responses from 32 Spanish stakeholders was received (Annex 3). Because not all the information on these responses is available, the Spanish stakeholders are listed separately in Annex 1.

Summary

Although the invitation to respond to the consultation was sent to a large number of organisations (162 European and international stakeholders + members of GB to diffuse nationally, for example in France it was sent to 195 stakeholders), a large portion (55%) of the responses come from researchers in universities or public or private research organisations.

The great majority of the stakeholders who responded largely understands the goals and scope of the JPI and considers them important (Figures 1-5). There was strong endorsement of the 5 core research themes with core themes 1 and 2 considered by 38% and 41% of the respondents respectively as most important (Figures 1-5). Thus, the Scientific Research Agenda is widely supported.

The majority of the stakeholders are also interested in working together with the FACCE – JPI to develop paths to markets in the different areas (Figure 6), to develop communication, advisory, policy support tools in the different areas (Figure 7), and in research results (Figure 8).

Some areas of special interest for consulted stakeholders were identified for each core theme. It is noted that many of these areas are already covered in the Scientific Research Agenda, if not in the five core themes, then in the overall scope of the JPI (p. 51) and in Annex 1, "Evidence-based research issues" (p. 61). The majority of suggestions concerned core theme ': Adaptation to climate change. There were also suggestions on supporting activities that the FACCE – JPI could undertake which are included in this summary report.

98% of the respondents wished to be informed of the JPI through a newsletter or the web site.

Figure 1. Ranking of core themes: Core theme 1: Sustainable food security under climate change (1 = most important and 5 = least important)

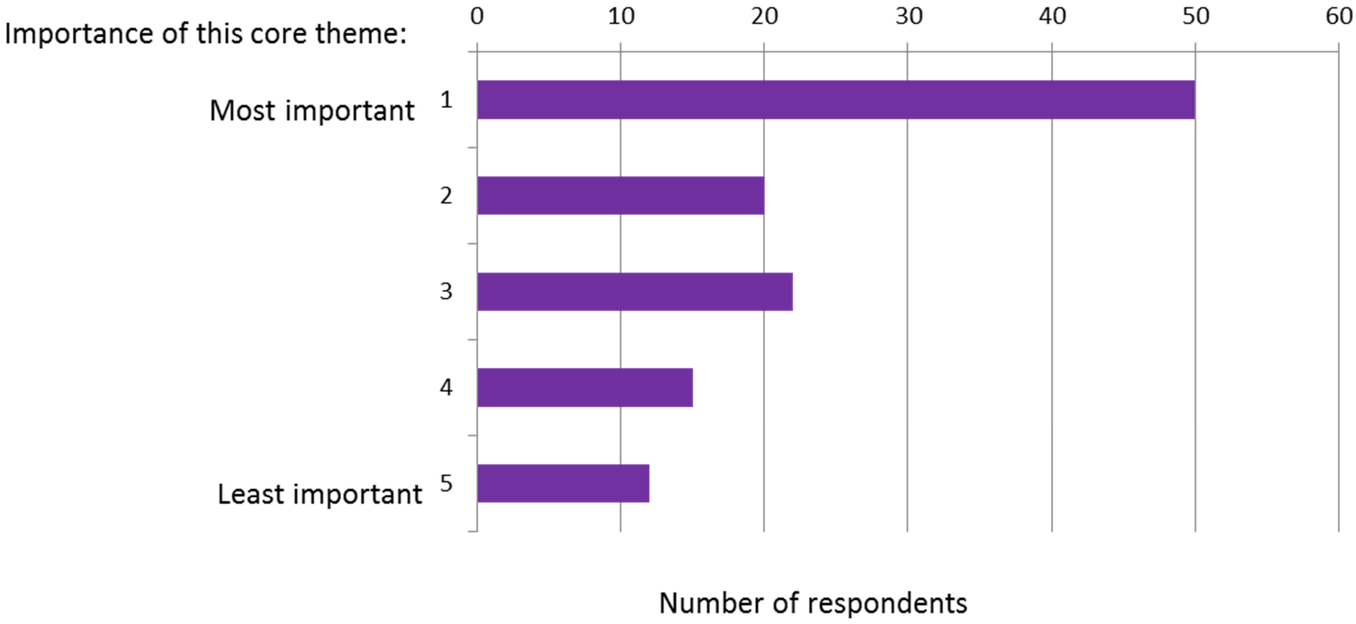


Figure 2. Ranking of core themes: Core theme 2: Environmentally sustainable growth and intensification of agriculture (1 = most important and 5 = least important)

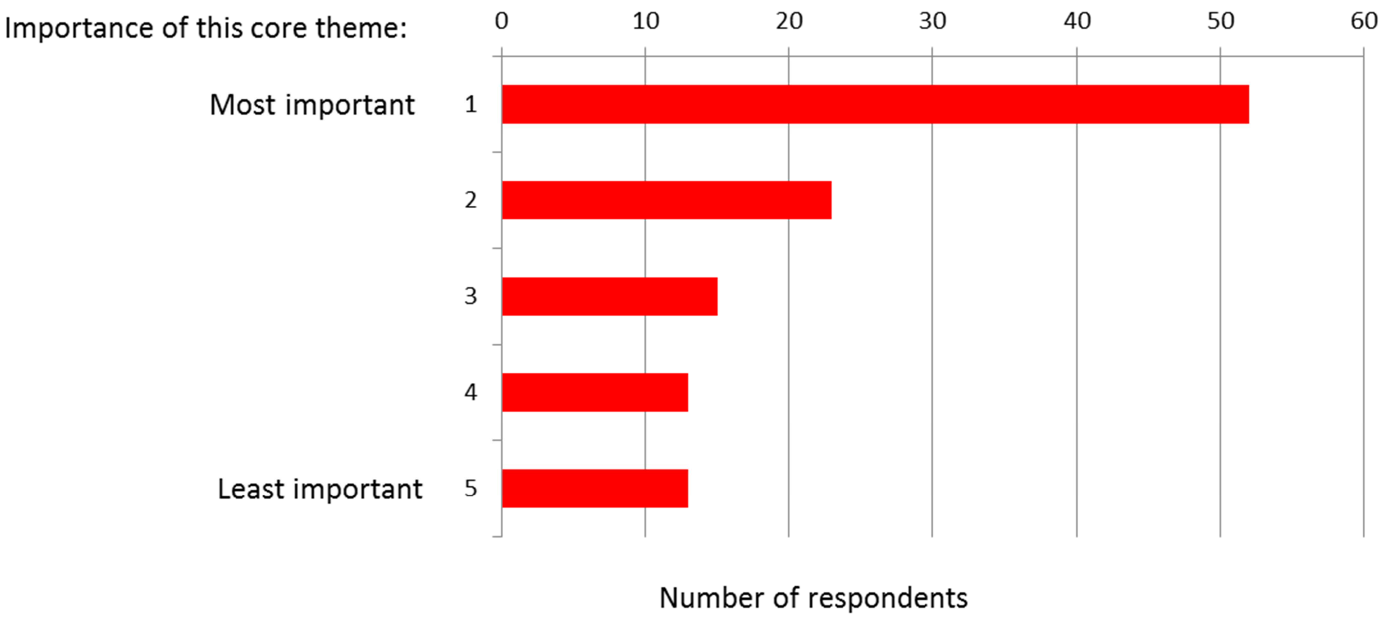


Figure 3. Please rank the Core themes for the importance on your sector - Core theme 3: Assessing and reducing tradeoffs between food supply, biodiversity and ecosystem services (1 = most important and 5 = least important)

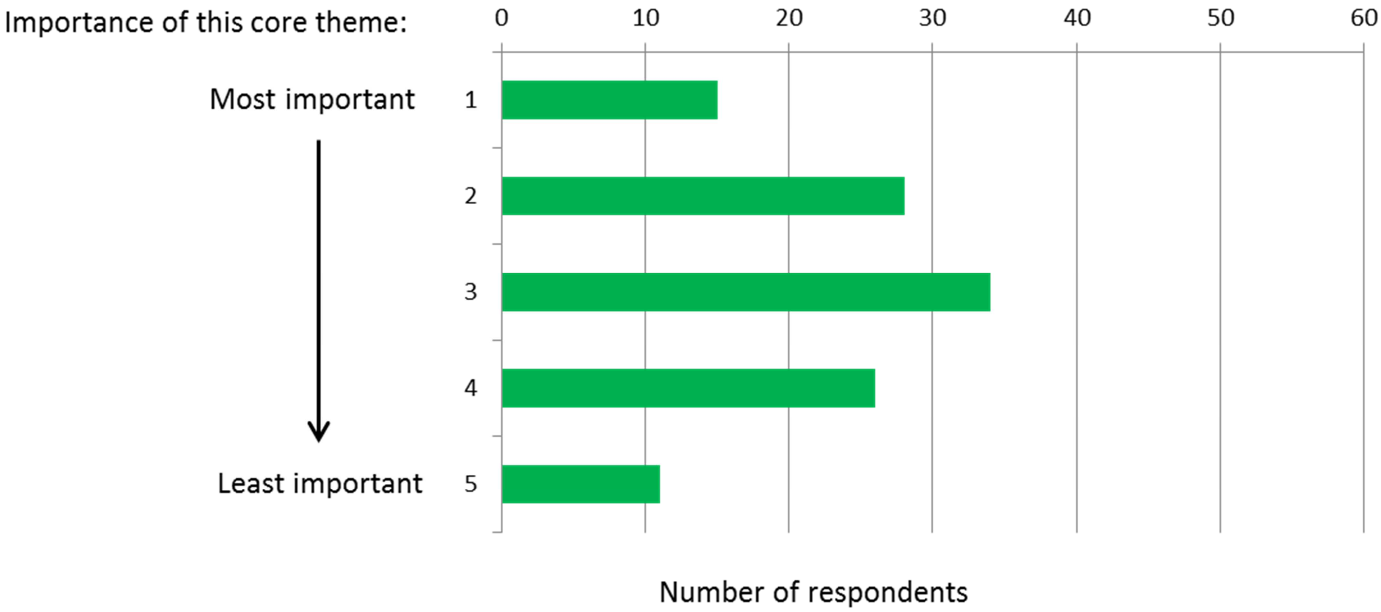


Figure 4. Please rank the Core themes for the importance on your sector - Core theme 4: Adapting to climate change (1 = most important and 5 = least important)

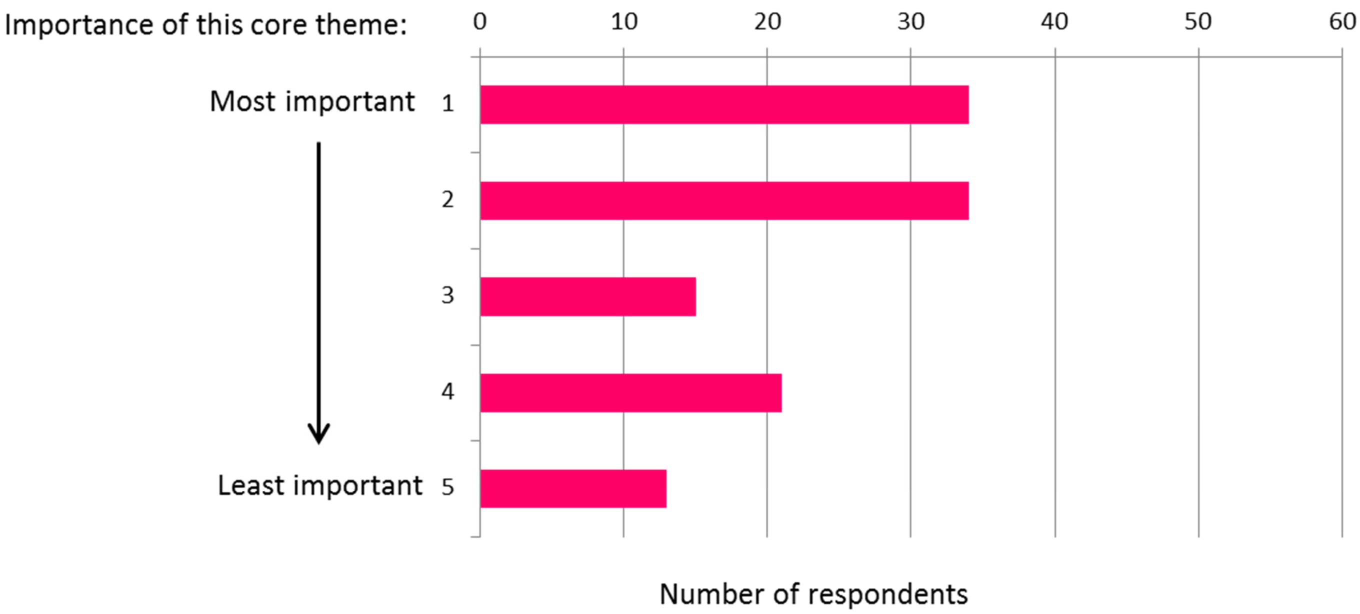


Figure 5 Please rank the Core themes for the importance on your sector - Core theme 5: Mitigation of climate change (1 = most important and 5 = least important)

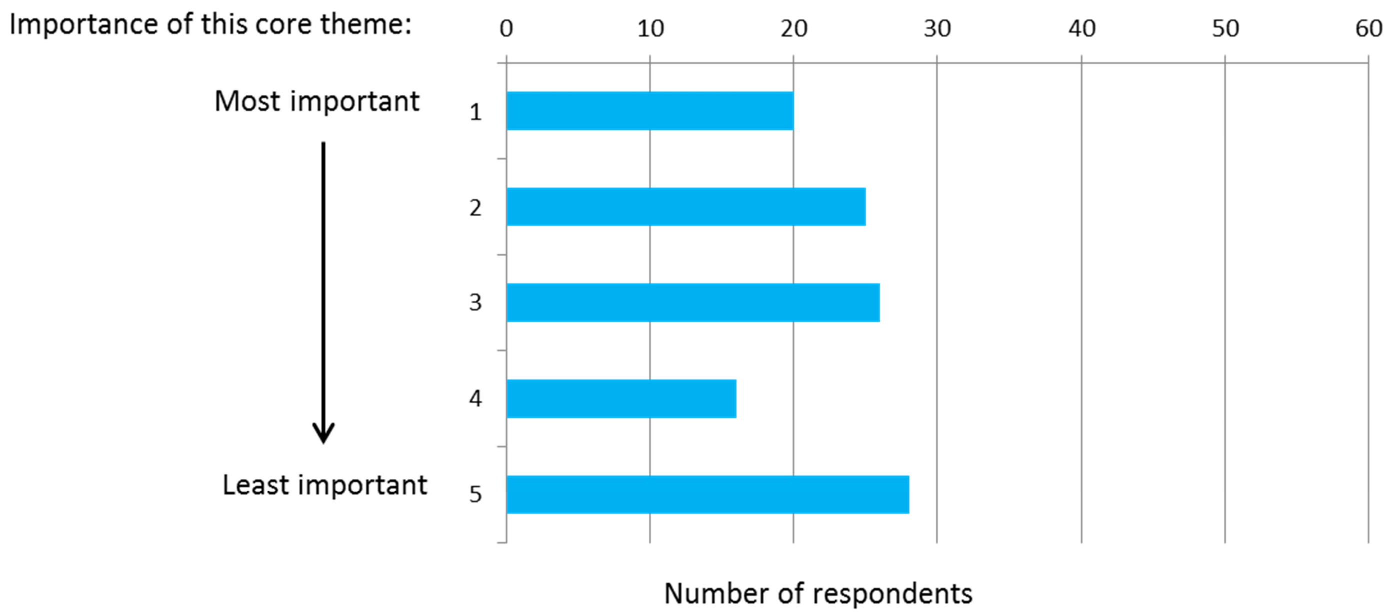


Figure 6. Would your organisation/you be interested in contacts with JPI teams to develop paths to markets in this area?

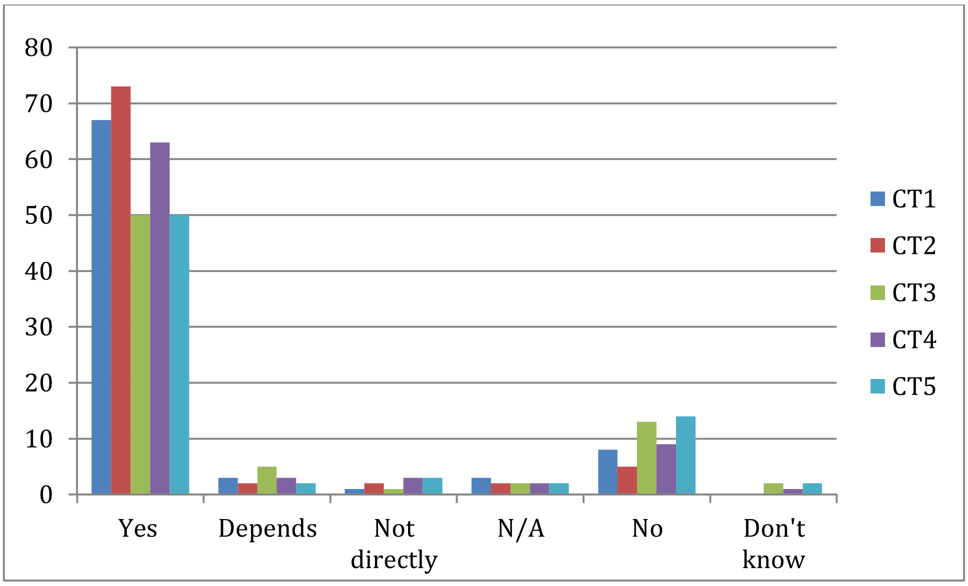


Figure 7. Would your organisation/you be interested in contacts with JPI teams to develop communication, advisory, policy support tools in this area?

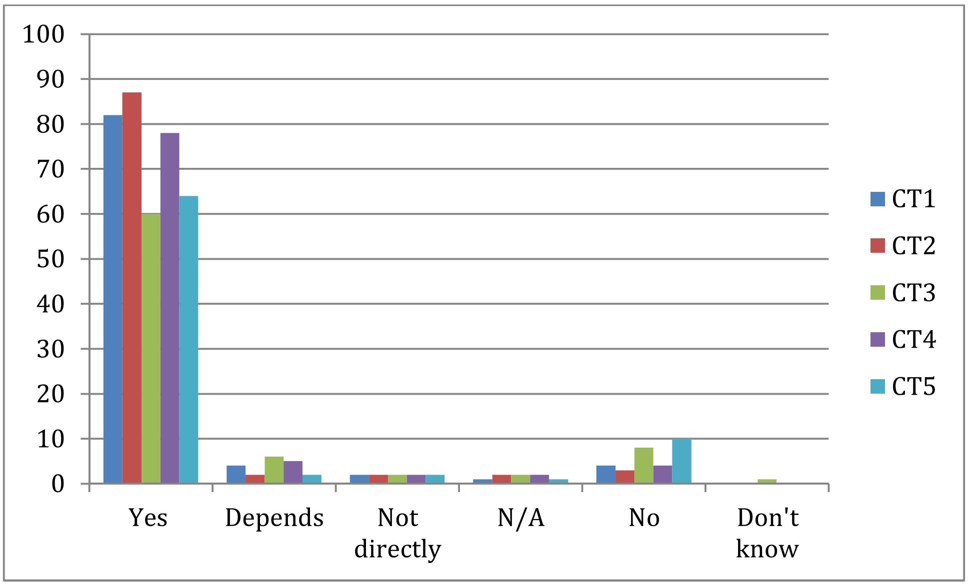
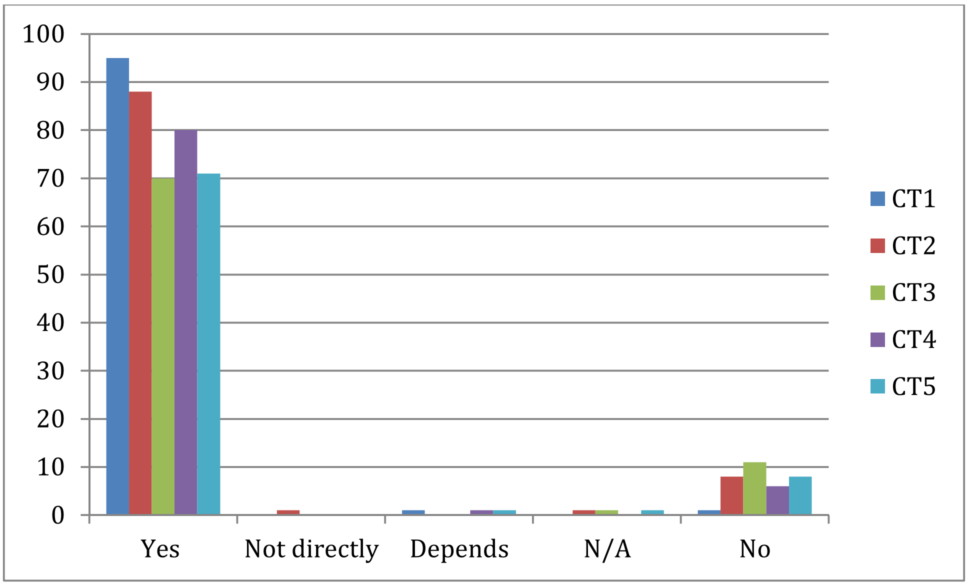


Figure 8. Would your organisation/you be interested by research findings in these areas?



