Report of stakeholder workshops concerning the Common Strategic Framework (CSF) and Horizon 2020 for Research and Innovation:

FOOD SECURITY & BIOBASED ECONOMY[1]

1. Introduction

Two informal workshops were organized by DG Research and Innovation in collaboration with policy DGs[2] to complement the public consultation on the Green Paper *'From Challenges to Opportunities: Towards a Common Strategic Framework for EU research and innovation funding'*. The aim was to help define the societal challenges and the research and innovation priorities that are relevant to food security and to the biobased economy. The events were intended also to draw upon the reflections of five expert groups that have studied the impacts of previous research in the area financed under FP5 to FP7.

The agenda was the same for both events, but the participation varied. The first workshop was attended by governmental experts participating in their own expert capacity[3]. The participants at the second workshop were drawn from the Bio-National Contact Points (Bio-NCPs), the ERANETs and the European Technology Platforms (ETPs) related to the bio-economy field.

The proposal of the Commission for a financial framework covering the years 2014-2020 was adopted on 29 June 2011; it includes a strengthened provision for research and innovation, seen as essential to the success of Europe in this period and beyond. The overall amount allocated to Horizon 2020 is EUR 80 billion in constant 2011 prices (EUR 90 billion in current prices) excluding funding for ITER. This amount is 46% higher than the funds available for 2007-2013. The share of research and innovation in the EU Budget under this proposal would be 8.5% in 2020. Of this total, EUR 4.5 billion are ear-marked for research and innovation on food security, the bio-economy and sustainable agriculture. The implications for marine research and bio-industries will need to be clarified.

The Council has called for future EU funding programmes to focus more on Europe 2020 priorities, address societal challenges and key technologies, facilitate collaborative and industry-driven research, streamline the instruments, radically simplify access, reduce time to market and further strengthen excellence. The Green Paper on the Common Strategic Framework responds to this request in broad strategic terms, bringing together existing financial instruments and simplifying procedures and project management. In part project management might be externalised by a transfer of responsibility to a specialised agency. Public-private partnerships would provide another route.

The Green Paper sought advice from stakeholders on how the strategic principles might be implemented. Response to the consultation was positive. Stakeholders largely confirmed the priority they gave to the main objectives of the CSF: to bring research and innovation together in an integrated funding programme; to simplify procedures and to support all

[1] This present report was prepared with the assistance of an independent expert – rapporteur, and reflects the main points of the debates of the two stakeholder workshops concerning the CSF - Horizon 2020 for Research and Innovation on Food Security and Biobased Economy held on 4 and 13 July 2011. Although great care has been taken to maintain the accuracy of information herein, the European Commission does not assume any responsibility for consequences which may arise from the use of the material. Any statement and opinion expressed in this report should not be taken to be representative of the views of the European Commission.

[2] DG Agriculture and Rural Development, DG Enterprise and Industry, DG Environment, DG Health and Consumers, DG Maritime Affairs and Fisheries

[3] Including members of the Programme Committee, of the Special Committee on Agricultural Research (SCAR) and of the Network on the Knowledge based Bio-economy (KBBE-NET).

stages in the innovation chain, with more attention than in the past to close-to-the-market activities including demonstration and piloting.

For priority in content, respondents agreed that in large part the focus of EU funding should be on agreed and defined societal challenges and EU policy objectives (for example in climate change, ageing and energy security.

For implementation, the consultation stressed that new initiatives should stand in continuity with past successes in particular the European Research Council, Marie Curie and collaborative research. More openness and flexibility is needed, less prescriptive calls, and better use of bottom-up instruments. Respondents noted the relevance of a wide range of policy sectors to the bio-economy with the consequence that actions taken within a sector may impact unfavourably on the bio-economy (or alternatively might stimulate it). Coherence amongst policies in a comprehensive strategy, that addresses transparently the trade-offs to be made, will ensure a faster and better achievement of results.

There is still no fully accepted set of societal challenges, but there is a widely circulated indicative list (a "working hypothesis") that includes "food security and the bio-economy". A public on-line consultation about the present state of the bio-economy and its prospects was held from 22/02/2011 to 02/05/2011; it sought the views of a wide range of stakeholders including public authorities, businesses and trade associations, academics and technical experts, civil society organisations and individual citizens. Respondents were generally optimistic about prospects; they thought that reductions of waste and pollution were likely to be the main benefit in the short term, but in the medium-term were generally positive about the value to agricultural practice, new bio-industries, employment and growth. The main barriers to progress were thought to be: insufficient links between decision makers and stakeholders; insufficient links between policies related to bio-economy; lack of long-term horizon scanning, foresight and impact analysis in decision making.

The workshops reported here undertook the task to develop form and content for the challenge, "Food security and the bio-economy". With this in mind the workshops were structured into three sessions moving from the overall design, the content and the exploitation of results.

2. Mapping the Grand Challenge

Overall, the organization of research and innovation according to the concept of Grand Challenges was well received by the bio-economy community in their responses to the public consultation, but there was a strong sentiment that Grand Challenges must be better and more consensually defined. The first session of the workshop contributes to that process. The debate addressed the questions: what are the societal challenges in relation to food and bio-resources; how can they be broken down to meaningful components; how can research and innovation best address these challenges?

Several possible ways of mapping the grand challenge of "food security and bio-economy" were proposed. This report of this session will first juxtapose those maps, review the common threads and points of difference and then present some of the points made in the debate (by presenters and participants) that help develop the issues.

There are many maps available

The public consultation sought guidance on the most significant research topics within the bio-economy. The most frequently cited were food security, climate change and the preservation of natural resources. Other topics mentioned included: protection of biodiversity and ecosystems services; alleviation of hunger and poverty (notably in relation to fisheries and aquaculture); low carbon economy (in association with climate change); water; employment.

The EC ex-post assessment of the research impact of FP7 and earlier programmes on agriculture proposed outlines of the main areas for future research. Five of the most important were:

- Continued rebuilding of agricultural research and innovation
- Transpose the outputs of basic and applied molecular biology research into practice, particularly through the genetic improvement of plants, animals and the development of new vaccines and other products.
- Research to support the ecological intensification of agriculture and forestry – increased exploitation of natural processes and cycles to grow and protect plants and animals.
- Understanding the regional character of the public goods provided by farmers and foresters
- Understanding the effect of delivering or protecting public goods on the economic competitiveness of farms and forests.

These research topics were selected in part to recognise the value of public goods that can arise out of publicly funded research and reflects the view that public research should address issues that private companies are for one reason or another likely to ignore. The list above either aims to deliver public goods through research or to facilitate the delivery of benefits by private research through complementary public activity.

Recent policy statements from DG Agriculture and DG Environment suggest that their policies on the bio-economy are converging towards a greening of the Common Agricultural Policy (CAP) and that the CAP should actively protect and restore natural resources. This policy integration is broadly compatible with the scope of research and innovation outlines in the ex-post assessment listed above.

A second map of priorities was introduced by one of the presentations that reflected the arguments from the BECOTEPS White Paper. Priorities are:

- Sustainable management of natural resources
- Sustainable production
- Improving public health
- Mitigating climate change
- Integrating and balancing social developments
- Global sustainable development

A third map from one of the policy DGs proposed:

- Sustainable agricultural production and food security (including some aspects of biotechnology such as genomics and molecular plant breeding)
- Climate change mitigation and adaptation (with the intent to help the agriculture/forestry sector to decrease greenhouse gas emissions and adapt to the climate change).
- Sustainable production of bio-mass for different and cascading use (including the development of high value added bio-based products; bio-energy; sustainable use of agricultural and forest biomass; wastes as well as products; strengthening the functioning and the sustainability of the food supply chain; food safety; food and biomass processing; fostering the cascade use of biomass)
- A competitive agriculture and balanced territorial development in the EU (trade-off of different land uses, ensuring cohesion of rural areas and preventing economic marginalisation, fostering activity diversification in rural areas, ensuring appropriate

relations between rural areas and urban centres, facilitating knowledge dissemination and innovation in rural areas, providing support to policy making

There are common threads and differences

There are strong common elements in these maps. All ways of classifying the terrain give importance to the sustainable use of natural resources, to understanding and preserving ecosystems, to making them robust to change and to improving the social condition of farmers.

There are also significant differences. The first map is rather inclusive in its disciplinary conception of the bio-economy and recognises the roles of biotechnology and the importance of public goods in agriculture. The second map goes furthest in recognising the possibilities of the bio-economy to contribute positively to challenges faced in other sectors of the economy, giving weight to health, climate change and global sustainable development. The third list is narrower, giving more importance to primary production within the EU with biotechnology in a supporting role.

The composite map would appear to have a fairly well defined region that recognises the need for research on primary production in its social, economic and environmental dimensions and in particular in better characterisation of the eco-systems on which sustainable production must ultimately be based. Around this region there is then scope to extend the map towards other sectors or towards the bio-economy interpreted more widely.