Core themes: areas of special interest

Areas of special interest for consulted stakeholders have been organised such that they correspond to the core theme that most closely covers the subject mentioned. All comments from stakeholders concerning these areas of special interest are listed in Annex 2. A summary of these remarks may be found here. Some suggestions were considered out of scope of the FACCE – JPI and these are also listed in Annex 2.

It was generally remarked that the FACCE – JPI should cover the range of research activities from fundamental research[3] through applied research, knowledge transfer including demonstration projects, innovation framework, communication-education- outreach. Further, it was suggested that assessment studies and modeling require experimental research and data. Finally, it was considered that top-down and bottom-up approaches need to complement each other. It was also noted that aquaculture is not treated in the core themes and the research priorities[4].

Core theme 1

For core theme 1, Sustainable food security under climate change, additional areas of interest centred around 3 subjects: Scenarios and modeling, economics and consumer behavior. Concerning scenarios and modeling, it was suggested that there is need for building and homogenization of robust datasets based on long term field crop experiments or observatories, linking remote sensing and cropping system modeling to address landscape scale processes. Further, there is need for improved methodologies to aggregate detailed field-level data and simulations up to a larger scale. Several respondents remarked the need for a better dialogue with stakeholders and policy-makers of results. Other suggestions included the need to develop scenarios of future European food production and supply; to develop new modalities for the scenario building exercise as well as production models and to improve the efficiency and reduce uncertainty in simulation models and GCM downscaling procedures. Finally, it was suggested that in the mid-term, there is need for quantitative methods for assessing resilience.

Another concern was economics aspects: modeling the drivers of volatility, the empirical study of price formation on agricultural markets, what effects increased competition for land-based resources have on producer prices, and transmission of volatility from farmers to consumers.

A third category of suggestions concerned consumer behavior: the need to understand consumer's attitudes and behavior towards sustainable food production issues as well as to develop less impacting lifestyles. It was also suggested that there is a need to understand consequences of changes in food systems (including food habits, processing, wastes, consumption …) on climate change (greenhouse gases (GHG), footprints, etc) and, conversely, climate change impacts on European food systems (including processing, retailing, transport, consumption patterns).

A final set of suggestions for core theme 1 concern the development of agricultural scenarios and common protocols for the combined implementation of climate, crop, livestock, trade models as well as model intercomparison. It is to be noted that these subjects will be treated in the FACCE – JPI pilot action, the Knowledge Hub called FACCE MACSUR which establishes a trans-European

[3] The FACCE – JPI has an extremely wide scope and cannot take on all related upstream research. It is acknowledged that this fundamental research is critical and it is mentioned in the section on "Upstream research".

4 In the description of the scope of the FACCE – JPI, aquaculture is treated in point 1.1: Agriculture. It is not currently considered a research priority of the JPI.

network of modelers working on crop, livestock and grassland and trade models (for more information, go to www.faccejpi.com).

Core theme 2

For core theme 2, Environmentally sustainable growth and intensification of agriculture, areas of special interest to stakeholders centred around a number of subjects: choice of crops, resource efficiency, productivity, farm systems, bioeconomy, energy and waste, genetic diversity and breeding and soil.

Concerning choice of crops, it was on the one hand suggested to focus on the highest value crops, such as small grain cereals, the Solanaceae (tomato and potato) and legumes and on the other hand, to look at alternative plants. As a long term priority, it was suggested to develop food and feed crops that are better adapted to human and domestic animal consumption from an evolutionary perspective than present crops.

A number of suggestions were made concerning the better understanding of resource efficiency in agriculture, specifically, improved nitrogen use efficiency and nitrogen-efficient crops; spatio-temporal variations in closely coupled C-N-H_2O cycles and phosphorus cycling in ecosystems as well as the need for coupled biophysical and economic models to deal with resource availability and resource use efficiency. Better use and recycling of nutrients, water and wastes, and pesticides need to be developed. It was also suggested that there is a need for efficient fertilisation management programs. A more fundamental question concerns plant roots adapted for better water and nutrient uptake. Finally, the question should be addressed of how resource use efficiency and production can be increased on agricultural land while at the same time maintaining ecosystem services, biodiversity and animal welfare.

Concerning productivity, it was noted that we need a fundamental understanding of crop yield and productivity to allow the achievement of high productivity and quality of the final products. It was further noted that organic farming is able to fulfill productivity demands including higher standards regarding the production, therefore considerable conceptual research still needs to be done on how to optimally represent the “ecosystem intensity” of a farming system. Productivity needs to be assessed at the scale of the farm or of the agricultural landscape, in order that innovations in agricultural practices, in the spatial organisation of crops, that are all linked to ecological engineering, are also taken into account This could be achieved through benchmarking at farm gate the current state and historical changes and their main economic and management drivers in productivity and resource use.

A number of suggestions concerned farm systems and their management. There is extensive scope for investigation of novel and creative farming systems or mixed farming systems, for example agroparks that combining crop, livestock and bioenergy systems for sustainable intensification. It would also be useful to look at diverse production systems and how they impact on biogeochemical cycles and sustainable intensification. It was also suggested to identify and assess good practical examples of designing resilient and sustainable farm systems, agriculture management (e.g. irrigation, landscape transformation, etc...) and low-carbon food distribution from national and regional projects. It is also noted that there is a need for the development of new models for farm management, including using organic farming methods as well as a need to examine the environmental and climate impacts of structural changes in agriculture – specialisation versus integration, small scale versus large scale, and geographic localisation?

The need to take the larger bioeconomy into account was recommended and in particular, the need to create new innovative and sustainable value chains that use forestry biomass, agricultural and livestock byproducts, such as crop residues and manure. The reduction of agricultural waste was further considered important. It was further suggested that there is a need to look at the production of bioenergy and biomass and their effect on the agricultural equilibrium. There is also a need to improve understanding of how bioenergy crops can be included in crop rotations and the potential of multiple-use crops as well as the trade-offs between agricultural biomass and food.

In terms of genetic diversity and breeding, it was considered that there is a need for new concepts for the evaluation and efficient use of genetic diversity for crop improvement to include yield increase, resistance to abiotic/biotic stresses and improved resource use. It was further suggested that there is a need to investigate the untapped potential in wild relatives/ancestral species related to crop plants as well as traditional cultivars.

Plant breeding (also treated in core theme 4) was suggested to be a short-term priority as plant breeding needs time: if new high yielding varieties should be on the market in 10-15 years, research should start immediately which includes combined development of genomic selection, ecological engineering, precision farming, ecotechnologies and biotechnologies for increased resource use efficiency and productivity in key agricultural systems.

An additional area of interest concerns soil. It was suggested that there is a need for improved understanding and control of soil functioning and biodiversity and biotic interactions at field and landscape scales as well as the identification of soil protection strategies.

<u>Core theme 3</u>

For core theme 3, Assessing and reducing tradeoffs between food supply, biodiversity and ecosystem services, areas of particular interest concerned biodiversity and ecosystem services. Questions include whether agrobiodiversity could help to counteract the consequences of climate change, how to make more efficient use of the other than the plant biota (microorganisms, animals, insects) for increased resource use efficiency and productivity in key agricultural systems, and which functions do whole organisms and populations have in real production systems. It was further suggested that there is a need for interdisciplinary research by combining agro-ecological research with social learning approaches to address the interconnections between biodiversity, food supply and ecosystem services.

Concerning ecosystem services, priorities concern mainly the assessment of ecosystem services: there is need for a review of ecological services, mechanisms to evaluate the eco-system services by designing indicators of sustainability and resilience of agricultural systems and finding parameters for modeling and to get an overall picture of the aggregate of services provided by agricultural systems and how they change with changing context.

<u>Core theme 4</u>

Core theme 4, Adaptation to climate change, received the most interest in the consultation. Areas of special interest concerned disease, pest and weeds, regional approaches / studies, farming systems and management, water, phenotyping and breeding. Many respondents pointed out the need to better understand existing and emerging plant and animal diseases, for example through epidemiological models, as well as the need to develop better protection strategies, including through genetic studies and breeding, control of vector (insects) transmission of emerging livestock diseases and biological control. It was also pointed out that there is a need to understand new weeds and the changes in the population of the existing ones.

A second area of interest concerned regional approached to climate change adaptation. The need to assess regional farming systems under climate change was stressed as well as the potential role and contribution of local regional supply chains in improving food security resilience at local level. It was also suggested to develop farming systems integrated in the specific landscapes and efficiently adapted to a regional level. Some respondents emphasized the need for particular attention to the Mediterranean, where climate change is expected to have early and strong impacts on agriculture.

Related to this, it was suggested to examine the links between different agricultural production systems and adaptive capacity with respect to physical and socio-economic indicators, both on community and on farm level. Another topic for investigation is the potential for management to provide adaptation, i.e. improved agronomy such as water harvesting and conservation tillage.

A third area considered of interest is water. The need for efficient technologies for water management including disinfection and re-use were pointed out. It was also suggested that understanding is needed on the effects of water deficits as well as flooding on productions systems and how to adapt to these conditions.

Phenotyping and breeding for adapted varieties was also considered as priority for the FACCE – JPI. It was suggested that there is a need for designing management relevant novel ideotypes adapted to climate change and elevated CO_2 and assessing groundbreaking designs for advanced plant and animal phenotyping facilities under climate change. A network of phenotyping facilities across Europe was suggested. As in core theme 2, it was suggested that breeding of adapted varieties of crops and grasses and more robust animals (including in aquaculture) should be a short-term priority as this is a long-term endeavor. It was also pointed out that there is a need to look at additional abiotic stresses such as flooding, soil salinity, frost and cold.

Core theme 5

For core theme 5, Mitigation of climate change, areas of interest concerned carbon sequestration, life cycle analysis, land use, assessing of emissions and mitigation potential and energy.

Concerning carbon sequestration, it was indicated that there is a need to better understand soils and their role in greenhouse gas emissions and the effects of forest management on soil carbon sequestration (including Mediterranean agro-forestry systems).

A second area of interest was considered to be life cycle analysis. It was suggested that there is a need to create an international network of agricultural researchers to build protocols for data collection/homogenisation aimed at developing robust datasets useful for LCA (Life cycle analysis), including for organic farming.

Concerning land use, further research is also suggested on how to achieve ecologically efficient land allocation at a variety of spatial scales, including identifying possible linkages between sustainable intensification of agricultural production and deforestation, and the need to increase food production on existing agricultural land, and to implement landscape level solutions for food security, adaptation and mitigation. A further topic concerns the identification of drivers of abandonment/intensification in EU agriculture and strategies for balancing the land use at regional scale.

Respondents considered that there is also a need for better modeling of greenhouse gas emissions as well as assessment of indirect emissions. Another key area is to increase understanding the abatement potential of different measures, including changes in food systems and the use of organic fertilisers.

Limiting use of fossil fuels and increasing energy efficiency in agricultural systems and making use of agroforestry resources for biofuels were additional suggestions from stakeholders.

Breakthrough technologies

In the Scientific Research Agenda (p. 54), the need for a roadmap of breakthrough technologies is highlighted. A number of responses from the consultation refer to areas that can be considered under this category. A general question concerns the potential for increased efficiency and productivity by innovative (eco-)technologies and agricultural production systems. The environmental impacts, including on biodiversity, of new technologies also need to be examined. Specific suggestions concern research on ICT and real-time sensing technologies to understand and efficiently control the introduction of new agronomic and supply chain practices. It is pointed out that the ICT sector has been identified as a major player in the fight against climate change – in particular its role in improving energy efficiency, but also efficiency of other resources. ICT can make a key contribution to unlocking the large untapped potential for improved energy efficiency across Europe. ICT also provide new approaches for sustainable intensification of agricultural systems (Knowledge based IT innovations).

Another suggestion concerns the development, in the long-term, of high efficiency mixed crop systems based on perennial plants for food and feed production, requiring a complete re-think for agricultural production and food consumption. It was also suggested that the development new crop varieties could aid in the mitigation of climate change, for example, nitrogen-fixing cereals would greatly reduce the use of nitrogenous fertilisers.

The development and wide-spread use of renewable energy technologies was also seen as a means of contributing to FACCE – JPI goals.

Upstream research

The FACCE – JPI has an extremely wide scope and cannot take on all related upstream research. It is nonetheless acknowledged that this fundamental research is critical. Among the subjects that were mentioned in this category are the need for increased research on reproductive biology of animals and plants and the role of diverse climatological circumstances on reproductive performance. Stress physiology of plants and animal is also cited as an area for increased fundamental research.

Another area considered as upstream research is the study of plant signaling and adaptation mechanisms in model plants such as Brachypodium as well as the study of plant interactions with beneficial microbes toward enhancing crop stress tolerance and an improved use of resources such as N, P and water.

Finally, it was suggested that there is a need for new bioinformatic and statistical tools for the integration of molecular, phenotypic and environmental data.

Global approach

Although FACCE – JPI is focused on Europe, the Scientific Research Agenda recognizes that Europe is part of a global system of food production and consumption. Thus, for FACCE-JPI it is proposed to cover the role of Europe for sustainable resource (land and water) use and for European and global food security. Nonetheless, the Scientific Research Agenda proposes a complementary focus on food security and climate change impacts on surrounding regions (e.g., the Mediterranean Basin) and on outside Europe (e.g., in Sub-Saharan Africa), that could be carried out through collaborations with other countries and with international programs, such as the Climate Change, Agriculture and Food Security (CCAFS) of the CGIAR.

Respondents to the consultation also raised issues relating to the global aspects of the FACCE – JPI challenges, for example, how policy decisions in EU will impact other regions of the world and the need to link European efforts to food security and climate change impacts in other parts of the world to understand the implications of our global economy under climate stresses. It was also considered that risk assessment of climate change impacts and concepts for sustainable intensification need to be developed for agriculture at a global level.

SUPPORTING ACTIVITIES

Protocols and data

A recurring remark concerned the need for harmonisation of methods and protocols as well as modeling systems and the need for common databases[5]. Specifically mentioned was the need for development of common protocols for measurements of key processes (e.g. carbon sequestration, greenhouse gas emissions) at field scale, development of protocols for climate model downscaling and the development of sound databases useful for Life Cycle Assessment in Agricultural systems. These tools were seen as necessary to order to enhance sharing and dissemination of information and new knowledge. See also the next section.

Sharing data and databases

Concerning how sharing of data and databases should be done, a large majority of respondents indicated that the sharing of public data and databases was of high importance, although questions of intellectual property were raised by a subset of the respondents. Mapping of existing databases could be a first step. The solutions proposed for sharing were research consortia or projects, workshops and networks. Some thought that centralized databases could be an answer. It was also pointed out that before resorting to new tools, existing databases could be shared, for example. ClearingHouse, CIRCLE-2 INFOBASE, the ICT-AGRI tool MKB (Meta Knowledge Base).

[5] A FACCE – JPI "project lifecycle" has been proposed by the Scientific Advisory Board that includes harmonisation of protocols, data sharing and common databases, and will be elaborated in the Strategic Research Agenda.

It was remarked that in order to share data and databases, common formats are necessary. “Another issue is the "homogenisation" of datasets and the quality control, implying the definition of clear protocols for data sharing which reduce ambiguity or bias.”

It was emphasized that it is necessary to maintain databases up to date for the information to be useful.

Many respondents thought that data and database sharing could be done through a website, and others indicated that publications or a newsletter would be a means.

Finally, it was suggested that EU funding could facilitate this process.

Research infrastructures

The question was specifically asked as to what are the research infrastructure needs to support the FACCE-JPI. The responses to this question were quite diverse, perhaps reflecting the need to better define what research infrastructures are. Although a few responses indicated that existing research infrastructures are sufficient, some pointed out the need for research equipment or experimental fields. It was also suggested that there could be research infrastructures based on networks of long term platforms specific for each production sector. A number of responses referred to the need for infrastructure related to data and modeling, such as a unified database, a meta-database or a modeling platform, requiring IT technologies. These issues confirm the priority in FACCE – JPI to continue dialogue with infrastructures (such as ANAEE and ELIXIR).

A large number of responses indicated the need to form partnerships and/or networks. It was pointed out that more cooperation and coordination are needed to avoid fragmented research and to promote efficient research funding. Different suggestions included networks and scientific co-ordination, including focus groups specifically for scientists in specialist fields, public-private partnerships (PPP) to transfer and share knowledge created by academia to industry and vice versa, or collaboration with developing countries, as joint Europe-developing country actions.

It was pointed out that the FACCE – JPI will require a broad range of independent researchers from various sectors and with different backgrounds and it was suggested that this could be aided by the identification of the existing groups across the EU who are vertically integrated to the Core Themes and then a further phase of identification of the groups who can provide cross cutting technology or commercial capabilities to the Core Themes. It was also indicated in this section that training and capacity building are important aspects. The need to communicate results was highlighted, particularly to stakeholders, including farmers.

Concerning this question, many responses indicated the need for additional funding. Concerning research infrastructures, some respondents indicated that it is not new infrastructures that are needed, but funds and personnel to run on the existent ones. It was suggested that “reduction of funding and fragmentation decreases the competitiveness in the face of rapid global technology development” and that long term research perspectives are needed.

The particular problem of transnational cooperation over a broad scope of research was highlighted: It was suggested that to get people to work across national boundaries and disciplines will require considerable 'greasing of wheels' through financial incentives to be done effectively.

It was suggested that there is a need for long-term coordinated funding schemes, which might come from the EU in the form of projects or ERA-NETs related to the JPI.

One specific suggestion was for the development of a network of interlinked long term observatories at field or catchment scales (e.g. for carbon sequestration and GHG emissions), able to supply robust databases which are essential for calibrating and validating biophysical models, under a wide range of EU conditions.

Links to other JPIs and European initiatives

The Climate JPI responded to the consultation and indicated that the FACCE – JPI needs more relations with climatology. In relation to the FACCE – JPI, they specifically highlight the need to know the user needs for climate services concerning climate variability, seasonal to decadal predictions and how to best supply the information needed for agriculture and farming systems. They also point to the need to further understand climate-forcing aspects of aerosols (and soot) and interactions. Further advances require process-oriented studies and consideration of observations, experiments and model development. They further state the need for long-term dedicated research studies involving observation programmes, theoretical studies, model development and process-oriented model evaluation.

In addition to the Climate JPI, FACCE – JPI will establish links with the JPI on water and to a lesser extent with the JPI Oceans. Several respondents emphasised the need to take water into account more fully in FACCE – JPI and other pointed to marine aquaculture as a way forward. Through establishing closer links with these other JPIS, FACCE – JPI will coordinate on research priorities to avoid duplications and cover gaps.

Links may also be made to the European Energy Research Alliance (EERA) to take on board questions concerning biofuels, as it was suggested that closer ties to the energy sector are needed.

Finally, the FACCE – JPI should make links to the European Institute of Technology (EIT) initiatives, the existing Knowledge and Innovation Community (KIC) on climate and the future KIC Food.

Education and training

The FACCE – JPI recognizes the need for education and training in the areas addressed as well as the need for capacity building. It is known that farmers in Europe are an ageing population. It was cited that throughout Europe, plant breeders are becoming scarcer, particularly in the public sector, and recruitment to plant breeding courses in Universities and other academic institutions is declining. This poses a severe sustainability challenge to the European plant breeding and seeds businesses and the development of future crops/cropping systems.

The role of Universities was also highlighted, both as educational institutions but also for their contributions to research and innovation, by creating framework conditions bringing research and innovation together.

It was also pointed out that social science and humanities are important research areas that can enable diffusion of skills in order to meet the global challenges. Intercultural understanding and interactive learning tools are among the many disciplines that are needed to fulfill the goals.

Communication and dissemination

Research community

Respondents indicated the need to communicate within the research community on FACCE – JPI outputs. It was suggested that there was need to publicise the JPI and its activities among researchers, perhaps through international conferences or seminars, through the web site and newsletter and by using modern communication technologies.

Stakeholders

A need to communicate and form links with stakeholders, in the broadest sense, was highlighted. This includes companies and especially SMEs, so that they can take up the research findings toward innovative products, practices and services, European Technology Platforms, all sectors of the bioeconomy web, farmers and the farming industry, including extension services (see also below) and NGOs.

Knowledge transfer

The need to transfer FACCE – JPI findings to stakeholders (here: end-users) and in particular, farmers and the farming industry, was highlighted. Specifically, the need to link outcomes of climate change risk assessment to the researchers/practitioners who will need to respond (e.g. crop breeders, disease researchers, land management expertise) was mentioned. It was suggested that there is a need for the integration of innovative and sustainable agricultural dynamics in the upstream and downstream sectors Specific suggestions included institutional innovation, "research-actions", i.e. the co-construction of new production systems with farmers and transposition of existing innovations (i.e. reuse or generalisation, with possible adaptation of innovative approaches which already exist) and the setting up a catalogue of techniques available on line (not restricted to techniques presently in use, but encompassing the whole "book of blueprints" which constitutes the original concept of a production function in economy).

Policy dialogue

The research from the FACCE – JPI can contribute to EU and national policies concerning food security and climate change and this policy dialogue will undoubtedly be necessary for the FACCE – JPI research to have an impact on the global challenge. The question of how the research produced will be taken up by policy makers, researchers, land managers is important and it was suggested that greater emphasis could be given to research focusing on the best policy mechanisms to achieve the objectives set out by the FACCE – JPI. Another question concerns the effects and consequences of different agreements, policies and laws on agricultural production and land use (e.g., the effect of the Sustainable Use Directive 2009/128/EC on the development of new improved farming systems and the implementation of changes in the agricultural production systems).