Agriculture is important

The farm sector faces some severe challenges; it faces difficult economic conditions, increasingly restrictive environmental constraints and must adapt to climate change. Growth in productivity is still positive, but is falling. On the market side, society is increasingly more demanding in terms of food quality, public goods and animal welfare. For these reasons agriculture is likely to become more dependent in the future on research, knowledge transfer, innovation and product commercialisation.

The changing preferences of consumers will alter the demands on agriculture. An aging society is likely to put a new accent on quality of food, in the expectation that it contributes to active and healthy ageing, and will make new demands on land for tourism, cultural and recreational activities. The demographic change is therefore likely to increase demands for the public non-food goods provided by land stewardship and landscape management.

The general consensus on the priority of research in sustainable agriculture tends to disguise strong differences of opinion on what this means. One interpretation is the wider adoption of organic agricultural practices, possibly intensified. Others would hold that technological improvements in identification and breeding of high-yield plants and animals and the control of and adaptation to biotic and abiotic stress will allow sustainable agriculture of a different kind. The need to increase output in Europe is also a point of dissent; some argue that Europe has no competitive advantage in volume, that it is difficult to increase volumetric production and that the effort should go into high-value products. In another view, food security must depend in part at least on increased domestic output and a sufficient supply of competitively priced primary production is necessary to limit price volatility and promote sustainable growth of the sector. Improving the productivity of EU agriculture is essential for this as there is little opportunity for more land to be put into production.

In the case of climate change, crop farming and the raising of livestock, as currently practiced, are major drivers of temperature increase, both directly, through emission of greenhouse gases (GHG), and indirectly through conversion of carbon-sink land and energy use. Transformation of agricultural practices, in particular the drastic reduction or elimination of fertilizer and pesticide dependence, would be a highly significant contribution to mitigation measures. Even if the most radical measures are taken in the immediate future, a

substantial amount of climate change will take place. Adaptation to climate change of agricultural production systems and forests has to be urgently addressed.

But the bio-economy extends beyond agriculture and food security

Nutrition

The contribution that the bio-economy can make to sectors beyond agriculture was recognised by many participants. Through the production of food that can be either favourable or detrimental to health, depending on the manner it is produced and through the by-products that can pollute or impoverish land, water and seas, agriculture, fisheries and the food manufacturing and distribution sectors are major players in the area of health, interacting with suppliers of health services. Consumer's health, farmer's health, and public health all need to be considered. Human nutrition research will reveal the impacts of food patterns, foods and food components. Obesity-related disease is now the largest contributor to the costs of services in public health.

There was no dissent from the strongly argued view by many participants that the topic of nutrition should be kept within the bio-economy. Ensuring the delivery of nutritious, safe and high quality food can only be achieved by understanding and improving the management of the entire food chain. Good nutrition starts on the farm by producing nutritious raw materials. The total quantities of nutrients and the share that will be bioavailable will then depend on how the food is stored, processed, distributed, sold and prepared. At the very end of the chain, consumer choices and habits play a decisive role. Inclusion of the entire food chain in the bio-economy, from production to consumption is indispensable as it is the only way of ensuring the link back to primary production which is where the story begins.

Fisheries

Representatives of marine interests noted that agriculture was dominant in the consultation paper and the responses, but there is considerable specificity in needs of the fishing industry that set it aside from agriculture and the special needs to be understood and reflected in the research programme. Harvesting of wild fish is an unpredictable activity. A fisherman has limited control over what the composition of the catch and restricted ability to meet stringent market requirements, for example for size of fish. Another distinction from agriculture is that the pressure on resources in agriculture arises from competition from non-food uses of land. In fisheries it arises from competing pressures on the marine environment itself, such as the multiple forms of pollution that eventually find their way to coastal, but also deep waters.

Aquaculture makes a rising contribution to European seafood landings; it represents more than 25% of landings by weight and more by value as farming tends to focus on higher value products and a higher value added chain; it provides jobs in rural and coastal areas where there are few alternatives. Aquaculture is also a steadily-increasing component of European seafood imports (including salmon, shrimp, pangasius, shellfish and sea-bream). The products of aquaculture have the lowest carbon footprint for animal protein supply and are generally recognised as a 'healthy' product with potential as the basis of 'functional' foods. In the medium-term there is potential for 'smart' bio-based products (e.g. from micro-algae). Future growth in the industry will be largely in marine conditions and will begin to move off-shore. Research and innovation involving the whole value chain will be needed to help the industry with this transition and to adapt to climate change.

Forestry

There is specificity in forestry also and representatives from the forestry sector observed that this specificity was not reflected in the consultation paper; for that reason it was hard for the sector to table a position. The forestry sector is potentially a large supplier of biomass. There are interesting opportunities to cascade the use of renewable feedstocks from forestry in

biotechnological and other type of processes to produce a range of high value-added materials and products. Demands on forestry products could increase substantially if the process of cellulose and lignin develop into commercial processes. There will be implications for forestry in its selection of species, breeding programmes and management of forests and plantations. The handling of waste in particular will need to be addressed.

Biotechnology

Although the bio-economy is not equivalent to biotechnology it does embrace biotechnology together with other technologies and there are important potential benefits to be gained from the use of this technology. It offers new ways to improve the productivity and efficiency of arable farming, emission reduction of various industrial processes, livestock and aquaculture; it can make them more robust to future changes (including climate change) and can help reduce environmental and other footprints.

Applications of enzymatic processes in industry are environmentally friendly and profitable; the extension to novel applications such as products from algae, offers the opportunity to create new fuels and bio-based products without jeopardising food crops. The potential for processes using micro-algae is promising and there are good opportunities to borrow some techniques from aquaculture. Waste streams from agriculture, forestry or the domestic sector become valuable feedstocks for the production of chemicals, building blocks, biomaterials and energy forms. The development and use of bio-based processes and products including the development of industrial biotechnology and other technologies towards a process technology tool box and the development of integrated and diversified biorefineries through demonstration plants should be a core area of research and innovation in order to reduce time-to-market of new bio-based products, secure long-term supply and satisfy the increasing demands.

Sustainability depends on understanding the eco-system

It is not possible to ensure sustainability of an eco-system without understanding how it works. For example, in the fishing industry, sustainable fishing depends on understanding the ecosystem that is harvested. Only on this basis can productivity be maintained. The study of marine eco-systems is not an intellectual curiosity, but a fundamental need and a part of the production system. Any failure to understand how the eco-system works will lead to lower production and higher environmental impacts. Eventually stocks will be fished down below a sustainable level. In this respect the relationship of science to fisheries is very different to its relationship to agriculture. The role of the public sector is also distinct; it is principally to manage a common resource, with implications within and outside its boundaries. High quality scientific evidence is required to construct and to implement policy in this area.

The strong emphasis on understanding the eco-system is of interest in agriculture also. Most agriculture takes place in soil; this is a living environment, the ecology of which bears on plant growth, yields, pests and diseases. It is important to reduce negative externalities and to promote technological and social innovations that help to integrate better natural system functions, the social fabric and production processes. This depends first on understanding those system functions. Properly conducted this can help orient agriculture in a way that contributes to food security, ensures the sustainability of farming and the quality of life of farmers, promotes their land-stewardship role and the quality of the environment and the ecosystem services. The dependence of some agriculture on migrant and often illegal labour is unsatisfactory and exploitative. It is necessary to recognise this and devise methods to cope.

An often neglected dimension of sustainability is biodiversity. Current practices in agriculture, fisheries and forestry are among the major drivers of biodiversity loss and ecosystem degradation world-wide. Space is the most crucial resource in this context, with

transformation of species-rich permanent grazing lands and wetlands into intensive monospecific or species-poor croplands or lignicultures. Pesticides and fertilizers play a determinant role in these transformations. There is also a risk that Europe limits the impact of fuel crops on its territory by surface swap methods (such as substituting fuel to paper as a product of existing lignicultures), but exports the impact (for instance by relying for paper production on destruction of Brazilian dry forests. The requirement to halt biodiversity loss will require hard trade-offs with agricultural and bio-industrial policies. Research into the options available and how they can be practically applied should be a priority.

The bio-economy needs also to act sustainably and it is not entirely clear that this is at present the case; for example, the environmental impacts of some first generation biofuel plants may be rather significant. A more thoughtful and joined-up taxation and regulatory system would help, for example duty is paid in imports of bio-ethanol from Brazil, but not bio-ethylene. Such peculiarities reflect a piecemeal approach in which the need to represent the underlying externalities is lost.