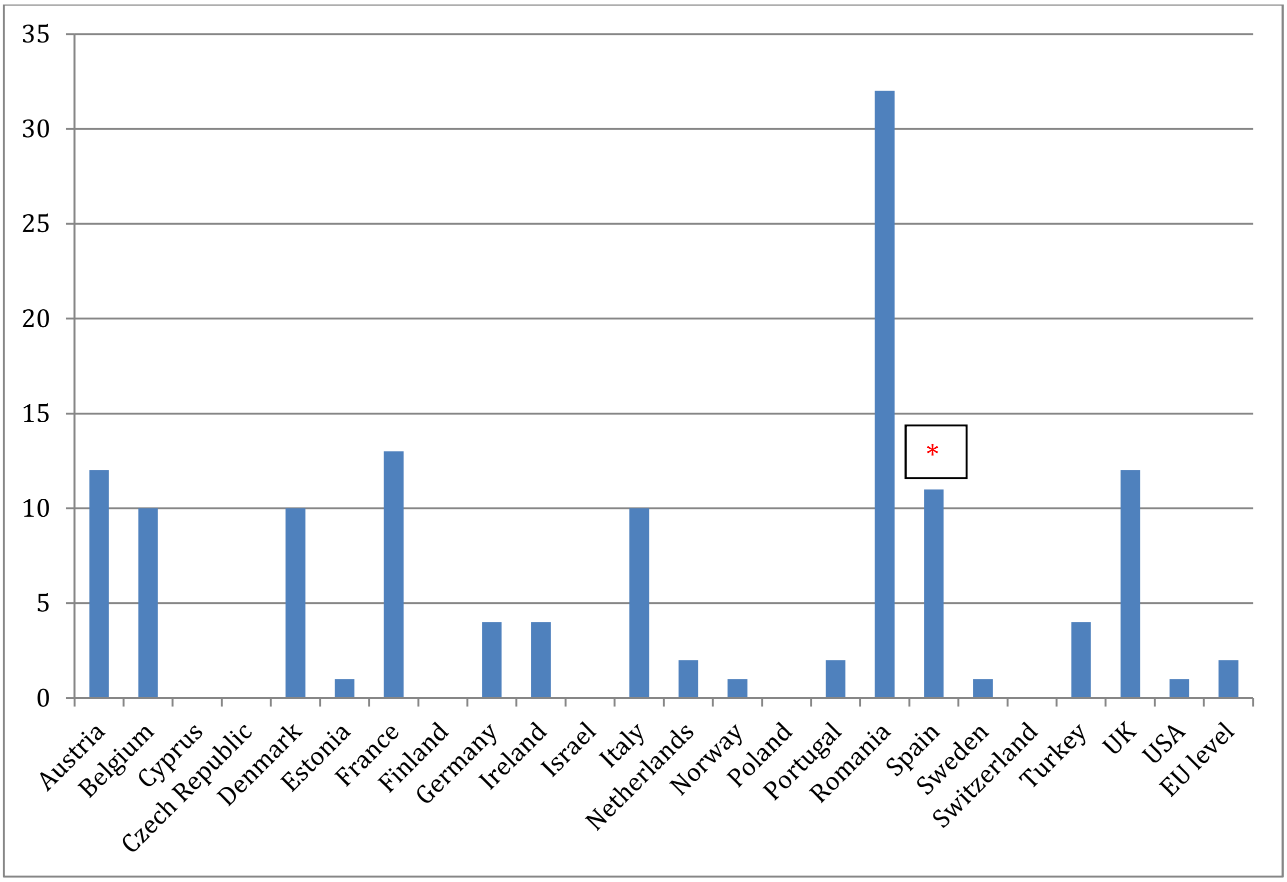
Concretely, it was suggested that a mid-term priority for the JPI should be to invest on research-policy interfaces and interdisciplinary approaches at the case-study scales, i.e. the development of a network of case-study scale observatories for experimenting new modalities for connecting

Funders

Through the participation of representatives of funding agencies in the Governing Board and mapping meetings (see www.faccejpi.com), a dialogue with funders has been initiated. It was suggested that there is a need to define a strategy for involving national and sub-national funding agencies in addressing efforts in the context of the FACCE issues, implying the encouragement of all EU researchers and funding agencies to develop research activities that are consistent with the FACCE priorities, protocols and approaches.

Annex 1: List of respondents

Participation by Country



*Plus summary from 32 responses in Spanish, see below.

International organisations (6)

a.v.e.c., Belgium
Animal Task Forces, Netherlands
Association for European Life Science Universities (ICA), Belgium
European Plant Science Organisation, EPSO
European Seed Association, Belgium
FoodDrinkEurope

International research initiative (1)

The Agricultural Model Intercomparison and Improvement Project (AgMIP), USA

European research initiative (e.g. ERA-NET, other JPIs) (6)

Circle-2, Portugal
ERAnet BiodivERsA, France
ERA-NET EUPHRESCO, Austria
ICT-AGRI ERA-NET, Denmark (2)
JPI Climate

European Technology Platform (4)

European Technology Platform 'Plants for the Future', Belgium
FABRE-TP, EU level organisation
Hervé MARION / ETPGAH, Belgium
TP Organics, Belgium

National Government (4)

Department of Agriculture Northern Ireland (DARD), Ireland
ISPRA - Italian Institute for Environmental Protection and Research, Italy
Ministry of Agriculture, Forestry, Water Management and Environment, Austria
Ministry of Agriculture, France Bruno Hérault, Centre d'études et de prospective

Regional/local government (2)

Van Cauwenberg/SPW, Belgium
Welsh Government, UK

Non government organisation (6)

AUREL POPESCU / ROMPAN - Romanian Employers Association of the Milling, Bakery and Flour Based Products Industry, Romania
IFAH-Europe, Belgium
Irish Cattle Breeding Federation Society Ltd, Ireland
Liliana Pagu, Women''s Association of Romania
1 anonymous

Private enterprise (250 or more employees) (1)

HOFIGAL Export Import S.A., Romania

Private enterprise (less than 250 employees) (5)

Enzymes&Derivates S.A., Romania
SAT 9892 VALLEHERMOSO SRL, Spain
SC ALL GREEN SRL, Romania
SC INTELECTRO IASI SRL, Romania, Turkey
Talat Ciftci /BIOSFER Ltd.

Public agency (8)

Andreas Baumgarten/AGES, Austria
BFW, Austria
Bluemel/Austrian Agency for Health and Food Safety, Austria
ERSAF, Regional Entity for Services to Agriculture and Forests, Lombardy Region, Italy
Geoff Radley / Natural England, UK
Helge Løtveit /Norwegian Food Safety Authority, Norway
Neil Auchterlonie, UK
Pearse Buckley / Sustainable Energy Authority of Ireland, Ireland

Farmers' organisation (5)

Etienne Pilorgé / CETIOM Technical institute for oilseed crops and industrial hemp, France
NFU, UK
Romanian National Private Employeers Union, Romania
World Farmers Organisation, Denmark
Centre National Interprofessionnel de l'Économie Laitière (CNIEL)

Farm extension/advisory service (2)

Kirsten Klitgaard / Knowledge Centre for Agriculture, Denmark
Oficina de Transferencia de Resultados de Investigación (OTRI), Spain

University/ higher education (29)

Citizen, Ireland
Cosier Viorica, Romania
Cozma Vasile/University of Agricultural Science and veterinary medicine Cluj-Napoca, Romania
Daniel Dezmirean / University of Agricultural Science and Veterinary Medicine Cluj Napoca, Romania
Dept. of Agronomy, Forest and Land Management, Italy
Dr Bruce Grieve, The University of Manchester, UK
Faculty of Veterinary Medicine, Romania
Gabriela CONSTANTINESCU (POP)/University Stefan cel Mare of Suceava, Food Engineering Faculty, Romania
Jørgen E. Olesen / Aarhus University, Denmark
Juan A. Blanco / Universidad Publica de Navarra, Spain
Katarian Vrede/Swedish University of Agricultural Sciences, Sweden
KU-LIFE, Denmark
Maria Blanco/Universidad Politecnica de Madrid, Spain
Ondokuz Mayis University, Turkey
Polytechnic University of Madrid, Spain
Popescu Corina/"Valahia" University of Targoviste, Romania
Prof Chris Franklin, UK
University Innsbruck, Austria
University of Aagronomic Sciences and Veterinary Medicine Bucharest - Faculty of Biotechnology, Romania
University of Agricultural Science and Veterinary Medicine Cluj Napoca, Romania
USAMV BUCHAREST, Romania
Vibeke Langer University of Copenhagen, Denmark
ZEF, University of Bonn, Germany
University of Bologna
University of Torino
University Lucian Blaga of Sibiu
Francesco Danuso - University of Udine
NAPLES UNIVERSITY FEDERICO II
Pier Paolo Roggero/University of Sassari

Public research organisation (26)

Agricultural engineering Research Council, Italy
AIT, Austria
CIRAD, France (2)

Dr. Anton Hausleitner, Austria
Eugen Gheorghiu/International Centre of Biodynamics, Romania
Felicia Muresanu/ Agricultural Research and Development Station Turda, Romania
GDAR, Turkey
Giles Oldroyd/John Innes Centre, UK
Greimel/citizen, Austria
Heinrich Prankl / BLT Wieselburg, Austria
ICEADR, Romania
INMA, r(Marin Eugen) Romania (2)
INRB,I.P./IPIMAR, Portugal
Institute for Agricultural and Fisheries Research, Belgium
Institute of Research and Development for Aquatic Ecology, Fishing and Aquaculture, Romania
Instituto Valenciano de Investigaciones Agrarias, Spain
Marian Vintila / Institute for Research and Developement for Industrialisation and Marketing of Horticultural Products, Romania
NEIKER-Tecnalia, Spain
Ramón Carreres/Rice Department (IVIA), Spain
Research and Development Station for Sheep and Goats Caransebes, Romania
Research Institute for Fruit Growing Pitesti, Romania
Research-Development Institute for Plant Protection, Romania
Rothamsted Research, UK
Wolfgang Cramer, France

Research funding organisation (4)

Agricultural Research and Development Station Braila, Romania
FNR, Germany
BBSRC, UK
anonymous, UK

Private research organisation (4)

CETaqua - Water Technology Centre, Spain
GFP - Gemeinschaft zur Förderung der privaten deutschen Pflanzenzüchtung e.V, Germany
Juan Manuel Saiz/CNTA. National Centre for Food Technology and Safety, Spain
Sebastien Treyer, France

Experienced researcher (13)

Austrian Institute of Economic Research, Austria
CARMEN BRACACESCU/INMA Bucharest, Romania
Charley, France
Citizen, France
Dr Zoe Wilson/University of Nottingham, UK
ESNOUF/INRA, France
Estonian University of Life Sciences, Estonia
Fatih Evrendilek/Abant Izzet Baysal University, Turkey
Mihael Cristin ICHIM/ STEJARUL Research Centre for Biological Sciences, Romania
University of Agricultural Sciences and Veterinary Medicine - Bucharest, Romania

University of Copenhagen, Denmark
Hans Peter Ravn, Univ. Copenhagen, Forest & Landscape, Denmark
Marco Acutis

Misc. (8)

Spanish KBBE Representative, CDTI. Centre for the Development of Industrial Technology. Ministry of Economy and Competitiveness, Spain
Bucharest Ilfov Occupationnal and Social Inclusion Regional Pact, Romania
Agricultural Science Association (ASA), Ireland
Agricultural think tank , SAF-agriculteurs de France, France
Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management, Department Milk, Thomas Neudorfer, Austria
European Food and Drink Industry association, Belgium
ACTA, France
Deltares, NL

Spanish stakeholders

INIA	National research institute
Clúster Agroalimentación y Salud- UPM y UCM	National research institute
Instituto de Investigaciones Marinas - CSIC	National research institute
Fundación Produce Aguascalientes	NGO
Fundación Global Nature	NGO
CERAI-Centro de Estudios Rurales y de Agricultura Internacional	NGO
GRUPO ENHOL S.L.	Private company
Biomar Iberia, S.A.	Private company
Ingeniatrics	Private company
CNTA. Centro Nacional de Tecnología y Seguridad Alimentaria	Private research institute
Centro Tecnológico Leitat	Private research institute
TRAGSATEC (Grupo TRAGSA)	Public company
INIA - CIFOR	Public Research Institute
Neiker-Tecnalia, Instituto Vasco de Investigación y Desarrollo Agrario	Public Research Institute
Centro de Investigación y Tecnología Agroalimentaria de Aragón	Public Research Institute
IVIA-DEPARTAMENTO DEL ARROZ	Public Research Institute
Centro Tecnológico Forestal de Cataluña	Public Research Institute
Instituto de Agrobiotecnología (IdAB). CSIC_UPNA_Gobierno de Navarra	Public Research Institute
IRTA (Institut de Recerca i Tecnologia Agroalimentaries)	Public Research Institute

Instituto Tecnológico de Canarias	Public Research Institute
INIA-CIFOR	Public Research Institute
Gobierno de Navarra. Departamento de Desarrollo Rural, Industria, Empleo y Medio Ambiente.	Regional administration
VICECONSEJERIA DE PESCA DEL GOBIERNO DE CANARIAS	Regional administration
BIOPLAT	Technology platform
Plataforma Tecnológica Española de Sanidad Animal, Vet+i	Technology platform
Plataforma Tecnológica Gallega de Medio Ambiente ENVITE	Technology platform
INVEGEN	Technology platform
Universidad Pública de Navarra	University
Universidad Politécnica de Madrid (UPM). ESTI Agrónomos	University
Universidad de León	University
Universidade de Santiago de Compostela	University
Campus de Excelencia Internacional Agroalimentario ceiA3 – Universidad de Cádiz	University

Annex 2: Areas of special interest to stakeholders

General remarks

- Short and medium term research priorities should not only include assessment studies and modeling but should also embrace experimental research (relating predictions with actual information on the adaptation of plants and farming systems))
- Need more experimental information using realistic scenarios before implementing the use of models.
- Always complement top-down with bottom-up approaches at all steps from strategy development to implementation
- Provide in and via FACCE JPI equally strong support of each component – basic research, applied research, knowledge transfer including demonstration projects, innovation framework, communication-education- outreach

Core theme 1: Sustainable food security under climate change

1.a.- Integrated food systems perspective, combining biophysical and socio-economic modelling with policy research perspective
1.b. Integrated risk analysis of the European agriculture (and food systems) under climate change: test responses to volatility both from natural and market phenomena
1.c. Global change impact and resilience of food systems (through the value chain and to the consumer)
1.d.- Europe's role in international markets, price volatility, global food security impacts
1.e;- Develop contrasted scenarios involving perceptions and policy dialog
1.f- Combine observations, experiments and modelling through the development of appropriate European research infrastructures.

Suggestions for Core theme 1: Integrated food security under climate change

- Scenarios and modeling
  - Develop scenarios of future European food production and supply
  - Develop production models to analyze the changes in productivity associated with climate change.
  -
  - Longer term: Develop new modalities for the scenario building exercise, beyond just forecasting and considering just available options, with a greater attention to the quality of the dialogical process between researchers, policy makers and stakeholders
  - Simulations to assess CC scenarios impacts on the production of the other regions of world, taking into consideration the different categories of goods (grains, oils, vegetal and animal proteins…)
  - There is a tremendous need for improved methodologies to aggregate detailed field-level data and simulations up to a larger scale that is more useful for policymakers and economic

modeling. This can be achieved using surveys, satellites, statistics, and process-based models, among other approaches.
- In the specific field of cropping system modelling (short term):building and homogenisation of robust datasets based on long term field crop experiments or observatories, linking remote sensing and cropping system modelling to address landscape scale processes (e.g .of abandonment and intensification)
- Improve the efficiency and reduce uncertainty in simulation models and GCM downscaling procedures
- Medium-term: Quantitative methods for assessing resilience.

Economics

- Transmission of volatile prices from farmers to consumers, who gains profit through volatile / rising prices?
- Modeling the drivers of volatility should be higher in priority
- The empirical study of price formation on agricultural markets that are increasingly financialized is essential to understand the agricultural economy. The Marschalien framework of supply and demand is outdated for understanding the formation of commodity prices.
- What effects does increased competition for land-based resources have on producer prices and the economy in the agricultural sector (more large-scale and specialized production, or integration of production in new kinds of ownership and collaboration)?

Consumers

- Understand consumer's attitudes and behavior towards sustainable food production issues
- Development of less impacting lifestyles
- Consequences of changes in food systems (including food habits, processing, wastes, consumption …) on climate change (GHG, footprints, etc) and, conversely, climate change impacts on European food systems (including processing, retailing, transport, consumption patterns).

Misc.
- Inclusion of aquaculture (seafood and fisheries being out of scope of the FACCE – JPI).

TO BE TREATED IN MACSUR

- Agricultural scenarios could be developed under the framework of AgMIP Representative Agricultural Pathways (RAPs).
- Development of common protocols for the combined implementation of climate, crop, livestock, trade models
- Contribution to the development of an international network of researchers building datasets and developing field experiments and model intercomparison exercise to reduce model uncertainty, e.g. development and validation of grassland and pasture modelling in Mediterranean dryland areas

- To develop prediction models to estimate the profitability of agricultural activities under different climatic conditions. This should be done taking into consideration environmental indicators of climate at regional level (Mediterranean)
- Develop production models to analyze the changes in productivity associated with climate change.
- Development of a transdisciplinary modeling framework capable of utilizing multi-model ensembles of climate, crop, and economic models

Core theme 2: Environmentally sustainable growth and intensification of agriculture

2.a.- Provide new approaches for improving farm management and for the sustainable intensification of agricultural systems, but also for low-input high natural value systems in Europe under current and future climate and resource availability;
2.b.- Understanding recent yield trends in Europe, taking into account changes in costs and prices and research investments as well as changes in environment, management and genotypes.
2.c.- Benchmarking efficiencies of resource use (water, N, energy) according to Genotype x Environment (including climate) x Management combinations across Europe
2.d. - Assessing and raising biological resource use efficiency of crop and livestock systems; increasing total factor productivity.
2.e.- Combining crop, livestock and bioenergy systems for sustainable intensification;
2.f.- Low input, higher efficiency seeds and breeds;
2.g.- Knowledge based IT innovations in agriculture;
2.h.- Improved understanding and control of soil functioning and biotic interactions at field to landscape scales.

Suggestions for core theme 2: Sustainable growth and intensification of agriculture

Choice of crops

- For enhancing crop adaption, it will be more efficient at least in the short-term to focus resources on the highest value crops, such as small grain cereals, the Solanaceae (tomato and potato) and legumes. In particular, Europe imports 80% of its animal feed and it would be highly desirable to develop a productive leguminous seed crop.
- Also the better utilisation of other plants, as alternatives to cereals and oilseeds in animal feeds, and alternative sources of protein to soy.
- Long long term. Development of food and feed crops that are better adapted to human and domestic animal consumption from an evolutionary perspective than present crops.