Coherence among policies is needed

The main obstacle to the progress in the bio-economy is precisely that it embraces several existing silos of legislation and administrative competence and is in this sense disruptive and threatening. Ideas that originate in one silo may challenge preconceptions and may even require legislative change in another. There are many examples; waste from agriculture and food production is high. This is a consequence of well-meant policies such as expiry dates on packaged food, but it leads to environmental damage. Subsidy policies for biofuels that are undertaken for the important, but limited, objectives of energy security have unforeseen and probably serious environmental and economic consequences elsewhere. Incentives to co-fire biomass in fossil fuelled power plants distort markets for forestry products. Policies for standards, risk capital, Intellectual Property Rights (IPR) may also contribute positively or negatively to the bio-economy. Research is needed to clarify some of these interactions and to help bring greater coherence across interventions

Much research and innovation is still needed to scope the prospects for the bio-economy. The availability of biomass in quality and quantity is unpredictable. It is not yet clear what will be required of the productive systems especially agriculture and forestry. Many aspects of the future are unclear; the rate of penetration of renewable electricity is uncertain and this will have implications for electric cars and public transport; the future costs and performance of new generations of fermentation technology are also unknown and so the need for transport fuels cannot be reliably assessed. All this suggests that a holistic review of policy interactions is not a one-off exercise, but a continuing process, backed by reliable scientific data and trustworthy forward looking activities.

Solutions can only be sought through a plurality of approaches

The complexity of the challenge of “food security and the bio-economy” was well revealed in the debate. It is clear that no single approach will address all the new knowledge required. Research will need to be multi-disciplinary and trans-disciplinary, so that the complexity of the problems is well understood; this will increase confidence that the solutions are global, not just fixes a part of the problem.

The need for research on sustainable primary production and the food chain is evident and should stand in continuity with successful research from past programmes. This work depends fundamentally on basic science to help understand the ecology of the living environments in which these activities take place. The scope of this work should include modern technologies for breeding, control of stress from pests and diseases and adaptation. The specificity of arable and animal husbandry, forestry, fisheries and aquaculture must be recognised and given due importance.

Research on the food chain should extend to strategies to enhance consumer protection, health and nutritional skills. The need for full chain studies of the food chain from the farm to the consumer was strongly supported. This should recognise that the food chain includes the human body and that good nutrition is insuperable from the nature of primary production and subsequent processing.

There is a need also to recognise the future potential of biotechnology in a range of applications including the industrial possibilities. The scope should include improved processes for fuel, but also the exciting possibilities of new chemical building blocks for e.g. polymers, bio-materials and large molecules for pharmaceutical purposes. These are important technologies that have a bearing on industrial competitiveness, health and on agriculture itself; they cannot be neglected.

The debate revealed also a need for a skilful integration of social science research that promotes the adoption of innovation and best practices in agricultural and forestry production systems. It should aim also at strengthening the scientific and technical basis for knowledge-based decision-making in policy and regulation and in guiding consumer behaviour.

Finally, it should not be forgotten that the purpose of a map is not to isolate regions, but to help the journey from one point to another. In whatever manner the boundaries may be drawn for administrative purposes, success will require that people can work across them.

3. Focus areas

This session explored the focus of research and innovation in the area: what should be the priorities for the EU level; how should this work relate to activities of Member States and international cooperation with third countries; what will be the new and emerging research areas, technologies and innovations that should be supported?

Priorities at EU level

The innovation cycle

The shift in focus of research and innovation to cover the whole innovation cycle was welcomed by participants. An overtly business-friendly research and innovation culture that encourages innovation is essential to the achievement of this aim. The distinct needs of the various steps in the innovation chain have to be recognised. The primary phase of innovation is the acquisition of new knowledge or the transfer of technology; this phase has to be aligned with the specific needs of the sector and users.

An important point in the cycle where innovation may fail is if the basic research infrastructure is not available and if funding cannot be found for the first steps of commercialisation. An example is the breeding of GM plants for plant-derived pharmaceutical proteins for which suitable specialised greenhouses are a prerequisite; this research could not proceed if the infrastructure were not available. Testing and developing concepts for the agricultural sector means that they must be evaluated under realistic farming conditions; incentives are needed for the operation of such farms. Access to genome sequencing, bioinformatics and pre-breeding centres is a critical requirement. The EC should continue support to developing large databases to access and manipulate bioinformatics data and extend it where necessary. A network of environmental and agricultural observatories covering the whole of Europe would provide valuable data and data series.

A second weakness in the cycle is the so called valley of death where an innovation leaves that point on the trajectory where it can be financed from research funds, but has not yet demonstrated a sufficiently convincing commercial case to attract funding from equity. This difficulty might be partially alleviated by financing and creating access to flexible, research-

oriented pilot plants and by increasing public funding for demonstration projects. The model of the European Industrial Bio-energy Initiative (EIBI) under the EU SET-Plan is a mechanism by which private sector consortia fund demonstration and industrial-scale plants. This experience should be developed, but for these actions to be possible and to give the programme credibility, it is crucial that adequate public-private governance structures and funding mechanisms are defined and more work on this may be necessary.