Resource efficiency

- Mid-term: improved nitrogen use efficiency; nitrogen-efficient crops.
- How can recycling of nutrients, water and wastes become more efficient (at different scales)?
- Phosphorus cycling in ecosystems

- Coupled biophysical and economic models to deal with resource availability and resource use efficiency
- Spatio-temporal variations in closely coupled C-N-H_2O cycles
- Promote Eco-efficiency: for the use of resources, water, pesticides and soil degradation.
- Development of efficient fertilisation management programs
- Medium-term: More focus on plant roots for better water and nutrient uptake.
- How can resource use efficiency and production be increased on agricultural land while at the same time maintaining ecosystem services, biodiversity and animal welfare

<u>Productivity</u>

- Research towards achieving high productivity and quality of the final products.
- Fundamental understanding of crop yield and productivity is essential in this area. It cannot be presumed that we have all knowledge we need of the crop systems in order to generate innovative solutions for the agricultural sector.
- Research priorities should not neglect that also organic farming is able to fulfill productivity demands including higher standards regarding the production. Therefore considerable conceptual research still needs to be done on how to optimally represent the "ecosystem intensity" of a farming system. Widely accepted standardised indicators are needed to make systems comparable not only along the output per ha but along all the criteria of relevance for sustainable agricultural production.
- Benchmarking at farm gate the current state and historical changes and their main economic and management drivers in productivity and resource use and institutional innovations
- It is very important that productivity is also assessed at the scale of the farm or of the agricultural landscape, in order that innovations in agricultural practices, in the spatial organisation of crops, that are all linked to ecological engineering, are also taken into account

<u>Farm systems</u>

- What are the environmental and climate impacts of structural changes in agriculture – specialisation versus integration, small scale versus large scale, and geographic localisation?
- Development of new models for farm management and new models for interaction with suppliers and buyers
- Identify and assess good practical examples of designing resilient and sustainability farm systems, agriculture management (e.g. irrigation, landscape transformation, etc...) and low-carbon food distribution from national and regional projects.
- Farming systems using e.g. within and between species diversity across trophic levels in combination with genomic selection and conventional breeding should be short term
- There is extensive scope for investigation of novel and creative farming systems. For example, aquaponics systems combine aquaculture of e.g. Tilapia with hydroponic cultivation of horticultural crops. Such a systems level approach could hold great promise for turning agricultural wastes into a useful resource and may have wide applicability
- Experiments in practice with closing cycles, such as agroparks; combining crop, livestock and bioenergy systems for sustainable intensification

- The interaction between livestock and crop production within polycultural, agro-ecological systems.
- How can integrated systems – at different scales - for crop, livestock and energy production be designed and evaluated?
- Use of diverse production systems and how they impact on biogeochemical cycles and sustainable intensification
- Wider use of a farming 'systems' approach that uses within and between species diversity in combination with genomic selection and conventional breeding.
- Organic farming methods
- Short -medium term action: biodiversity based low-input high productivity multi-component farming systems

Bioeconomy, including waste and bio-energy

- We also recognize the need for integrating research and information into a bioeconomy value network (see Becoteps white paper)
- Utilisation of forestry biomass, agricultural and livestock byproducts and industry byproducts.
- By focusing the utilisation of the high value output (food, health ingredients, medicine) from the biomasses before the remaining part is left for medium value products (feed, materials) and in the end bio fuels and heat energy being a low value fuel product.
- New innovative and sustainable value chains must be created to meet the transition from fossil to bio based society with a clear focus on food security. Regarding food security it is important to utilize the crop residues, which today are left in the fields, for production of new food products and food and feed ingredients.
- Bioenergy and Biomass and their effect on the agricultural equilibrium.
- Logistics of agricultural raw materials
- Address the problem of losses and wastage of agricultural and food products
- Agricultural waste management; Reduction of waste in the food chain, use of side-products of production
- Valorisation of plant wastes
- Better utilisation of wastes
- Improved manure management in relation to GHG emissions and resource use efficiency (also CT5)
- How can recycling of nutrients, water and wastes become more efficient (at different scales)?
- Development of new harvesting concepts
- Concepts for bioenergy crop rotation and the extended potential of multiple use crops
- Improved understanding of how bioenergy crops can be included in crop rotations and the potential of multiple-use crops
- Impact on agricultural biomass as well as food; any synergies or trade-offs between them?
- Get a good idea of real life energy profiles of different production systems

Genetic Diversity

- New concepts for the evaluation of genetic diversity

- Concepts for the efficient use of genetic diversity
- Research into the management of genetic diversity in populations
- Assessment of existing germplasm for crop improvement to include yield increase, resistance to abiotic/biotic stresses and improved resource use. Need experimental evaluation of genotypes that have the required traits for breeding programmes.
- Untapped potential in wild relatives/ancestral species related to crop plants.
- Not only promote agricultural diversity but also the recovery of traditional cultivars.
- Study genetic variation in the utilisation of new and existing sustainable feed sources to replace marine feeds.

Breeding

- Plant breeding needs time, if new high yielding varieties should be on the market in 10-15 years, research on that has to start immediately to reach this goal, therefore the above mentioned long term priorities have to be switched to short term (Combined development of genomic selection, ecological engineering, precision farming, ecotechnologies and biotechnologies for increased resource use efficiency and productivity in key agricultural systems -> medium term)

Soil

- Soil characteristics and adaptive capacity of farming systems
- Identification of soil protection strategies
- A clearer entry through improved understanding and control of soil functioning and biotic interactions at field and landscape scales.
- In the specific context of high input farming systems: Understand the relationships between cropping systems, soil biodiversity and the improvement of nitrogen use efficiency and reduce the GHG emissions.

Core theme 3: Assessing and reducing tradeoffs between food supply, biodiversity and ecosystem services

3.a.- Provide new approaches to the increased use of functional biodiversity in agricultural systems (e.g. intercropping, mixtures, conservation agriculture…)
3.b.- Developing methods for assessing and valuing biodiversity and ecosystems goods and services (e.g. carbon sequestration, water storage…) in intensive agricultural systems;
3.c.- Develop approaches for optimizing the trade-off between agriculture and ecosystem services in a variable environment (climate change, volatility…) and at farm scale;
3.d.- Develop a solid knowledge basis for the provision of public goods by European agriculture, so that ecosystem services are delivered efficiently and effectively.

Suggestions for core theme 3: Optimizing tradeoffs: food production, biodiversity & ecosystems services

Biodiversity

- The impact of climate change on biodiversity and small farmers in medium and long term.

- How will CC affect the biodiversity is one theme, but turned around: How can the agrobiodiversity help to counteract the consequences of CC?
- Efficient use of the other than the plant biota (microorganisms, animals, insects) for increased resource use efficiency and productivity in key agricultural systems.
- Which functions do whole organisms and populations have in real production systems?
- Enhance interdisciplinary research by combining agro-ecological research with social learning approaches to address the interconnections between biodiversity, food supply and ecosystem services
-

Ecosystem services

- In the specific context of low input systems: Understand the role(s) of micro-gradients in mixed agro-ecosystems (eg trees in silvo-arable systems, edges) in improving the stability and resilience of ecosystem services
- The main issue is to get an overall picture of the aggregate of services provided by agricultural systems and how they change with changing context
- Review of ecological services
- Increased basic understanding and evaluation the present understanding of agricultural ecosystem functioning in parameters that can be adapted for modelling
- The now suggested activities are focused on assessment and modelling that requires that the basis for the understanding of agricultural ecosystems is sound.
- To define/establish mechanisms to evaluate the eco-system services by designing indicators of sustainability and resilience of agricultural systems.
- To complement the use of new with the generation of solid knowledge to understand the ecosystem processes technologies associated with resilience capacity and adaptation to climate change.

Misc.

- The potentials of permaculture and agroforestry could be of interest. In addition, the aspect of direct marketing which abbreviates CO_2 footprint by shorter ways of distribution and contributes to an empowerment of rural areas is as well forgotten as one solution to reduce trade-offs.

Core theme 4: Adaptation to climate change

4.a. Adaptation to climate change and increased climatic variability throughout the whole food chain, including market repercussions;
4.b. Tailoring adapted regional production systems under climate change;
4.c. Adapting seeds and breeds through conventional breeding and biotechnology[6] to new combinations of environment and management: e.g. abiotic stresses, elevated CO_2;
4.d. Monitoring pests and diseases and developing climate-informed crop and animal protection;
4.e. Adaptive water management in agriculture, watershed management, flood management, irrigation technologies, water re-use;

[6] Biotechnology here is used in a broad sense, referring to marker-assisted selection, genomic selection and genetic modification methods.

4.f. Adapting food processing and retailing, markets and institutions to increased climatic variability and climatic change.

Suggestions for core theme 4: Adaptation to climate change

Disease, pests, weeds

- Improve Plant breeding and Plant protection strategies
- Biological control of pests and diseases.
- Creating network connection across Europe mapping and interpreting the patterns of changes in occurrence of problems with growing conditions, pests and diseases changing their distribution, behaviour, importance and phenology
- Disease prevention to improve efficiency and so reduce emissions (livestock)
- Weed control.
- Impact of future climate changes on animal health and welfare
- Disease resistance and robustness of animals, specifically the opportunities to cope with various environments, Reduction of global animal disease levels (also 2,4,5)
- Data on livestock disease occurrence and its evolution over time
- The impact of climate change on the movement of disease into new areas
- The optimisation of pest, weed and disease management programs in a changing world
- Control of livestock diseases by low input procedures, incl. vaccines, prevention, genetic resistance; control of vector (insects) transmission of emerging livestock diseases
- The study of emerging animal diseases related to the presence of insect vectors into unusual new regions given the climate (particularly zoonotic diseases
- (Regional scale) strategies for preserving gene resistance against pests, diseases and pathogens in crop species, drought and heat tolerant productive crop species and thermo-tolerant animal species are short term priorities
- Forecasting pests and diseases.
- Epidemiological models and near real time climate-informed forecasts of pests and diseases.
- Which management options and technologies exist to combat emerging pests and diseases in crop and livestock production?
- Control of animal health and the spread of pathogens that affect them.
- Looking into the future of new possible animal diseases and their prevention
- Higher priority (and corresponding efforts) should be given to epidemiological models, including identification of potential new pests in Europe.
- Limiting effects of climate change and the associated risks for animal health (including existing and emerging pests and diseases).
- To obtain healthy food by promoting plant and animal health.
- Other biotic stresses apart from pests and diseases should be taken into account, for example increase knowledge about new weeds and the changes in the population of the existing ones

Regional approaches / studies

- What is the value added created by **regional farming systems** under climate change?

- Research should also address the adaptive potential of different agricultural production systems towards the regionally expected key impacts of climate change, e.g. increased water stress, heavy precipitation events, or pest and disease pressure.
- Potential role and contribution of local regional supply chains in improving food security resilience at local level
- Develop farming systems integrated in the specific landscapes and efficiently adapted to a regional level.
- Tailoring adapted regional production systems under climate change: I see big differences in adaptation strategies in the different European regions, but all the adaptation problems need to be faced under the specific pedo-climatic and social conditions.
- More attention at local systems and regional scale.
- Cultivar suitability and shifts in the length of regional growing seasons.
- Assessment of the eco-efficiency of key farming systems within European sub-regions.
- Analysis of the regional environment: Sustainable de-intensification when necessary.
- Some plants require long term before becoming productive (e.g. vineyards). Actions performed now can give benefits several years later. As a consequence of the research priorities above mentioned, I think that there should be also the inclusion of a new climatology of the agricultural production. In other words, to produce some thematic maps showing, for each area, which are the best cultivations there, according to the future climate scenarios. Then, it will be necessary also to convince farmers and producers about these changes, but this operation will be not pertinent to scientists.
- Exchange of good practices for Mediterranean and Mediterranean-continental crops.
- Introduce research priorities in relation with vegetables grown in Mediterranean conditions / greenhouses.

Farming systems and management

- Linkages between on-farm and landscape farming system diversity and adaptive capacity with respect to physical and socio-economic indicators, both on community and on farm level.
- What are the vulnerability, adaptability and resilience of different agricultural production systems?
- Longer-term: Potential for management to provide adaptation, i.e. improved agronomy such as water harvesting and conservation tillage.

Water

- Water management efficient technologies for irrigation
- Water disinfection and re-use in the food industry
- Make more use of water aspects in FACCE JPI, especially groundwater resources!
- Special interest would be in water deficits, temperature (including predictions of root/soil temperature) as well as flooding issues (predictions as well as adaptation of plants and farming systems) but also increasing CO_2 as an important input factor for plant production.
- Already try to seek adaptive and mitigative strategies for more robust, flexible and sustainable fresh water supply on the short term!

Phenotyping

- Advances concerning ideotypes (especially oilseed crops) and phenotyping methodologies and facilities.
- Designing management relevant novel ideotypes adapted to climate change and elevated CO_2 and assessing groundbreaking designs for advanced plant and animal phenotyping facilities under climate change.
- Network of phenotyping facilities across Europe and in emerging countries covering essential environmental regions for adaptation
- Establishment of a network of phenotyping facilities for crop/variety selection
- Translational phenotyping activities – going from the lab to the field
- Short term: collection of a large set of a broad range of phenotypic records

Breeding

- Plant breeding needs time; if new high yielding resource-use efficient varieties adapted to climate change should be on the market in 10-15 years, research would have to start immediately to achieve this goal
- The importance of genetic data on aquaculture species, providing a resource that supports improvements in the efficiency of production within changing scenarios.
- Breeding more robust animals that are able to cope with a more variable temperature and water supply without detriment to health, welfare and productivity
- Improving grassland management and grass breeding at a more variable temperature and water supply
- Breeding of plants for improving sustainable cropping systems (low input, high yield)
- How can crop species and varieties and livestock species and breeds be adapted to new climatic conditions (higher temperature, longer periods of drought, extreme weather events etc), and what is the potential for domestication of "new" species (e.g. to utilize marginal areas and organic waste)?
- The identification of germplasm that is more able to withstand fluctuations in temperature during reproduction, and the development of molecular tools to overcome temperature stress are vital to ensure future sustainable crop yields under conditions of climate change and temperature fluctuations.
- Drought and heat tolerant productive oil crop species.
- Promote Eco-technologies: plant breeding, biomass production, and seeds of cultivars suitable for adaptation to climate change.
- Long term: Invest on a diversity of crops and varieties of food and non-food crops. Invest on cropping system diversification and strategic allocation of agricultural production at regional and global scale (eg reduce vulnerability associated to specialisation of crop/livestock production in few districts at global scales)
- Other abiotic stresses apart from water stress or heat should be considered as priorities for core theme 4. Thus, adverse conditions like soil salinisation, flooding or oxidative stress (drought, flooding, soil salinity, frost, cold, heat) are unfortunately common in our study areas, causing important agronomical and economical damage

Misc.

- The influence of climate change on plant fertility
- Resilience of animal feeding and drinking systems (also 2,4,5)
- Modelling the effects of temperature increase on animal performance and efficiency to modify the current housing conditions ((also 2,4,5)
- Short-term: Remote sensing techniques for plant roots.
- New modeling approaches for improving adaptation, especially to extreme events
- Short term: - design adaptation strategies in the short-term on the basis of the current transition emerging from increased climate change variability, in order to support short-run policy making

Core theme 5: Mitigation of climate change

-5.a. Contribute to direct reductions of GHG emissions through carbon sequestration, substitution of fossil-based energy and products, and mitigation of N2O and CH4 emissions by the agriculture and forestry sector, while reducing GHG emissions associated with indirect land use change;
- 5.b. Develop monitoring and verification methodologies of field, animal and farm scale GHG budgets, including, or not, indirect land use and cradle to grave life cycle;
-5.c. Develop verifiable GHG mitigation and carbon sequestration measures in farming systems;
-5.d. Develop technologies and methods to substitute fossil-fuel energy through increased use of biomass and other renewable energies in the agriculture sector without jeopardizing food security.

Suggestions for core theme 5: Mitigation of climate change

<u>Carbon sequestration</u>

- Soil C sequestration/remote sensing application for the evaluation of forest management effects
- Soils are very poorly understood and the systems and species responsible for release of GHG from soils is also poorly understood. Research is required in this area
- Low input – high C sequestration management of plant production
- Develop methods to estimate the carbon sequestration capacity of Mediterranean agro-forestry systems.

<u>Life cycle analysis</u>

- Medium term: Create an international network of agricultural researchers to build protocols for data collection/homogenisation aimed at developing robust datasets useful for LCA (Life cycle analysis)
- Common framework for Life Cycle Assessments (LCA) of livestock production systems and of crop production systems
- Develop adequate tools to deliver “carbon footprints” for products from organic farming, that are produced in a context of multiple outputs including ecosystem services.
- Integral analysis of the environmental impact of agricultural practices by measuring the efficiency and the climate footprint of crops: Measure net fluxes of energy /temperature, CO_2, methane (CH_4) and water, as well as, the effect of soil cover changes taking place in agricultural land and agro forestry systems of the Iberian Peninsula.

- Measure the water and carbon footprint of crops and industrial products.

Land use

- Looking for ways of achieving ecologically efficient land allocation. Research is needed into how this might be done at a variety of spatial scales.
- Research that compares 'Land Sparing' against 'Land Sharing'. How sustainable, in a world with 9 billion people, will be 'biodiversity based low-input high productivity multi-component farming systems'?
- Identifying possible linkages between sustainable intensification of agricultural production and deforestation, and the need to increase food production on existing agricultural land, and to implement landscape level solutions for food security, adaptation and mitigation.
- Identify drivers of abandonment/intensification in EU agriculture and strategies for balancing the land use at regional scale

Assessing of emissions and mitigation potential

- The assessment and quantification of indirect emissions is also a key area that has not been assessed in any detail.
- Technical and economical abatement potential of GHG mitigation measures and policy analysis.
- Abatement potential of changes in food systems, including approaches such as economics and sectoral policies (2)
- Add the mitigation potential of the use of organic fertilizers: more research is needed on the production emissions of compost and manure compost and on the soil born N2O emissions after the application of organic manures and legume cropping
- To build an efficient simulation model for prediction of GHG emission from Agricultural areas.
- Integrating cost-effective mitigation measures at farm level.

Energy

- Develop technologies and methods to limit use of fossil-fuel energy
- Energy efficiency and energy supply in agricultural systems
- Fuel crops: Define the availability of agro-forestry resources to be used as biofuels.
- More efficient electric supply for vehicles and machinery.
- Replacement of fossil oil based energy and products by biobased commodities
- Reduction of the use of fossil energy in agricultures.
- To develop FACCE, the JPI must include focused attention on more sustainable energy sources, reducing energy consumption and eliminating energy waste. Energy efficiency is at the heart of the EU’s Europe 2020 Strategy for smart, sustainable and inclusive growth and of the transition to a resource efficient economy. Increased efficiency is an essential way to reach a sustainable future.

Misc.

- Aquaculture should be addressed within this core theme, directing looking at the efficiency of production of protein against other animal protein production systems, and balancing this against the efficient utilisation of resources.

- Risk assessments and GHG emissions data will be important as long as they are based on sound experimental information under realistic conditions.
- When dealing with food industries and transport, a key issue is the localisation of activities
- Reduction of emissions by livestock, in particular through nutrition and animal breeding

Considered out of scope

- Broaden the priorities towards trees and forestry issues!! Make the connection between agriculture and forestry more visible in FACCE.
- Develop sustainable processing, packaging, preservation and distribution systems
- Develop food technologies using local products suitable for modern life styles and increasing compatibility with the healthy diet concept.
- What are the effects of different policies on rural livelihoods and entrepreneurship?
- How can economic and social sustainable development in rural areas and food security in cities be combined?
- Devising a more sound indicator outside of per capita GNI or economic growth of how sustainable our communities are in terms of both ecosystem health, productivity and well-being and distributive injustice of power and income.
- The certification of agriculture machines
- Finding ways of reducing and/or reversing peat wastage.
- Climate change risks and influences on human rights (displaced persons, destroyed environments etc)
- An interactive study on how climate change can influence not only European agriculture but also human and implicity women's rights, the right to health, the right to a healthy environment, the right to a healthy life.
- Interactions between agricultural and forest ecosystems
- Cultural Landscape Research
- Modelisation of links between biodiversity and food consumption patterns.
- Impact of Sustainable Collective Catering.
- Include more forestry issue (forest management and product development)
- Sustainable and cost-efficient food processing
- Database on LCA of processed foods
- Long term effect of the use of genetically modified agricultural products as feed and food (On health? On climate change? On environment?).

Annex 3. Global analysis of stakeholder responses to the small questionnaire in Spanish

The analysis of the responses shows a high interest for the following areas:

- 2_Environmentally sustainable growth and intensification of agriculture.
- 3_Assessing and reducing tradeoffs between food supply, biodiversity and ecosystem services

Both areas were chosen by around 60% of those that responded the questionnaire. The other three areas also show a high level of interest ranging between 40 and 50%.

Regarding the sub-areas, all of them showed a level of interest around 30% and 60%.

Specific priorities for each area

Area 1. Sustainable food security under climate change

The major issues indicated by the stakeholders are:

- Increasing risk and environmental variability due to climate change and their impact in agriculture and food industries.
- Optimize the efficiency and energy savings to avoid the negative effect on activities leading to food production in a changing environment.
- Managing and recycling of residues and the generation of by-products from agriculture and food industries.
- Study the response of species used in agriculture and livestock production in response to climate change.

The suggested research activities can be summarized as follows:

- Research to establish measures for reutilisation of residues and sustainability of agricultural activities.
- To develop prediction models to estimate the profitability of agricultural activities under different climatic conditions. This should be done taking into consideration environmental indicators of climate at regional level (Mediterranean)
- Measure the water and carbon footprint of crops and industrial products.
- Research towards achieving high productivity and quality of the final products.
- Exchange of good practices for Mediterranean and Mediterranean-continental crops.

Area 2. Environmentally sustainable growth and intensification of agriculture)

The major issues indicated by the stakeholders are:

- Threats and risks associated to keep the desired standards of animal health.
- Slow incorporation of eco-technologies such as precision agricultures and plant breeding.
- Eco-efficiency: Efficiency in the use of natural resources and energy while decreasing residues.
- Intensification of agricultural practices is not always the best way: it favors biodiversity losses and does not assure benefits for the growers and favors losses of crop diversity.
- One of the largest problems in Europe is land abandonment and depopulation of rural areas.

The suggested research activities can be summarized as follows:

- Develop production models to analyze the changes in productivity associated with climate change.
- Promote de Eco-technologies: plant breeding, biomass production, and seeds of cultivars suitable for adaptation to climate change.
- Promote Eco-efficiency: for the use of resources, water, pesticides and soil degradation.
- Bioenergy and Biomass and their effect on the agricultural equilibrium.
- Control of animal health and the spread of pathogens that affect them.
- Analysis of the regional environment: Sustainable de-intensification when necessary.

Area 3. Assessing and reducing tradeoffs between food supply, biodiversity and ecosystem services

The major issues indicated by the stakeholders are:

- Difficulties associated with the trade-off between agricultural practices and ecosytem and biodiversity conservation. This is mainly due to the low relationship between agricultural crops and the territorial a ecological situation in the areas where they are being grown.
- Threat associated with the changes in the soil use and the difficulties to control GMOs.
- Adequate valorisation of ecosystem services by increasing the awareness of growers towards the positive effect of ecosystem conservation.
- Promote new legislation/policies and funds towards this issue (at European level)

The suggested research activities can be summarized as follows:

- To define/establish mechanisms to evaluate the eco-system services by designing indicators of sustainability and resilience of agricultural systems.
- Integral analysis of the environmental impact of agricultural practices by measuring the efficiency and the climate footprint of crops: Measure net fluxes of energy /temperature, CO_2, methane (CH_4) and water, as well as, the effect of soil cover changes taking place in agricultural land and agro forestry systems of the Iberian Peninsula.
- Design of sustainable processes and environmentally respectful.

Area 4. Adaptation to Climate Change

The major issues indicated by the stakeholders are:

- Maintain the biodiversity of crop species and look for new species and commercial cultivars adapted to climate change, using as a basis the autochthonous species of each region. Reduction of intra- and inter-genetic variability may limit the adaptation possibilities.
- Selection of forestry and crop species of interest for EU markets.
- Uncertainty and impossibility to predict the effects of climate change.
- Development and application of new Plant Molecular Biology tools to obtain cultivars resistant to pests and diseases.
- Lack of objective and local information regarding global change and climate change.

The suggested research activities can be summarized as follows:

- To complement the use of new with the generation of solid knowledge to understand the ecosystem processes technologies associated with resilience capacity and adaptation to climate change.
- Impact of Sustainable Collective Restoration.
- To obtain healthy food by promoting plant and animal health.
- Not only promote agricultural diversity but also the recovery of traditional cultivars.

Area 5. Mitigation of Climate Change

The major issues indicated by the stakeholders are:

- Lack of eco-efficiency in the agricultural sector, which is a traditional sector still, relying on fossil energy.
- Need to change traditional systems of agricultural production.

- Develop new cultivars highly productive and at the same, time respectful with the environment, by reducing GHG emissions and mitigation climate change.

- High vulnerability of the Mediterranean forestry systems.

- Up to now, ecosystem services do not have any positive economic impact for the grower.

The suggested research activities can be summarized as follows:

- Fuel crops: Define the availability of agro-forestry resources to be used as biofuels.

- Develop methods to estimate the carbon sequestration capacity of Mediterranean agro-forestry systems.

- Utilisation of forestry biomass, agricultural and livestock byproducts and industry byproducts.

- Development of policies and coordination of the research being conducted in this area.

- Reduction of the use of fossil energy in agricultures.

Annex 4. Position papers

1. Plant Reproduction and the adverse effects of climate change and temperature stress

Dr Zoe A Wilson, University of Nottingham, UK

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29 February 2012

Plant reproduction and the formation of viable gametes are vital to fertilisation and seed formation. They are therefore fundamental for ensuring reliable crop yields for both animal and human use, and thus maintaining Food Security. However, plant reproduction and particularly pollen formation, is one of the most vulnerable stages in the plant life cycle to abiotic stress. Significant crop yield losses occur due to temperature fluctuations during pollen development; temperature stress results in a failure of viable pollen formation, a consequential lack of fertilisation and ultimately reduced seed set. In some species, pollen remains viable for extremely short periods of time, thus making them especially vulnerable to extreme fluctuations in environmental conditions. With the predicted increases in global temperature and greater variability in extremes of temperature, there is a very high risk that plant reproduction, and in particular pollen development, will be adversely effected, with resultant large-—-scale crop failures and reduced yield.

A greater understanding of the:-

• the molecular processes of pollen development,

• the identification of germplasm that is more able to withstand fluctuations in temperature during reproduction,

• and the development of molecular tools to overcome temperature stress are vital to ensure future sustainable crop yields under conditions of climate change and temperature fluctuations.

Research in this area is essential to any strategy for sustainable agricultural production, particularly given the predicted changes in overall global temperature, and the extremes in temperature ranges that are expected. Achieving these goals requires a deeper understanding of plant reproduction that will allow us to ensure future food security.

2. European Plant Science Organisation EPSO:

We are answering as an independent academic association with more than 220 research institutes and universities from 30 countries mainly in Europe, and 3100 individuals, as members, representing over 28000 people working in plant science.

Our organisations' main activity is science policy and support to research. Our members work in the following areas: agriculture, forestry, environment, food security, climate change, water, plant breeding, plant health, biotechnology, biodiversity, nature conservation, international cooperation, health, policy making, research and infrastructure.

The name of our organisation is "European Plant Science Organisation, EPSO" www.epsoweb.org

Country of location: EU level organisation

This input is the outcome of discussion and consultation among our members.

Contact: epso@epsomail.org
Karin Metzlaff, EPSO Executive Director, BE
Jonathan Jones, Sainsbury Laboratory, UK
Bruce Osborne, IC Dublin, IE
Ulrich Schurr, Phytosphere Institute, Julich Research Center, DE

EPSO's free text additional comments (this page 2) – in addition to the answers to the online consultation (pages 3-15)

This valuable consultation also raises interesting and important questions that we would like to expand on.

1. The questionnaire does not sufficiently pose questions about what specific technologies and new areas of research are required to achieve the JPI's ambitious goals.

2. To intelligently adapt farming systems to the novel (combined) stresses that are anticipated as a consequence of climate change, a more fundamental understanding of plant signaling and adaptation mechanisms in model plants such as *Brachypodium* (closely related to wheat) is essential. Thus, support for basic research in problem-oriented European research consortia is still required to support practical applications. There is also considerable scope for basic science-led adjustments/modification of crop signaling mechanisms to promote simultaneous delivery of enhanced tolerance to both abiotic and biotic stresses.

3. For enhancing crop adaption, it will be more efficient at least in the short-term to focus resources on the highest value crops, such as small grain cereals, the *Solanaceae* (tomato and potato) and legumes. In particular, Europe imports 80% of its animal feed and it would be highly desirable to develop a productive leguminous seed crop.

4. With a better fundamental understanding of plant interactions with beneficial microbes, simple steps towards enhancing crop stress tolerance could be envisaged as well as an improved use of resources such as N, P and water. New developments in our understanding of plant-microbe associations could also be utilized to produce novel N-fixing associations and a reduced reliance on nitrogen fertilizers.

5. There is extensive scope for investigation of novel and creative farming systems. For example, aquaponics systems combine aquaculture of e.g. *Tilapia* with hydroponic cultivation of horticultural crops. Such a systems level approach could hold great promise for turning agricultural wastes into a useful resource and may have wide applicability.

6. An important area not addressed by the questionnaire is education and training. Throughout Europe, plant breeders are becoming more scarce, particularly in the public sector, and recruitment to plant breeding courses in Universities and other academic institutions is declining. This poses a severe sustainability challenge to the European plant breeding and seeds businesses and the development of future crops/cropping systems.

3. Swedish University of Agricultural Sciences (SLU).

2012-03-30

Consulation FACCE JPI: Six future challenges and 37 research questions

Future Agriculture – livestock, crops and land use is a strategic multidisciplinary research platform at the Swedish University of Agricultural Sciences (SLU). Most of the work within the platform has large relevance for FACCE JPI.

In the Future Agriculture platform researchers, together with the agricultural sector, authorities and nongovernmental organizations identify and do research on issues regarding the sustainable use of natural resources. The emphasis is on agricultural production, including livestock, crop production and land use.

In the strategic programme Future Agriculture – Livestock, Crops and Land Use (Bengtsson et al, 2010; http://www.slu.se/en/collaborative-centres-and-projects/future-agriculture/publications-and-printed-matter/) six major challenges are identified:

- Reduction of the environmental impact of agriculture and mitigation of climate change
- Adaptation of agriculture to a changing climate
- Management of present and potential risks
- Responses to societal values and contribution to policies
- Agriculture and rural development
- Resolution of conflicting goals of agriculture and land use

Reduction of the environmental impact of agriculture and mitigation of climate change

In order to reduce the environmental impact of agriculture and its contribution to climate change research is needed on a range of topic areas such as, e.g., design of efficient highly productive systems with minimized use of resources, how to better utilize ecosystem services in agricultural production and land use, the impact of consumption patterns, and the implications of structural changes in the food production chain.

Research questions:

1. How and by which methods can agriculture mitigate climate change?
2. How can agriculture mitigate land degradation and other environmental pollution?
3. How can recycling of nutrients, water and wastes become more efficient (at different scales)?
4. What are the environmental and climate impacts of structural changes in agriculture – specialization versus integration, small scale versus large scale, and geographic localisation?
5. What is the potential for increased efficiency and productivity by innovative technologies and agricultural production systems?
6. What are the environmental and climate impacts of different consumer preferences and consumption patterns?

Adaptation of agriculture to a changing climate

Adapting agriculture to climate change requires new skills in many areas such as efficient water use and recycling solutions, alternative crops and cropping systems, genetically altered strains and varieties, improved protection against animal and plant diseases and pests, and robust systems, e.g. farm buildings, that are adapted to extreme weather events such as heat waves, floods and drought.

Research questions:

7. What are the vulnerability, adaptability and resilience of different agricultural production systems?
8. Which functions do whole organisms and populations have in real production systems?
9. How can crop species and varieties and livestock species and breeds be adapted to new climatic conditions (higher temperature, longer periods of drought, extreme weather events etc), and what is the potential for domestication of “new” species (e.g. to utilize marginal areas and organic waste)?
10. How can resource use efficiency and production be increased on agricultural land while at the same time maintaining ecosystem services, biodiversity and animal welfare?
11. Which management options and technologies exist to combat emerging pests and diseases in crop and livestock production?
12. How can integrated systems – at different scales - for crop, livestock and energy production be designed and evaluated?
13. Which options for new land uses exist and what are the potential advantages and disadvantages of more land into different types of agricultural production?

Management of present and potential risks
Management of actual and potential risks requires more knowledge of hazards and acceptance for new and advanced technology, as well as more studies about production systems resilience. Knowledge is needed to cope with different types of changes and to have preparedness for extreme situations, pandemics as well as opportunities for self-sufficiency in food.
Research questions:
14. What threats against food security do diseases and pests emerging in crops and livestock constitute, and how can they be managed?
15. How can threats against food security caused by climate change and other ecosystem changes/collapses be managed and avoided?
16. How does the use, or refusal to use, of new technologies and farming systems affect food security?
17. What consequences does poor food security have for social unrest and local conflicts?
18. How do agricultural production systems constitute threats for ecosystem resilience, and affect risks of ecosystem and environmental collapse, and climate induced catastrophes?
19. How do agricultural production systems increase or decrease the risks of zoonotic pandemics?

Responses to societal values and contribution to policies
To understand community values and provide a basis for policy decisions, studies on different stakeholders' ethical concerns related to food production and its environmental impact are needed. Important questions deal with import of cheap food and the export of pollution, the impacts of increased food prices and the effects of policy instruments.
Research issues:
20. What is the normative status of different forms of agricultural production (food, feed and fuel)?
21. Which different sets of values related to agriculture, food and technology can be identified?
22. What are the consequences of different sets of values, with regard to the actions (or not) of producers, consumers and politicians?
23. How are political processes leading to international, regional and national agreements, policy instruments and laws supporting or restricting agricultural land use and production (climate, environment, biodiversity, trade, rural development, animal health and welfare, etc)?
24. What are the effects and consequences of different agreements, policies and laws on agricultural production and land use?

Agriculture and rural development
This challenge requires increased knowledge of the interrelations between rural development and agricultural land use. It calls concurrently for increased knowledge of the socio-economic organisation of agricultural production and land use, and for knowledge of the drivers and barriers for living and working in diverse rural areas. Questions such as ownership, labour demand, natural resources governance, synergy effects of production with other aspects of the rural economy are central, as well as questions of quality or life in rural areas, not least in relation to urban areas.
Research issues:
25. How do changes in agricultural and food production systems affect rural communities and rural economies?
26. What effects does increased competition for land-based resources have on producer prices and the economy in the agricultural sector (more large-scale and specialized production, or integration of production in new kinds of ownership and collaboration)?
27. What is the importance of different forms of land tenure, ownership, and collective action for agriculture and rural development?
28. How do urban and rural areas interact through flows of natural resources, goods, energy, ideas, capital, people, and through means of transportation?
29. How can economical and social sustainable development in rural areas and food security in cities be combined?
30. What are the effects of different policies on rural livelihoods and entrepreneurship?
31. How can new knowledge on communication and collaboration be applied in agricultural production and natural resource management?

Resolution of conflicting goals of agriculture and land use

Solving conflicts of interest that are related to agriculture include research on how to handle situations where different goals work against each other, or where you come to different conclusions due to different values. These may be questions ranging from production intensity, impacts on climate and environment, animal and human health to land use and land ownership conditions, all of which also are related to values and power relations in society.

Research issues:

32. What are the conflicts and trade-offs between different agricultural land uses: Conflicts between goals; different techniques or land management systems?
33. How can conflicts over water resources and water use regionally and locally be addressed and resolved?
34. What are the possibilities for resolving conflicts between urbanisation and agriculture, (e.g. urban planning, urban farming, small scale production in urban/peri-urban areas)
35. How can trade-offs and synergies between ecosystem services, production, climate impact, biodiversity, animal and human welfare and health be identified and managed?
36. What are the possibilities for multiple-use and multifunctional systems to resolve conflicts in agriculture and land use?
37. How do human values affect the possibilities and methods for managing and resolving conflict?

Reference

Bengtsson J, Magnusson U, Rydhmer L, Jensen ES, Vrede K, Öborn I. 2010. Future Agriculture – livestock, crops and land use. A strategic programme for research. Swedish University of Agricultural Sciences (SLU). ISBN: 978-91-576-9008-1.

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Future Agriculture
The Swedish University of Agricultural Sciences

4. 4. Aalborg University

30. March 2012 J.no.: LNA/LMU

Public consultation – comments regarding the Strategic Agenda for FACCE-JPI

Introduction

Europe requires urgent and coordinated action to move towards a society independent of fossil resources. Additionally, the impact of demographic developments is increasing and our natural resources need to be used more wisely. Our societies face security challenges which are growing in scale and sophistication. Challenges such as climate change, population growth and our dependence on fossils for fuels and materials do, however, also provide powerful opportunities to develop innovative products and services, creating growth and jobs in Europe. Smart, sustainable and inclusive growth are key words for Europe and for the targets set for 2020.

These statements were also pointed out in the EU Presidency Conference: Bioeconomy in Action in March 2012 and reflected in the Copenhagen Declaration http://bioeconomy.dk/about/the-copenhagen-declaration-for-a-bioeconomy-in-action/view

In Joint Programming the European Member States join forces in tackling the European challenges and at the same time increase European knowledge and growth. However, an increased multidisciplinary approach to research is essential to establish a framework for stronger coherence between various research agendas to foster technological and social innovation in Europe.

With regard to the FACCE-JPI, Aalborg University will draw the attention to the following issues - issues in which the university has high level of knowledge and research competencies:

Resource availability, bio refinery, biotechnology

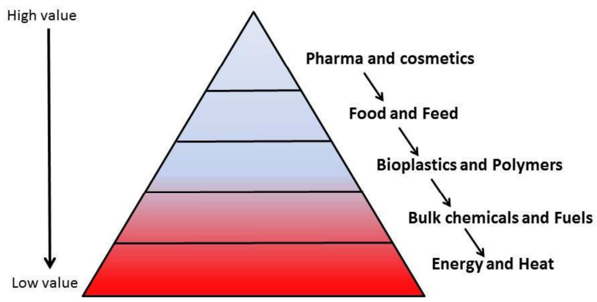
One of the Grand Challenges is how to reach a resource efficient Europe based on a non-fossil society.

New innovative and sustainable value chains must be created to meet the transition from fossil to bio based society with a clear focus on food security. Regarding food security it is important to utilize the crop residues, which today are left in the fields, for production of new food products and food and feed ingredients.

Europe has the potential of taking the lead in creating new value chains from the bio production, housing the internationally leading biotech industries and a considerable agri-food sector. By focusing the utilization of the high value output (food, health ingredients, medicine) from the biomasses before the remaining part is left for medium value products (feed, materials) and in the end bio fuels and heat energy being a low value fuel product.

To reach a resource efficient society, Europe need a fundamental shift towards an economy that uses natural resources more sustainably and smarter and fully exploits the potential of bio-based products. Bio refineries can spur innovation and growth through a strong alignment along the value chain between farmers, universities and local communities.

The below figure shows the value chain for an optimized profit of a bio refinery - the more that can be exploited at the highest levels in the triangle – the better.



ICT

The ICT sector has been identified as a major player in the fight against climate change – in particular its role in improving energy efficiency, but also efficiency of other ressources. By directly reducing demand for primary energies, energy-efficiency is in effect a fast, cheap and clean way to address energy resource issues. ICT can make a key contribution to unlocking the large untapped potential for improved energy efficiency across Europe. Among others it calls for a more optimal use of ICT in private homes, in the public sector, as well as in the industrial sector. ICT also provide new approaches for sustainable intensification of agricultural systems (Knowledge based IT innovations).

ICT has over the years become an increasingly smarter and more efficient tool to facilitate communication between stakeholders. Exploring mobile communication in meeting the demands for reducing food waste and improving healthy consumption can be a valid way to meet the food security goals.

Energy

To develop FACCE, the JPI must include focused attention on more sustainable energy sources, reducing energy consumption and eliminating energy waste. Energy efficiency is at the heart of the EU's Europe 2020 Strategy for smart, sustainable and inclusive growth and of the transition to a resource efficient economy. Increased efficiency is an essential way to reach a sustainable future.

Aalborg University points to six areas for energy efficiency which are essential for a sustainable future;

1) Power electronics – which includes applications of solid-state electronics for the control and conversion of electric power, 2) Automation and Control, 3) ICT – embedded software, teleinfrastructure, mobile, green ICT, 4) Eco Design – more goods and services while using fewer resources and creating less waste and pollution, 5) new energy sources, 6) new construction materials.

Social Science and Humanities

Social science and humanities are important research areas that can enable diffusion of skills in order to meet the global challenges. Intercultural understanding and interactive learning tools are among the many disciplines that are needed to fulfill the goals.

Final remarks

Universities play a crucial role in the innovation chain, both as an active protagonist that creates innovation and brings it to the market, as well as through creating framework conditions bringing research and innovation together. To contribute to the goals of food security and sustainable agriculture in the face of climate change, Aalborg University welcomes the opportunity to join JPI teams with regard to the develop paths to markets within the areas mentioned above.

Annex 5. Scientific Research Agenda

AGRICULTURE, FOOD SECURITY AND CLIMATE CHANGE

JOINT PROGRAMMING INITIATIVE (FACCE JPI)

SCIENTIFIC REASEARCH AGENDA

SCOPE, COMMON VISION AND PRIORITY ACTIONS

Scientific Advisory Board, December 2010

Preamble

The Scientific Advisory Board (SAB) of the Agriculture, Food Security and Climate Change Joint Programming Initiative (FACCE JPI) has been elected by the Governing Board (GB) to elaborate a common scientific vision for the JPI, in line with clear global priorities and based on the proposal and on conclusions of Governing Board meetings. The SAB was also asked to provide by the end of 2010 a list of priority actions and advice on the scientific governance for JP implementation.

This document stems from three SAB meetings on June 10, September 16 and December 1, 2010. It is based on contributions of SAB members[7] and on comments on earlier versions by the GB. This scientific research agenda has been approved by the Governing Board of the FACCE JPI on December 17, 2010. It will be revised periodically, every two years.

[7] SAB Members in 2010: Kenneth Cassman, Elias Fereres, Stephen P. Long , Frits Mohren, Bernd Müller-Röber, Pirjo Peltonen-Sainio, John R. Porter , Johan Rockström, Thomas Rosswall, Jean-François Soussana (Chair), Henning Steinfeld, Joachim von Braun.

Executive Summary

Four complementary and interactive goals are defined for research within the Agriculture, Food Security and Climate Change (FACCE) Joint Programming Initiative:

i) Provide new approaches for the environmentally sustainable growth and intensification of agriculture in Europe and increase the resilience of food systems to deliver European food security, feed, fuel, fibre as well as other ecosystem services under current and future climate and resource availability;

ii) Provide an integrated impact assessment of climate change throughout the whole food chain, including market repercussions;

iii) Contribute to direct reductions of GHG emissions through carbon sequestration, fossil fuel energy substitution and mitigation of N_2O and CH_4 emissions by the agriculture and forestry sector, while reducing GHG emissions per unit area and per unit product associated with land use change;

iv) Sharply reduce trade-offs between food production and the preservation of biodiversity, ecosystem functions and services.

Five core research themes have been adopted to meet these goals:

1. Sustainable food security under climate change, based on an integrated food systems perspective: modelling, benchmarking and policy research perspective.

2. Environmentally sustainable growth and intensification of agricultural systems under current and future climate and resource availability;

3. Assessing and reducing trade-offs between food production, biodiversity and ecosystem services;

4. Adaptation to climate change throughout the whole food chain, including market repercussions;

5. Greenhouse gas mitigation: N_2O and CH_4 mitigation in the agriculture and forestry sector, carbon sequestration, fossil fuel substitution and mitigating GHG emissions induced by indirect land use change.

The JPI will need to bring together: core themes 2 and 3; core themes 4 and 5; core theme one across all. Priority actions have been defined within each of these core themes.

We first address the scope of the FACCE JPI, then express a common vision and finally provide a list of core themes and of early priority actions.

1. Scope of the FACCE JPI

While recognizing that priorities are needed, a broad scope is first presented here, before addressing in the next section our common vision of the FACCE JPI.

1.1 Agriculture. Agriculture can be defined in a broad sense as the production of food, feed, fuel and fibre by land based systems. Thus, the sector includes annual and perennial crops, grasslands, livestock and forestry, rural landscapes, land use, biodiversity and ecosystem services. Freshwater and marine aquaculture are also included because feed production is required as input to these systems. Marine fisheries are not considered within the scope, since these will be addressed by the 'Healthy and productive seas and oceans' JPI. Competition for land will grow and it is important to focus on the sustainable intensification of production and, at the same time, consider ecosystem services that agriculture can offer, as well as linkages with the broader bioeconomy[8]. Bioenergy, biofuels and biomaterials are included as they will become even more important as prices of fossil-based energy and raw-materials rise and as the environmental and security risks associated with dependence on fossil fuels are recognized.

1.2 Food security. Agricultural production is not the only component determining people's food security. The UN-FAO World Food Summit 1996 created a definition, which is used in the context of the JPI: 'Food Security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life'. The JPI will highlight supply and utilisation of food with less research on processing, packaging, distribution, retail and economic access. The JPI will also embrace the safety aspects of food security, as defined above, and the agricultural and food policies that impact on food safety and nutrition. Further, the JPI will map and monitor emerging technologies that impact on agriculture and food security. However, the FACCE JPI will not include issues covered by the 'Healthy food for healthy life' JPI, such as: the determinants of diet and physical activity; eating habits and diet advice and diet-related chronic diseases.

1.3 Climate change. The future of agriculture and of food security will take place under climate change and under other global environmental changes[9]. The JPI, while considering climate change in a global and regional context, must develop scientific understanding to assist European Union farmers in adapting locally to climate variability and climate change, and to ensure that EU farming and food systems contribute to reducing greenhouse gas emissions. The link between the global, European and local farm levels necessitates that scaling issues are addressed early on in the programme. Collaborations with the climate research community[10] need to be organised. Since many mitigation efforts can also assist in adaptation it is important to integrate the two, taking into account regional variation across Europe. Links will be made to the Climate Change JPI as well as the Global Research Alliance on Agricultural Greenhouse Gases to avoid overlaps and provide complementarity.

1.4 Water. Special attention should be paid by the FACCE JPI to water management in agriculture, since about 70% of the global freshwater pre-empted by human use is allocated

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[8] The usual definition of bioeconomy includes biorefinery as part of agricultural processes which can be included in the FACCE JPI. However, the corresponding industrial processes are not within the scope.

[9] Rate of biodiversity loss, saturation of the nitrogen and phosphorus cycles, stratospheric ozone depletion, global freshwater use, change in land use, atmospheric aerosol loading and chemical pollution (Rockström et al., Nature, 2009)

[10] World Climate Research Programme (WCRP) of the World Meteorological Organization (WMO), International Council for Science (ICSU) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO, 'Connected Climate Knowledge for Europe' JPI.

to agriculture. Adaptive water management in the context of climate change, increasing demands from non-agricultural sectors and limited water supply needs to be developed by research targeting water use efficiency in both rain-fed and irrigated agriculture and reduction of yield loss from water deficits. Links will be made to the water JPI to avoid overlaps and provide complementarity.

1.5 Land use. Today, approximately 12% of the Earth's land area is under intensive crop production and close to 20% is pasture and rangeland used for livestock production. Future land-use on Earth must accommodate multiple competing demands for food and fibre, energy, services, infrastructure and conservation by some 9 billion people – on a non-expandable global surface. There is a need for integrative, systems-level research approaches by the JPI to address changes in land use both in Europe and at a global scale, in links with climate change and with food security.

1.6 Scope of the economic and social approaches. Integration of economic approaches and expertise will be important in developing FACCE-JPI. Economics is of importance for identifying research priorities and innovation opportunities, as are social attitudes, consumer preferences, risk management, international trade, employment and institutional issues, etc, given their direct relevance to climate change and food security. Other social sciences (such as sociology, policy sciences etc…) may also be required. This will necessitate a sound consultative process across disciplines.

1.7 Scenarios of global change and time horizon. Current climate research efforts (Intergovernmental Panel on Climate Change, 5^{th} Assessment Report) start from atmospheric GHG concentration pathways to generate new socio-economic and climate scenarios, which can be used for integrated assessments of impacts, adaptation, mitigation and vulnerability. The proposed Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) will develop biodiversity scenarios beyond those initiated by the Millenium Ecosystem Assessment. For agriculture and food security, important areas include the development of contrasted future agricultural scenarios and storylines, upgrade of models (including biophysical, biological, economics) and ensemble modelling for risk assessment. Most climate modelling considers timescales of 50-100 years, but increasing attention should be given to shorter-term seasonal/decadal predictions. Therefore a JPI time horizon of a few decades is proposed, perhaps until 2050. Time horizons will also dictate the geographical scope needed – for example 2050 would need a global horizon, but shorter timescales over the next 3-5 years could focus on the EU.

1.8 Geographical scope. The focus is on Europe, but Europe is part of a global system of food production and consumption. The research agenda of Europe in the food, agriculture and climate change domains has impacts on the global research capacities and creates potentially important spill-over effects to other regions of the world. Thus, the JPI must consider Europe's role in a global context and how the global context will affect Europe. For FACCE-JPI it is proposed to cover the role of Europe for sustainable resource (land and water) use and for European and global food security. A complementary focus on food security and climate change impacts on surrounding regions (e.g., the Mediterranean Basin) and on outside Europe (e.g., in Sub-Saharan Africa) is recommended and could be carried out through collaborations with other countries and with international programs, such as the Climate Change, Agriculture and Food Security (CCAFS) of the CGIAR. The JPI will greatly advance the study of agriculture in developed countries for global food security and this will complement CGIAR international efforts which are currently centred on developing countries.

2. Common vision and core research themes

The SAB has further elaborated the central theme of the FACCE JPI in the form of a common vision.

2.1 Strategic research

The interactions between agriculture, food security and climate change have been envisioned highlighting the three binary interactions and the single ternary interaction, which are at the heart of the FACCE JPI (Fig. 1). The complex system formed by each of these components and by their interactions is under multiple pressures from external drivers, such as the rising food and fibre demand, globalisation and global environmental changes and is moreover constrained by planetary boundaries such as land and water limits.

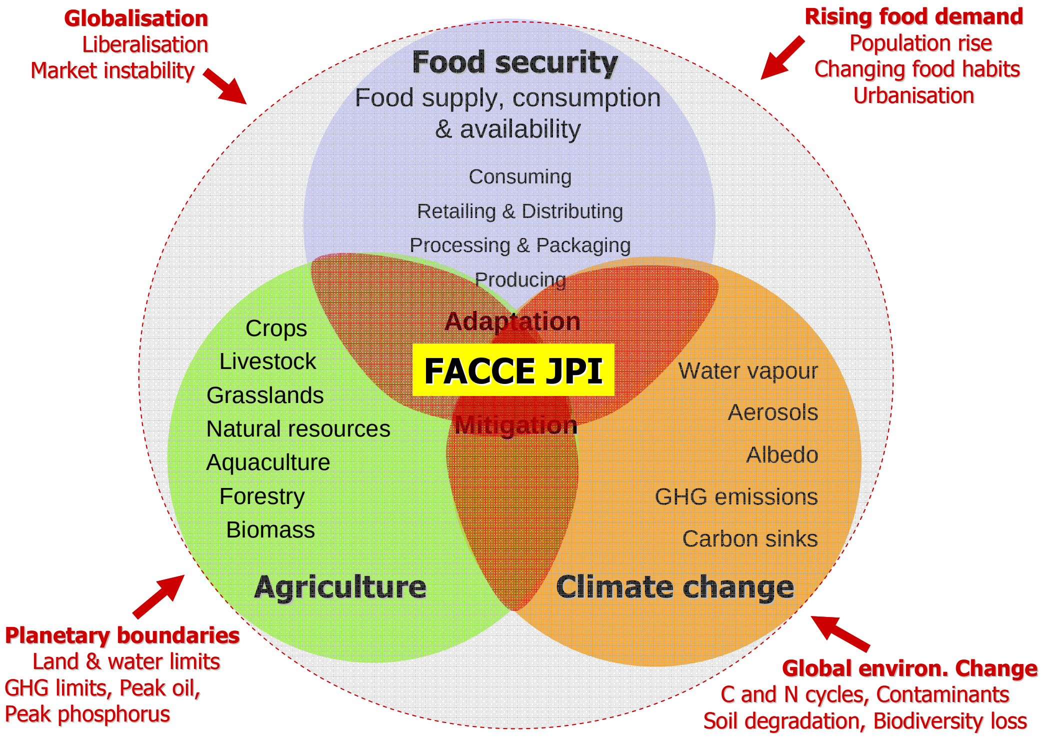

Fig. 1. A vision of research areas in the FACCE JPI showing drivers (in red) and highlighting interactions between agriculture, food security and climate change.

To answer these challenges, research undertaken should be mission oriented, with four complementary and interactive goals:

i) Provide new approaches for the environmentally sustainable growth and intensification of agriculture in Europe and increase the resilience of food systems to deliver European food security, feed, fuel, fibre as well as other ecosystem services under current and future climate and resource availability;

ii) Provide an integrated impact assessment of climate change throughout the whole food chain, including market repercussions;

iii) Contribute to direct reductions of GHG emissions through carbon sequestration, fossil fuel energy substitution and mitigation of N_2O and CH_4 emissions by the agriculture and forestry sector, while reducing GHG emissions per unit area and per unit product associated with land use change;

iv) Sharply reduce trade-offs between food production and the preservation of biodiversity, ecosystem functions and services.

2.2 An integrated research agenda

To reach these goals, research should be integrated on a large scale:

- A systemic understanding should be gained, by developing and integrating a large range of disciplines from climatology, to ecology, agronomy, forestry and socio-economy, through plant, soil, microbial and animal sciences, that must be strongly connected to a foundation of agro-ecological and socio-economic modelling.
- Key European infrastructures need to be assembled in order to integrate scenarios, observations, experiments and models in order to develop and inter-compare agro-ecological and socio-economic projections while assessing their uncertainties.
- Economics of short- and long-term adaptation/mitigation strategies should be analysed also aiming at improving current food security while taking into account: i) uncertainties in the projections of climate change and impacts, ii) the valuation of ecosystem functions and services and their resilience.
- Developing and implementing specific solutions at the ecosystems and policy levels based on detailed information on regional impacts and meaningful assessment of the adaptive options and their feasibility at local and farm levels. Workable adaptation options will be developed in close collaboration with decision-makers and stakeholders involved in the research and development process.
- A roadmap of breakthrough technologies in the areas of crop, livestock, fuel and fibre production, of land, water and genetic resources management and of biodiversity conservation and use will be developed. When mature, these innovations will be considered for integration in production systems and in policy measures.

Such an integrated research agenda has been envisioned to deliver key outputs for Europe by contributing: i) to raising the biological efficiency of European agriculture, ii) to responding to a globally increased food demand, iii) to operating agriculture within greenhouse gas, energy, biodiversity and contaminant limits and iv) to building resilience in agricultural and food systems (Fig. 2).

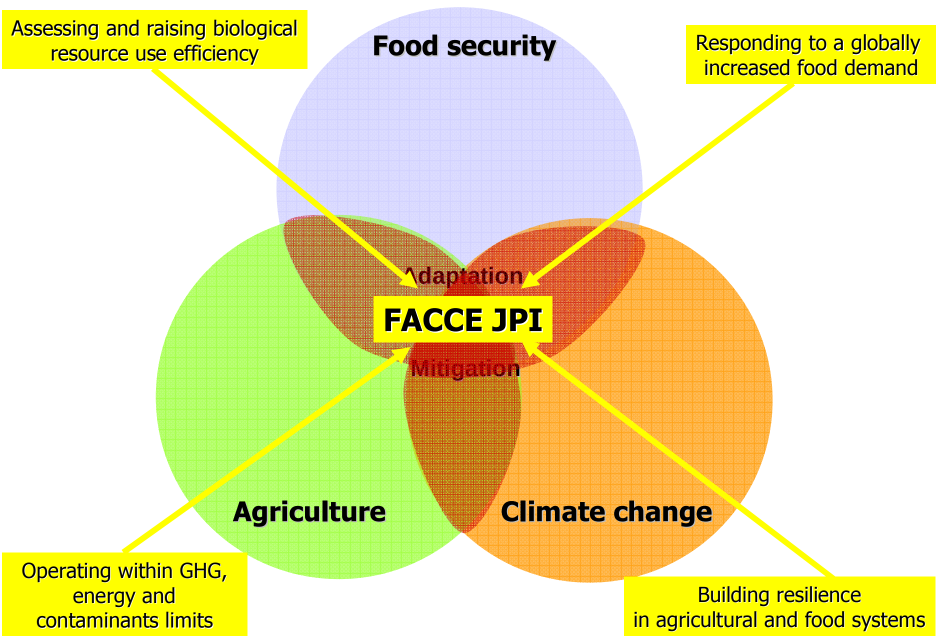

Fig. 2. A vision of key outputs (underlined in yellow) of FACCE JPI for Europe.

2.3 Core research themes

2..3.1 Criteria for core research themes

A set of criteria has been developed in order to select the core research themes of the FACCE JPI. According to these criteria, core themes should:

- Be evidence based,
- Be groundbreaking at European level,
- Have high expected returns,
- Be of urgency for Europe and/or regions of Europe,
- Reinforce Europe's contribution to global public goods,
- Be interdisciplinary,
- Provide guidance for developing the research agenda,
- Be complementary, with clear links and synergies within and across themes.

2.3.2 Five core research themes

Following, these criteria, the following five core research themes have been adopted:

1. Sustainable food security under climate change, based on an integrated food systems perspective: modelling, benchmarking and policy research perspective.
2. Environmentally sustainable growth and intensification of agricultural systems under current and future climate and resource availability;
3. Assessing and reducing trade-offs between food production, biodiversity and ecosystem services;
4. Adaptation to climate change throughout the whole food chain, including market repercussions;
5. Greenhouse gas mitigation: N_2O and CH_4 mitigation in the agriculture and forestry sector, carbon sequestration, fossil fuel substitution and mitigating GHG emissions induced by indirect land use change.

The JPI will need to bring together: core themes 2 and 3; core themes 4 and 5; core theme one across all. This leads to the following scientific structure (Figure 3) of the FACCE JPI.

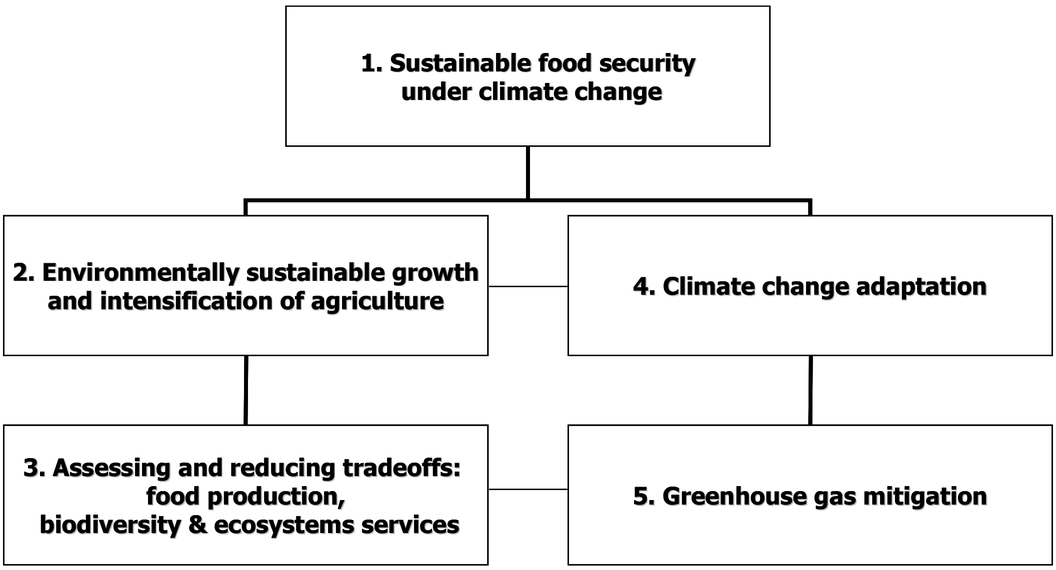

Figure 3. The five core themes forming the FACCE JPI.

Core theme 1: Sustainable food security under climate change

- Integrated food systems perspective, combining biophysical and socio-economic modelling with policy research perspective

- Integrated risk analysis of the European agriculture (and food systems) under climate change: test responses to volatility both from natural and market phenomena

- Global change impact and resilience of food systems (through the value chain and to the consumer)

- Europe's role in international markets, price volatility, global food security impacts

- Develop contrasted scenarios involving perceptions and policy dialog

- Combine observations, experiments and modelling through the development of appropriate European research infrastructures.

Core theme 2: Environmentally sustainable growth and intensification of agriculture

- Provide new approaches for improving farm management and for the sustainable intensification of agricultural systems, but also for low-input high natural value systems in Europe under current and future climate and resource availability;

- Understanding recent yield trends in Europe, taking into account changes in costs and prices and research investments as well as changes in environment, management and genotypes.

- Benchmarking efficiencies of resource use (water, N, energy) according to *Genotype x Environment (including climate) x Management* combinations across Europe

- Assessing and raising biological resource use efficiency of crop and livestock systems; increasing total factor productivity.

- Combining crop, livestock and bioenergy systems for sustainable intensification;

- Low input, higher efficiency seeds and breeds;

- Knowledge based IT innovations in agriculture;

- Improved understanding and control of soil functioning and biotic interactions at field to landscape scales.

Core theme 3: Assessing and reducing tradeoffs between food supply, biodiversity and ecosystem services

- Provide new approaches to the increased use of functional biodiversity in agricultural systems (e.g. intercropping, mixtures, conservation agriculture…)

- Developing methods for assessing and valuing biodiversity and ecosystems goods and services (e.g. carbon sequestration, water storage…) in intensive agricultural systems;

- Develop approaches for optimizing the trade-off between agriculture and ecosystem services in a variable environment (climate change, volatility…) and at farm scale;

- Develop a solid knowledge basis for the provision of public goods by European agriculture, so that ecosystem services are delivered efficiently and effectively.

Core theme 4: Adaptation to climate change

- Adaptation to climate change and increased climatic variability throughout the whole food chain, including market repercussions;

- Tailoring adapted regional production systems under climate change;

- Adapting seeds and breeds through conventional breeding and biotechnology[11] to new combinations of environment and management: e.g. abiotic stresses, elevated CO_2;

- Monitoring pests and diseases and developing climate-informed crop and animal protection;

- Adaptive water management in agriculture, watershed management, flood management, irrigation technologies, water re-use;

- Adapting food processing and retailing, markets and institutions to increased climatic variability and climatic change.

Core theme 5: Mitigation of climate change

- Contribute to direct reductions of GHG emissions through carbon sequestration, substitution of fossil-based energy and products, and mitigation of N_2O and CH_4 emissions by the agriculture and forestry sector, while reducing GHG emissions associated with indirect land use change;

- Develop monitoring and verification methodologies of field, animal and farm scale GHG budgets, including, or not, indirect land use and cradle to grave life cycle;

- Develop verifiable GHG mitigation and carbon sequestration measures in farming systems;

- Develop technologies and methods to substitute fossil-fuel energy through increased use of biomass and other renewable energies in the agriculture sector without jeopardizing food security.

[11] Biotechnology here is used in a broad sense, referring to marker-assisted selection, genomic selection and genetic modification methods.

2.3.3 Main research issues in the five core research themes

In each of the five core themes, there will be a need to address in a highly coordinated way a number of evidence based research issues which are listed in Annex 1. This annex provides further details on how each issue could be addressed within the scope of the FACCE JP and could, hence, contribute to core research themes.

Table 1. Major research issues (a to h, see Annex 1) to be addressed under each of the five core themes (CT)

	a. Scenarios of global change & adaptive strategies	b. Food systems and food security	c. Land use & sustainable management of biodiversity and natural resources	d. Crops: production, health and breeding	e. Livestock: production, health and breeding	f. GHG mitigation and C sequestration by agriculture	g. Bioenergy and biofuels	h. Forestry as related to agriculture and food security
CT1 Food security under climate change	X	X	X					
CT2 Sustainable intensification of agriculture		X	X	X	X	X		
CT3 Assessing tradeoffs between food supply, biodiversity and ecosystem services		X	X	X	X	X	X	X
CT4 Adaptation to climate change	X	X	X	X	X	X	X	
CT5 Mitigation of climate change	X	X	X		X	X	X	X

2.4 Fast track priorities

In order to facilitate the start of early actions by the FACCE JPI, a first list of actions with low hanging fruits has been identified and their relevance to CTs has been earmarked. First illustrative examples of medium and long term actions have also been identified.

Core Theme 1: Sustainable food security under climate change

- Possible pilot action. Detailed climate change risk assessment for European agriculture in a global context: how will climate variability and change affect regional farming systems in near and far future? What are the risks and the opportunities for European food security and agriculture? In collaboration with the international project AgMIP, an ensemble of crop and livestock models will be benchmarked, inter-compared and coupled to both climatic and economic models.
- Medium term: Consequences of changes in food systems (including food habits, processing, wastes, consumption …) on climate change (GHG, footprints, etc) and, conversely, climate change impacts on European food systems.
- Longer term: Modelling the drivers of price volatility and its role on food systems and food security. Use of Representative Concentration Pathways

(RCPs) and development of a range of contrasted scenarios including changes in food habits, processing, etc.

Core Theme 2: Environmentally sustainable growth and intensification of agriculture

- Possible pilot action. Benchmarking at farm gate the current state and historical changes (and their main drivers: economics, Genotype x Environment x Management) in productivity and resource use and institutional innovations and investment needs for sustainable intensification. Assessment of variability in systems by screening a large number of situations, as if taking a meta-analysis approach.
- Medium term. Production of innovative scientific gold standards for agricultural monitoring. Satellite studies where countries could identify key systems with raised productivity and reduced GHG emissions, in which average values of variables can be benchmarked.
- Longer term. Combined development of genomic selection, ecological engineering, precision farming, ecotechnologies and biotechnologies for increased resource use efficiency and productivity in key agricultural systems.

Core theme 3: Assessing and reducing trade-offs between food supply, biodiversity and ecosystem services.

- Possible pilot action: Assessment of ecosystem services in European landscapes and how these link to biodiversity, productivity and resource use efficiency and how they are to be valued by society and economically.
- Medium-term: biodiversity based low-input high productivity multi-component farming systems using e.g. within and between species diversity across trophic levels in combination with genomic selection and conventional breeding.
- Longer term: adaptive management of high natural value agricultural landscapes producing specific products in high demand.

Core theme 4: Adaptation to climate change

- Possible pilot action. Designing management relevant novel ideotypes adapted to climate change and elevated CO_2 and assessing groundbreaking designs for advanced plant and animal phenotyping facilities under climate change.
- Medium term. Understand the adaptive value of diversity, specialization and trade in European agriculture, through appropriate modelling.
- Longer term. Epidemiological models and near real time climate-informed forecasts of pests and diseases. Regional scale strategies for preserving gene resistance against pests, diseases and pathogens in crop and animal species. Drought and heat tolerant productive crop species and thermo-tolerant animal species.

Core theme 5: Mitigation of climate change

- Possible pilot action. Soil carbon sequestration estimation and verification methodologies based on soil surveys, remote sensing, management practices, process modelling, data streams (ICOS, Integrated Carbon Observation System) and novel verification methods (e.g. neutron scattering).

- Mid-term: Assessment of the eco-efficiency of key farming systems within European sub-regions. Technical and economical abatement potential of GHG mitigation measures and policy analysis.
- Longer term: Abatement potential of changes in food systems, including approaches such as economics and sectoral policies, to be linked with adaptation above.

2.5 Issues related to implementation

Several factors in implementation of the FACCE JP will need to be considered by the Governing Board during the development of the action. These include infrastructures, observation and modelling experiments, data and databases, high level synthesis, mobility, innovation and skills.

ANNEX 1. Evidence based research issues

In this annex, we provide further details on research issues which are relevant for the FACCE JPI, by briefly setting the scene for an issue and then by discussing what should be done about it and how it is to be done.

a. Scenarios of global change and adaptive strategies

Timescale and links with earth and climate sciences. Most climate modelling considers timescales of 50-100 years, but increasing attention is being given to seasonal/decadal predictions. For FACCE-JPI, key issues for evaluating future scenarios include impact assessment of climate change throughout the entire food chain, including market repercussions. Hot spots areas where climate change will have biggest impact need to be identified, within and possibly outside the EU. FACCE-JPI will also help determining which climate data are required to model crop and ecosystem performance under current and changing climate. The EU could gain global advantage by including detailed and robust crop and livestock components in regional climate impact models coupled with socio-economics. A key link would be with the emerging JPI on climate change. Given recent trends of yield stagnation for major cereal crops within the EU and Asia, the FACCE JPI should provide global leadership to understanding the scientific basis for these trends and how they will be affected by climate change.

Improving scenarios. For scenarios it is proposed that important areas are to identify a range of plausible futures for European farming, in relation to socio-economic, environmental and policy issues. Another element is to upgrade current crop, livestock and farming system models (including biophysical, biological, economics) to perform risk assessment and identify hot spots of high returns in terms of adaptation and mitigation. The development of scenarios is also important for the engagement of stakeholders. Europe needs a strong capacity in modelling and scenario building, which will require a tight coupling with observational and experimental data streams.

Risk assessment and vulnerability. To better deal with climate variability and change, it is envisioned that future crop, livestock, fuel and fibre modelling studies will need to use a risk assessment approach by combining an ensemble of GHG emission (or stabilization) scenarios, of regional climate models and of process-oriented impact models, as well as an ensemble of adaptation and mitigation options concerning both management practices and species/cultivars/breeds. This will provide a first step for comparing regional vulnerabilities and adaptation strategies across Europe. Developing this modelling framework will require experimental data concerning: (i) the role of extreme climatic events, (ii) the interactions between abiotic factors and elevated CO_2, (iii) the genetic variability in plant CO_2 and temperature responses, (iv) the interactions with biotic factors, including pests and diseases, (v) the effects on harvest quality, and (vi) the potential for genetic and management improvements to address each of these factors. Moreover, this direct risk assessment for agriculture will need to be extended to account for indirect vulnerabilities resulting from competition for natural resources (e.g. land and water) use and from global market instability and changes.

b. Food systems and food security

Consumer preferences and needs. Consumer preferences and attitudes change and this will have a major impact on the demands from the agricultural sector. This needs to be analysed using the best available social science expertise. Market access, food safety and convenient food (high quality food products and low prices) are needed. Consumers are also reacting to changes in markets, which necessitates economic analyses both at the farm, regional and global levels. The emergence of voluntary certification systems that address social and environmental concerns including fair trade, organic agriculture, sustainable harvests, and carbon footprints should also be studied as it may affect consumer preferences and food systems.

Post-harvest losses and food wastes. Food wastes have reached large levels in most industrialized countries, while post-harvest losses have been reduced. In contrast, in poor developing countries, food wastes are minimal, while post-harvest losses tend to be large. Novel research on how to minimize food wastes during food process, transport and retail is required, while options for recycling and reuse (e.g. composting, bioenergy…) should also be further explored, while considering health issues.

Institutional issues. Institutional issues are also important, especially as mitigation strategies are agreed on at the global and national levels. There is a need to consider and model behavioural and regional institutional constraints and synergies that help and hinder adoption of mitigation and adaptation measures. Such analyses should contribute to and draw on relevant policy options to promote adoption of such measures. Barriers and constraints to be considered relate to associated sector policies (e.g. Water Framework Directive, land degradation, biodiversity conservation…) and local/regional food security objectives. Beyond effectiveness and efficiency, there are equity dimensions of adapting the agriculture sector to mitigation and adaptation challenges. Institutional perspectives are moreover required for addressing vulnerabilities and the possibility to use index-based insurance systems to minimize farmer vulnerabilities under climate variability and change. In the development of the JPI it will be essential to ensure that social science expertise is included from the start in the definition of the programme.

c. Land use and sustainable management of natural resources and biodiversity

Land use. Higher resolution and more consistent land-use, land-cover and agricultural practices data and projections are required both for Europe and on a global scale, in order to match the needs for integrated assessment models covering land use change, agriculture, food security and climate change, and also taking into account direct and indirect land use change from biomaterial, bioenergy and biofuels expansion. Moreover, there is scope for developing research on criteria to be used when assessing future land use patterns in terms of e.g. food, fibre and energy supply, food security, natural resources and biodiversity conservation, as well as climate change adaptation and mitigation.

Soils. Soil management and use should be given special attention since soils are not renewable within a lifetime. Restoring degraded soils, minimizing soil, wind and water erosion, and building-up of soil organic matter is a win-win strategy leading to increases in soil fertility, carbon sequestration (i.e. mitigation) and water holding capacity (i.e. adaptation). Emphasis should be placed on the role of the soil biota for biogeochemical cycles in the context of an environmentally sustainable growth and intensification of agriculture.

Water. Water scarcity in agriculture will increase, demanding new approaches to manage the limited water supplies at different scales from farms to regions. Demonstrating the potential of adapting water use by rainfed and irrigated agriculture, combining knowledge-based innovative technologies, modelling and transfer of technologies and of innovative practices from the Mediterranean region to areas further North in Europe will be needed. Modelling at a range of scales (from field to river basin) can be used to scope innovations that will require a combination of changes in management practices (e.g. conservation agriculture, field scale soil moisture and plant water status forecast; real-time climate-informed irrigation practices; deficit irrigation practices; field-scale drip irrigation technologies; re-use of sewage water), in plant genetics (change from irrigated maize to rainfed sorghum/maize, change in plant ideotypes including control of cycle duration and of plant architecture in major crops) and in near real-time applications (data from sensors and remote sensing can be combined with simulation models for optimizing the characterization of soil moisture contents and vegetation state and adjusting crop management). Agricultural systems need to be adapted to contribute to the restoration of a good ecological status of all waters within river basins by sharply reducing organic pollutants and heavy metals loads.

Ecosystem services and biodiversity. There are clear links between ecosystem degradation and the persistence of rural food insecurity. Benefits derived from ecosystems can be direct or indirect and tangible or intangible, as reflected in the typology used by the Millenium Ecosystem Assessment – which distinguishes provisioning, regulating, cultural and support services. Significant changes in policies, institutions and practices are necessary to make advances for reconciling biodiversity conservation, ecosystem services and food security. Recent developments in trait-based ecology could help adapt and (re-)design agroecosystems to meet both goals of biodiversity conservation and food security. Just as crop genetic erosion undermines food security, biodiversity loss in general undermines the provision of the ecosystem services agriculture itself depends on. Estimating the value of ecosystem services in monetary terms is still a bottleneck for policy support. This economic evaluation is best applied not to an entire ecosystem but to an incremental change and within a specified policy context. This approach clearly requires increased efforts to further reduce uncertainties and develop internationally agreed standards.

d. Crops: agronomy, plant health and breeding

Sustainable increases in yields. Emphasis should be placed on developing crop production systems of increased productivity while reducing the environmental footprint of agriculture per unit product. This will require accurate benchmarking of current agroecosystems and the design, experimentation, and modelling of alternative systems. The central importance of interactions between genotype, environment and management should be emphasized as the basis of production. Primary production, water and nutrient use efficiency, tolerance to abiotic stresses were also seen as important, in order to combine the necessities of sustainability with increases in yield. Increased emphasis should be placed on increasing the yields of legumes, in order to reduce the dependency of Europe in terms of soybean imports and to substitute mineral fertilizers by biological N_2 fixation. Increasing crop yields will need the involvement of public plant breeders and geneticists due to the long time frame to develop new varieties. The combination of management and genetic diversity is a key way forward for the applied development of cropping systems and cultivars to answer FACCE-JPI challenges. New integrated approaches are needed for molecular, cellular and whole-plant phenotyping technologies under laboratory, greenhouse and field conditions to identify useful genotypes and to use biodiversity more effectively in selection and breeding. New modelling approaches will also need to be developed to interpret "omics" data for plant breeding. A critical component of climate change modelling and agriculture's impact on GHG emissions is the rate at which crop yields will vary on existing farm land.

Plant health. The impact of climate change on rate of change in evolution of pests to current genetic resistances of crops is becoming a critical issue. Research is needed to slow evolution of pest's resistance and to reduce use of herbicides, insecticides and fungicides in crop production. Improved understanding of the pest evolution process and innovative models to predict it can help guide research on crop management, breeding and genetics to address this problem. Advances for detecting in advance important future pathogens are required based on understanding the biology of hosts and pathogens or pests and their interactions under climate change. Integrated crop protection strategies are required to reduce pesticide use and this implies far reaching changes in management practices (e.g. crop rotations), that need to be further explored.

Genetic resources and plant breeding. A broader use of species diversity, of species mixtures and of genetic diversity within crop species will be a key for adaptation to climate change. This also implies that there are increased needs for conservation and exploration of plant genetic resources. Alternative crops, multi-components systems (e.g. agroforestry), crop mixtures (e.g legume-based mixtures) and genetic diversity within a crop species are, together with improved conventional breeding and biotechnology, needed to develop new cultivars of current crops and to explore the potential of new crops for adapting to climate change as well as rising atmospheric carbon dioxide and ozone. More effective transfer of knowledge is needed from advances gained using model species into practical application in crops, including plant breeding. There are promising opportunities to increase yields e.g. through altered phenology and improvements in photosynthesis that could lead to transformative, rather than incremental progress.

e. Livestock: production, animal health and breeding

Animal health. It will be important to manage the threat from, and impact of, animal diseases and zoonoses, including both current and newly emerging or exotic diseases, and spread of disease from and to wild animals. Risks of animal disease transmission and spread are increasing with climate change and increased movement of animals and people. Effective surveillance, monitoring, prevention and treatment are all required. Integrated animal health strategies, involving a reduced use of antibiotics in production systems and integrating pain, distress and discomfort reduction issues should also be studied.

Sustainable livestock systems. As with crop systems, the emphasis should be placed on better closing carbon, nitrogen and phosphorus cycles and reducing greenhouse gas emissions in livestock farming systems or integrated crop-livestock systems and thereby increasing production, while reducing environmental footprint per unit product. Waste should be better treated at farm level to recover valuable components (e.g. phosphorus). Emphasis should also be placed on reducing knock-on effects such as the eutrophication of water bodies and increasing the conversion efficiency of water and nutrients, along long supply chains which are typical for animal production systems. Mitigation will be required, combining reduced non-CO_2 emissions (enteric fermentation of ruminants, nitrous oxide emissions from pastures and feed crops), increased carbon sequestration in soils, better assessment of the GHG balance of farming systems through the development of farm-gate assessments and of lifecycle analyses. Moreover, these mitigation strategies will need to be effectively combined with adaptation strategies concerning animal tolerance to high temperatures and to increased parasitic pressures, as well as climate change adaptation of grasslands and of feed crops.

Animal breeding. The potential of genomic selection should be further explored by defining phenotypes and goals for multi-criteria selection. Such goals should include improved environmental footprint, product yield and quality, better health, improved welfare and robustness. Analysis of genetic diversity to explore livestock adaptation to diverse environments and product characteristics is also required.

Feed resources. Renewed attention to the exploitation of feed resources is needed to evolve systems that are minimally competitive with humans for food by capitalising on the advantages of ruminants for generating high quality products from land that cannot otherwise be cropped, and by maximising the use of by-products and co-products in non-ruminant systems.

Integrated crop-livestock systems. Mixed systems for mitigation and adaptation (e.g. crop-livestock; agro-forestry…) should receive far greater attention for their potential role in food security, in reduction of environmental footprint and in climate change adaptation and mitigation. Such systems have the ability to offer a range of ecosystem services that are not usually available in monocultures.

f. **Greenhouse gas mitigation and carbon sequestration by agriculture**

Asssessing the radiative forcing of the atmosphere by European agriculture.
On a global scale, the agriculture sector accounted for an estimated emission of 5.1 to 6.1 Gigaton (Gt) CO_2 equivalents per year in 2005 (10% to 12% of total global anthropogenic emissions of greenhouse gases (GHGs) (IPCC, 2007) and for ca. 60% of N_2O emissions and 50% of CH_4 emissions). Nevertheless, while useful for national inventories, this sectoral analysis has several deficiencies. First, it does not account for indirect GHG emissions generated by farm activity through the use of farm inputs (e.g. fertilisers, feed, pesticides), which are covered by sectors such as industry (e.g. for the synthesis and packaging of inorganic N fertilisers and of organic pesticides), transport (e.g. fuel combustion for transport of fertilisers and feed), and buildings (e.g. electricity and fuel). Second, agricultural activities also induce land-use changes – especially deforestation – caused by expansion (or decline) of pastures and arable lands, which are not included in the agriculture sector balance. Third, changes in soil stocks caused by carbon sequestration or loss in arable lands, grasslands and peatlands managed by agriculture are also not directly included in the carbon balance of the agriculture sector. In the same way, indirect effects of agriculture on the nitrogen cascade lead to further greenhouse gas emissions or uptake, which need to be better assessed. Finally, at the Earth system scale, there are further feedbacks of agriculture in terms of radiative forcing of the atmosphere through changes in albedo, water vapour and heat fluxes momentum. Improved methodologies are therefore required to consistently address the radiative forcing which is both directly and indirectly caused by European agriculture, taking into account these various effects.

Estimating and verifying farm scale GHG budgets. Further research combining measurements, process understanding and modelling is needed to reduce current uncertainties in the N_2O and CH_4 emissions from European farming systems and farming practices. Moreover, methods for projecting and verifying changes in soil organic carbon stocks (i.e. C sequestration) at the field and farm scale are required in order to assess the net GHG emissions of farming systems in CO_2 equivalents. This may lead to a change in paradigm with increased emphasis placed on soil C sequestration opportunities in pastures, in arable feeding systems, as well as in the restoration of degraded soils.

Developing GHG mitigation options that are consistent with climate change adaptation. A variety of options need to be further developed for mitigation of greenhouse gas emissions from crop and livestock production systems on the farms, as well as emissions embedded in farm inputs. The technical potential of these options should be better established for a large range of soil, climate and farming systems conditions in Europe. Moreover, the abatement (economic) potential of technically effective measures needs to be identified, also considering social and policy barriers for their implementation.

Developing a policy framework of GHG mitigation in agriculture. As countries put policies in place to curb GHG emissions, the agriculture sector will be especially concerned. If not properly designed, these strategies may be ineffective in reducing emissions while at the same time causing economically, socially and even environmental negative spillovers. Understanding how policy frameworks addressing climate, energy or agriculture will affect the crop-livestock-climate nexus is thus urgent; their social acceptance and cost-effectiveness across crop and animal production systems being central issues. Integrating both mitigation (i.e. reduce the greenhouse gas emissions) and adaptation (i.e. deal with the unavoidable impacts) strategies to climate change is needed and it remains a significant challenge for the scientific community that will require further research.

g. <u>Bioenergy, biofuels and biomaterial</u>

Crop-derived bioenergy and biofuels and, to a lesser extent, non-food crops competing with food crops may not be tenable in the long-run. Arable land resources are limited and expansion of farmland into forest, grassland and woodland areas will result in biodiversity loss and significant carbon emissions, which may negate the primary justification for carbon savings with bioenergy and biofuels. As long as biofuel expansion is based on first-generation food crops, the speed of biofuel increase needs to be balanced by increases in overall agricultural productivity. Use of crop residues for bioenergy and biofuels may also lead to reduction in organic carbon supply to soils and, hence, in lower soil organic carbon stocks. The key challenge for commercial second-generation biofuels is to develop conversion technologies at industrial scale and at competitive prices. These technologies, still at the laboratory experimentation and demonstration stage, require large-scale feedstock supplies and pose logistical and sustainable management challenges. A substantial potential for producing lignocellulosic feedstocks on currently unprotected grassland and woodlands exists worldwide but its exploitation is likely to increase pressures on biodiversity and ecosystems. Integrated studies on land use changes and competition between food and non-food production systems will be required, assessing the consequences of European policies for a range of options concerning biomaterial, bioenergy and biofuels targets. Moreover, integrated systems combining food and energy production will be studied and assessed in terms of climate change adaptation and mitigation and contribution to global food security.

- **<u>h. Forestry as related to agriculture and food security</u>**

Forests and woodland are an important part of land use and land cover, and provide timber and other goods and services. Forests and woodlands may contribute to GHG mitigation, carbon sequestration and fossil fuel substitution. Forests and woodlands, as well as their production of fibers will be considered by the FACCE JPI in as far as this interacts with land use, food security, climate change mitigation, ecosystem services and conservation of biodiversity at the landscape level.

Annex 6. Consultation Questionnaire

BACKGROUND INFORMATION

WHAT IS JOINT PROGRAMMING? Joint Programming is a process that was defined by the European Commission in 2008 as part of the building of a European Research Area (ERA). The overall aim of Joint Programming is to pool national research efforts in order to make better use of Europe's precious public R&D resources and to tackle common European challenges more effectively in a few key areas. It will follow a structured strategic process whereby Member States agree on a common vision and strategic research agenda to address major societal challenges. In Joint Programming, Member States are expected to coordinate national research activities, group resources, benefit from complementarities and develop common research agendas, to provide the long-term, stable research base that is needed to address major societal challenges. WHY A JOINT PROGRAMMING INITIATIVE (JPI) ON AGRICULTURE, FOOD SECURITY AND CLIMATE CHANGE? Agriculture, food security and climate change pose key challenges for the world. The 2007-2008 world food crisis was a stark reminder that all countries need to build more resilient food systems in the light of expected (and unexpected) changes ahead. Research must play a leading role in bringing solutions. Europe has and continues to develop knowledge and technologies to underpin sustainable and competitive food production systems. Agriculture (including forestry and aquaculture) are highly exposed to climate change – the variability of crop yields has already increased as a consequence of extreme climate events, such as the summer heat of 2003 and the spring drought in 2007 in Europe. The agriculture and land use sector contributes 10 % of the net greenhouse gas emissions of EU 27. European agriculture also has large impacts on natural resources (soil, water and air), biodiversity and ecosystem services. Agriculture has to meet a demand for food which is estimated to rise globally by 50% by 2030 and by 70 to100 % in 2050, due to population growth, urbanisation and increased affluence in many societies. A European Research Area needs to play its role in sustained growth in the agriculture sector (crops, livestock, fisheries, forests, biomass and commodities) to: • Meet growing world food demand • Enhance rural livelihoods • Stimulate economic growth • Maintain and restore ecosystem function / services HISTORY OF THE FACCE-JPI The Joint Programming Initiative (JPI) on Agriculture, Food Security and Climate Change (acronym: FACCE) evolved from the outputs of the Standing Committee on Agriculture Research (SCAR) foresight exercises through which Member and Associated States identified food security and climate change as two of the major key issues impacting on the future of European agriculture. The Council of the EU confirmed this JPI theme in its Conclusions of 3 December 2009 and adopted this JPI in October, 2010. Today, the FACCE-JPI brings together 21 Member States and Associated Countries*. A pilot action, to establish the first FACCE-JPI Knowledge Hub, is underway. Seventeen countries are taking part in this call that will address "A detailed climate change risk assessment for European agriculture and food security, in collaboration with international projects" (see below under priorities). Discussions are also currently on-going regarding a future international call on greenhouse gas mitigation in agriculture, bringing together countries of the FACCE-JPI and the Global Research Alliance on Agricultural Greenhouse Gases. WHAT ARE THE GOALS OF THE FACCE-JPI? Four key goals have been defined to contribute to sustainable agriculture and food security in the face of climate change: i) Provide new approaches for the environmentally sustainable growth and intensification of agriculture in Europe and increase the resilience of food systems to deliver European food security, feed, fuel, fibre as well as other ecosystem services under current and future climate and resource availability; ii) Provide an integrated impact assessment of climate change throughout the whole food chain, including market repercussions; iii) Contribute to direct reductions of greenhouse gas (GHG) emissions through carbon sequestration, fossil fuel energy substitution and mitigation of N2O and CH4 emissions by the agriculture and forestry sector, while reducing GHG emissions per unit area and per unit product associated with land use change; iv) Sharply reduce trade-offs between food production and the preservation of biodiversity, ecosystem functions and services. HOW DOES THE FACCE-JPI PLAN TO MEET THESE GOALS? To reach these goals, research should be integrated on a large scale: • A systemic understanding should be gained, by developing and integrating a large range of disciplines from climatology, to ecology, agronomy, forestry and socio-economy, through plant, soil, microbial and animal sciences, that must be strongly connected to a foundation of agro-ecological and socio-economic modeling. • Key European infrastructures need to be assembled in order to integrate scenarios, observations, experiments and models in order to develop and inter-compare agro-ecological and socio-economic projections while assessing their uncertainties. • Economics of short- and long-term adaptation/mitigation strategies should be analysed also aiming at improving current food security while taking into account: i) uncertainties in the projections of climate change and impacts, ii) the valuation of ecosystem functions and services and their resilience. • Developing and implementing specific solutions at the ecosystems and policy levels based on detailed information on regional impacts and meaningful assessment of the adaptive options and their feasibility at local and farm levels. Workable adaptation options will be developed in close collaboration with decision-makers and stakeholders involved in the research and development process. • A roadmap of breakthrough technologies in the areas of crop, livestock, fuel and fibre production, of land, water and genetic resources management and of biodiversity conservation and use will be developed. When mature, these innovations will be considered for integration in production systems and in policy measures. WHAT ARE THE EXPECTED OUTPUTS OF THE FACCE-JPI? The FACCE-JPI plans to deliver key outputs for Europe by contributing: i) to raising the biological efficiency of European agriculture, ii) to responding to a globally increased food demand, iii) to operating agriculture within greenhouse gas, energy, biodiversity and contaminant limits, iv) to building resilience in agricultural and food systems. *Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Israel, Italy, The Netherlands, Norway, Poland, Romania, Spain, Sweden, Switzerland, Turkey, United Kingdom

PUBLIC CONSULTATION INFORMATION

TARGET GROUPS This public consultation aims at gathering views and evidence from stakeholders on the key priorities and areas for research to contribute to the goals of food security and sustainable agriculture in the face of climate change. Contributing to these goals will require the support and effort of participating EU Member States and Associated Countries and their stakeholders. This includes the scientific community, either individually, as consortia (e.g., other European or global initiatives) or as research performing organisations including universities; funding organisations including national Ministries; farmers and extension services, including farmers associations; the related private sector including SMEs and industry, individually or as represented by European Technology Platforms; Non-Governmental Organisations and civil society. PERIOD OF CONSULTATION From 26.01.2012 to 30.03.2012 BACKGROUND The FACCE – JPI Scientific Advisory Board (SAB) has elaborated a Scientific Research Agenda, detailing the scope, core research themes and the priority actions. Following the publication of the Scientific Research Agenda, themes are elaborated in dedicated mapping meetings to provide further input towards the development of the Strategic Agenda. The foresight and mapping activity for strategic collaboration is part of the internal process towards the strategic agenda. Furthermore, a broad public stakeholder consultation is held. OBJECTIVE OF THE CONSULTATION The consultation aims to reinforce the SAB analysis of the key issues to be addressed as well as to gather views on their importance: goals, core research themes and priority actions, and implementation. HOW TO SUBMIT YOUR CONTRIBUTION We welcome contributions from citizens, organisations and public authorities. A summary of the contributions will be published on the Internet. It is important to read the specific privacy statement attached to this consultation for information on how your personal data and contribution will be dealt with. THE CONSULTATION DOCUMENT Before submitting your contribution, please read carefully the consultation document which provides background and guidance to the FACCE-JPI and the consultation. THE QUESTIONNAIRE You can respond to one or more of the sections of the questionnaire. Only Section 1 on 'information about the respondent ' is mandatory to fill in. In addition to responding to the questionnaire on-line, you can submit a separate written contribution by sending it to SecretariatJPI@paris.inra.fr. REFERENCE DOCUMENTS You can read the FACCE-JPI Scientific Research Agenda (http://www.faccejpi.com/FACCE-JPI-Home/FACCE-JPI-News/Scientific-Research-Agenda). You can read the report of the mapping of the Core Theme Climate Change Mitigation (https://www.faccejpi.com/FACCE-JPI-Home/FACCE-JPI-News/First-mapping-meeting-report-on-climate-change-mitigation-is-available) CONTACT DETAILS Secretariat FACCE - JPI E-mail: SecretariatJPI@paris.inra.fr Postal address: INRA, 147 rue de l'Université, 75338 Paris cedex 07, France. Attention: Heather McKhann RESULTS OF CONSULTATION AND NEXT STEPS A summary of results of the consultation will be published on the FACCE – JPI website (www.faccejpi.com) and will result in the publication of the Strategic Research Agenda in 2012.

YOUR INFORMATION

Publication of data A synthesis of your contributions received via this online questionnaire together with the identity of responding organisations/affiliations, will be published on the web. Therefore, in order to take part in this consultation, you must indicate prior agreement to the publication of your organisation data (opt-in).

Consent to publication of data *

- ( ) I agree (opt-in)
- ( ) I agree only without any publication of my organisation data:
- ( ) I disagree (the questionnaire will be kept confidential and will not be included in the synthesis)

I am replying as/on behalf of a * (if you represent more than one category, please choose the most relevant one):

- ( ) national government
- ( ) regional/local government
- ( ) public agency
- ( ) research funding organisation
- ( ) public research organisation
- ( ) private research organisation
- ( ) university/ higher education
- ( ) doctoral candidate/early-stage researcher
- ( ) experienced researcher
- ( ) farmers' organisation
- ( ) farm extension/advisory service
- ( ) private enterprise (less than 250 employees)
- ( ) private enterprise (250 or more employees),
- ( ) international organisation
- ( ) non government organisation
- ( ) European research initiative (e.g. ERA-NET)
- ( ) international research initiative
- ( ) Other:

Please indicate your field of work * (more than one may be indicated)

- [ ] Agriculture
- [ ] Livestock
- [ ] Forestry
- [ ] Environment
- [ ] Food Security
- [ ] Climate Change
- [ ] Water
- [ ] Soil
- [ ] Plant, animal breeding
- [ ] Fertilisers, irrigation
- [ ] Plant, animal health
- [ ] Biotechnology
- [ ] Food industries
- [ ] Biodiversity
- [ ] Nature conservation
- [ ] Socioeconomic sciences and humanities
- [ ] International cooperation
- [ ] Health
- [ ] Policy making

- [ ] Regional development
- [ ] Finance, banking, insurance
- [ ] Trade and retailing
- [ ] Research infrastructures
- [ ] Space and geomonitoring
- [ ] Other:

Please provide your title (Mr./Mrs./Ms., Dr., Prof.)

- ( ) Mr.
- ( ) Mrs.
- ( ) Ms.
- ( ) Dr.
- ( ) Prof.
- ( ) Other:

Please provide your name/ organisation's name * If you are responding as a citizen, enter "citizen"

Please provide your position *

Please provide your email address * (will not be published)

Please provide your country of residence/establishment * [e.g. Austria, Belgium etc., EU level organisation, other (at most 1 answer)

Have you or do you intend to submit an additional separate written contribution? * (maximum 2 pages) [

- ( ) yes
- ( ) no

Assessing the FACCE- JPI challenges

1, Provide new approaches for the environmentally sustainable growth and intensification of agriculture in Europe and increase the resilience of food systems to deliver European food security, feed, fuel, fibre as well as other ecosystem services under current and future climate and resource availability; 2, Provide an integrated impact assessment of climate change throughout the whole food chain, including market repercussions; 3, Contribute to direct reductions of greenhouse gas (GHG) emissions through carbon sequestration, fossil fuel energy substitution and mitigation of N2O and CH4 emissions by the agriculture and forestry sector, while reducing GHG emissions per unit area and per unit product associated with land use change; 4, Sharply reduce trade-offs between food production and the preservation of biodiversity, ecosystem functions and services.

• Please assess the challenges undertaken by the FACCE-JPI in terms of their usefulness for your organisation (or for you) : 4, extremely useful, 3, very useful, 2, useful, 1, of no value to me/my organisation.;

1	2	3	4
( )	( )	( )	( )

Please explain your response

We now have a series of questions on each of the five core themes (please read the questions for the five themes before starting to answer)

Core theme 1: Sustainable food security under climate change

- Integrated food systems perspective and risk analysis - Global change impact and resilience of food systems (through the value chain and to the consumer) - Europe's role in international markets, price volatility, global food security impacts - Develop contrasted scenarios involving perceptions and policy dialogue - Combine observations, experiments and modeling

Related to this core theme, what are the major problems your sector is facing?

Are there areas of this core theme that you are more specifically interested in?

Which sort of research results would be useful for you/ your organisation in this core theme?

When would you need such research results (in the next 5, 10, 20 years) ?

How do you see your contribution to innovation in this area?

Would your organisation/you be interested in contacts with JPI teams to develop paths to markets in this area?

Would your organisation/you be interested in contacts with JPI teams to develop communication, advisory, policy support tools in this area?

Research priorities for Core theme 1

The first research priorities defined for this core theme are: – Short term action. Detailed climate change risk assessment for European agriculture in a global context: how will climate variability and change affect regional farming systems in near and far future? What are the risks and the opportunities for European food security and agriculture? An ensemble of crop and livestock models will be benchmarked, inter-compared and coupled to both climatic and economic models. A call was open to address this priority in 2011. – Medium term: Consequences of changes in food systems (including food habits, processing, wastes, consumption …) on climate change (GHG, footprints, etc) and, conversely, climate change impacts on European food systems (including processing, retailing, transport, consumption patterns). – Longer term: Modeling the drivers of price volatility and its role on food systems and food security. Development and use of scenarios (e.g. IPCC Representative Carbon concentration Pathways) and development of a range of contrasted scenarios including changes in agricultural production systems, in food habits, in food processing, etc.

Would your organisation/you be interested by research findings in these areas?

Can you suggest other priorities for this core theme?

Core theme 2: Environmentally sustainable growth and intensification of agriculture

- Provide new approaches (for improving farm management, sustainable intensification of agricultural systems and low-input high natural value systems) - Understanding recent crop/yield trends in Europe - Benchmarking efficiencies of resource use - Assessing and raising biological resource use efficiency; increasing productivity - Combining crop, livestock and bioenergy systems for sustainable intensification - Low input, higher efficiency seeds and breeds - Knowledge based IT innovations in agriculture - Improved understanding and control of soil functioning and biotic interactions

Related to this core theme, what are the major problems your sector is facing?

Are there areas of this core theme that you are more specifically interested in?

Which sort of research results would be useful for you/ your organisation in this core theme?

When would you need such research results (in the next 5, 10, 20 years)?

How do you see your contribution to innovation in this area?

Would your organisation/you be interested in contacts with JPI teams to develop paths to markets in this area?

Would your organisation/you be interested in contacts with JPI teams to develop communication, advisory, policy support tools in this area?

Research priorities for core theme 2

– Short term action. Benchmarking at farm gate the current state and historical changes (and their main drivers: economics, Genotype x Environment x Management) in productivity and resource use and institutional innovations and investment needs for sustainable intensification. Assessment of variability in systems by screening a large number of situations, as if taking a meta-analysis approach. – Medium term. Production of innovative scientific gold standards for agricultural monitoring. Satellite studies where countries could identify key systems with raised productivity and reduced GHG emissions, in which average values of variables can be benchmarked. – Longer term. Combined development of genomic selection, ecological engineering, precision farming, ecotechnologies and biotechnologies for increased resource use efficiency and productivity in key agricultural systems.

Would your organisation/you be interested by research findings in these areas?

Can you suggest other priorities for this core theme?

Core theme 3: Assessing and reducing tradeoffs between food supply, biodiversity and ecosystem services

- Provide new approaches to the increased use of functional biodiversity in agricultural systems - Developing methods for assessing and valuing biodiversity and ecosystems goods and services in intensive agricultural systems - Develop approaches for optimizing the trade-off between agriculture and ecosystem services in a variable environment and at farm scale - Develop a solid knowledge basis for the provision of public goods by European agriculture

Related to this core theme, what are the major problems your sector is facing?

Are there areas of this core theme that you are more specifically interested in?

Which sort of research results would be useful for you/ your organisation in this core theme?

When would you need such research results (in the next 5, 10, 20 years)?

How do you see your contribution to innovation in this area?

Would your organisation/you be interested in contacts with JPI teams to develop paths to markets in this area?

Would your organisation/you be interested in contacts with JPI teams to develop communication, advisory, policy support tools in this area?

Research priorities for core theme 3

The first research priorities defined for this core theme are: – Short term action: Assessment of ecosystem services in European landscapes and how these link to biodiversity, productivity and resource use efficiency and how they are to be valued by society and economically. – Medium-term: biodiversity based low-input high productivity multi-component farming systems using e.g. within and between species diversity across trophic levels in combination with genomic selection and conventional breeding. – Longer term: adaptive management of high natural value agricultural landscapes producing specific products in high demand.

Would your organisation/you be interested by research findings in these areas?

Can you suggest other priorities for this core theme?

Core theme 4: Adaptation to climate change

- Adaptation to climate change and increased climatic variability - Tailoring adapted regional production systems under climate change - Adapting seeds and breeds through conventional breeding and biotechnology - Monitoring pests and diseases and developing climate-informed crop and animal protection - Adaptive water management in agriculture, watershed management, flood management, irrigation technologies, water re-use -Adapting food processing and retailing, markets and institutions

Related to this core theme, what are the major problems your sector is facing?

Are there areas of this core theme that you are more specifically interested in?

Which sort of research results would be useful for you/ your organisation in this core theme?

When would you need such research results (in the next 5, 10, 20 years)?

How do you see your contribution to innovation in this area?

Would your organisation/you be interested in contacts with JPI teams to develop paths to markets in this area?

Would your organisation/you be interested in contacts with JPI teams to develop communication, advisory, policy support tools in this area?

Research priorities for core theme 4

The first research priorities defined for this core theme are: – Short term action. Designing management relevant novel ideotypes adapted to climate change and elevated CO_2 and assessing groundbreaking designs for advanced plant and animal phenotyping facilities under climate change. – Medium term. Understand the adaptive value of diversity, specialization and trade in European agriculture, through appropriate modeling. – Longer term. Epidemiological models and near real time climate-informed forecasts of pests and diseases. Regional scale strategies for preserving gene resistance against pests, diseases and pathogens in crop and animal species. Drought and heat tolerant productive crop species and thermo-tolerant animal species.

Would your organisation/you be interested by research findings in these areas?

Can you suggest other priorities for this core theme?

Core theme 5: Mitigation of climate change

Contribute to direct reductions of greenhouse gas emissions - Develop monitoring and verification methodologies of field, animal and farm scale GHG budgets - Develop verifiable greenhouse gas mitigation and carbon sequestration measures - Develop technologies and methods to substitute fossil-fuel energy

Related to this core theme, what are the major problems your sector is facing?

Are there areas of this core theme that you are more specifically interested in?

Which sort of research results would be useful for you/ your organisation in this core theme?

When would you need such research results (in the next 5, 10, 20 years)?

How do you see your contribution to innovation in this area?

Would your organisation/you be interested in contacts with JPI teams to develop paths to markets in this area?

Would your organisation/you be interested in contacts with JPI teams to develop communication, advisory, policy support tools in this area?

Research priorities for core theme 5

Concerning this core theme, a work group of FACCE-JPI has organised a mapping exercise in 2011 in order to identify joint programming opportunities and activities within this core theme. Mapping exercises will be organised for the other four core theme as well. The conclusions and recommendations of the mapping exercise on core theme 5 are: Research themes identified for joint action are: • Mitigation options focusing on carbon sequestration in crop production: soil nutrient management; efficiency of crops, grasslands and forests as carbon sinks; • Protocols and certification for methods to assess greenhouse gas emission; • Reduction of emissions by livestock, in particular through nutrition and animal breeding; • Carbon and nitrogen cycling in the ecosystems; common framework for Life Cycle Assessments (LCA) of livestock production systems and of crop production systems; • Study of indirect emissions. Tools identified for cooperative research are: • Harmonisation modeling systems and efforts; • Optimisation of cooperation between this initiative and others, like the Global Research Alliance; • Identification of infrastructures to be shared; • Development of adequate tools for judging integrated production systems. The first research priorities defined in the Scientific Research Agenda for this core theme are: – Short term action. Soil carbon sequestration estimation and verification methodologies based on soil surveys, remote sensing, management practices, process modeling, data streams (ICOS, Integrated Carbon Observation System) and novel verification methods (e.g. neutron scattering). – Mid-term: Assessment of the eco-efficiency of key farming systems within European sub-regions. Technical and economical abatement potential of GHG mitigation measures and policy analysis. – Longer term: Abatement potential of changes in food systems, including approaches such as economics and sectoral policies, to be linked with adaptation above.

Would your organisation/you be interested by research findings in these areas?

Can you suggest other priorities for this core theme?

Questions on all 5 core themes:

Among the 5 core themes, which has priority for your sector?

Why does it have priority?

	1	2	3	4	5
Core theme 1: Sustainable food security under climate change	( )	( )	( )	( )	( )
Core theme 2: Environmentally sustainable growth and intensification of agriculture	( )	( )	( )	( )	( )
Core theme 3: Assessing and	( )	( )	( )	( )	( )

	1	2	3	4	5
reducing tradeoffs between food supply, biodiversity and ecosystem services					
Core theme 4: Adapting to climate change	( )	( )	( )	( )	( )
Core theme 5: Mitigation of climate change	( )	( )	( )	( )	( )

What additional actions can you suggest to develop FACCE JPI?

Implementation

How important is sharing data and databases?

In your opinion, how should this be done?

In your opinion, what are the research infrastructure needs to support the FACCE-JPI?

If you are responding as an SME or industry representative what role could you imagine for your SME/industry in the FACCE-JPI?

In your sector, what do you consider the role of SMEs and industry in bringing about the FACCE-JPI goals?

Communication

Do you wish to be informed of FACCE - JPI news (through a website, newsletter)?

- ( ) Yes
- ( ) No

Glossary

Biodiversity: The degree of variation of life forms within a given ecosystem, biome, or an entire planet. Biotechnology: Field of applied biology that involves the use of living organisms and bioprocesses in engineering, technology, medicine and other fields requiring bioproducts. Biotechnology also utilizes these products for manufacturing purpose. Biotechnology: Field of applied biology that involves the use of living organisms and bioprocesses in engineering, technology, medicine and other fields requiring bioproducts. Biotechnology also utilizes these products for manufacturing purpose. Carbon sequestration: Carbon sequestration describes long-term storage of carbon dioxide or other forms of carbon to either mitigate or defer global warming and avoid dangerous climate change. Globally, soils are estimated to contain approximately 1,500 gigatons of organic carbon, more than the amount in vegetation and the atmosphere. Modification of agricultural practices is a recognized method of carbon sequestration as soil can act as an effective carbon sink offsetting as much as 20% of carbon dioxide emissions annually. Ecosystem services: Humankind benefits from a multitude of resources and processes that are supplied by natural ecosystems. Collectively, these benefits are known as ecosystem services and include products like clean drinking water and processes such as the decomposition of wastes. Intensive agricultural systems: Intensive farming or intensive agriculture is an agricultural production system characterized by the high inputs of capital, labour, or heavy usage of technologies such as pesticides and chemical fertilizers relative to land area.

[Submit]