Once developed innovative products can face difficulties in accessing markets, as a consequence of unsympathetic regulation, lack of appropriate standards or different standards across member states. Research on appropriate regulatory instrument and the development of standards should proceed in parallel with the technical innovation.

In some fields of established practice, innovation is not necessarily a top-down phenomenon, but is generated on the ground. The European Innovation Partnership in Agriculture (EIP-A) under preparation was cited as an example of an instrument adapted to these circumstances and that will cater for the diverse needs of SMEs, farmers and industry.

Public-private funding

It is often desirable to use public funding to leverage private funding and shift research and innovation in directions that are seen to be socially desirable. There have been several experiments within the framework programmes to do this; but few that address food security and the bio-economy. The European Technology Platforms (ETPs) and the Joint Technology Initiatives (JTIs) are attempts in different ways to manage this relationship between public and private interests. The ETPs provide a framework for stakeholders, led by industry, to define research priorities; they are not in themselves a public-private financial partnership, but they define a Strategy Research Agenda that for implementation would require substantial finance for public and private sources. The participants confirmed the value of these arrangements.

The JTIs are genuine financial public-private partnerships (PPPs), but it may be too early to assess their merits; the public-private partnerships under the Economic Recovery Plan, with European Union, European Investment Bank (EIB) and national funding, are sometimes cited as a more flexible arrangement. The Risk-Sharing Finance Facility of the EIB is another successful initiative that has so far levered 15 times the combined Commission and European Investment Bank contribution. The European Industrial Bio-energy Initiative (EIBI) noted earlier is another model that could be relevant. The nature of the most suitable vehicle still needs reflection.

The most recent addition to the tools available is the idea of European Innovation Partnerships that will provide a framework to analyse EU activities and policies from research to market. They will not be funding agencies, but will bring together public and private interests. This could be an interesting option for the bio-economy.

SMEs

An ex-post assessment of earlier framework programmes has identified several barriers to the participation of SMEs. Calls can be so specific that they limit the number of SMEs that are qualified and interested. The time taken to decide on grants and the long delays in payment can be a strong disincentive for SMEs to participate. In larger projects, led by large companies, SMEs may feel that they have no real role in the project. The low success rate, the high costs of preparation and the complexity of associated processes such as application, reporting, claiming can also be discouraging.

The nature and role of SMEs varies widely across sectors, e.g. from Information and Communication Technologies (ICT) to Knowledge-Based Bio-Economy (KBBE). A targeted, sector-specific strategy for the involvement of SMEs is therefore needed. Given the importance of SMEs in the bio-economy, smaller projects should be included that can

accommodate smaller actors. To compensate for the possible loss of critical mass, projects might be put into pre-arranged clusters. This approach could also be consistent with the grand challenge orientation. Clusters of projects could be the programmatic principle that could convert sets of individual projects into coherent programmes that address the grand challenges.

Medium-size industries in the agro-food sector are often better placed than SMEs to drive innovation as they have more resources and a higher awareness of the benefits of innovation. Mechanisms to encourage SME participation are still necessary with carefully planned mechanisms to promote knowledge exchange. SMEs are not only research participants, but potential users of Research and Innovation (RI) results and potential beneficiaries at a broader level (process innovation, greener practices, resource efficiency). Involving SMEs at the outset as partners in a RI project is often difficult for several reasons, as noted above. Simplification of procedures and a reduction in the administrative burden would encourage greater participation. More flexible rules should make it possible for SMEs to join already running projects, with simple procedures. The role of professional and trade associations could be important to facilitate this “leaner” type of involvement

Difficulties noted above of bridging the funding gap between public financing of research and commercialisation by private equity is often an especial problem for SMEs as they lack the means to finance from their own resources that would likely be available to large companies. Measures to alleviate this would be particularly important for SMEs.

Participatory approach

Adoption of a participatory approach was warmly recommended both by experts and national representatives. The shift in this direction marks in a sense the transition from a research programme to a programme of research and innovation. The previous FPs have developed good mechanisms for consultation with suppliers and producers, but it is not clear that the research community has yet the proper tools to consult effectively with consumers and other users.

Many of the problems that the grand challenges address are a consequence of consumer behaviour and in particular of unsustainable patterns of consumption. For example, a great deal of food is wasted at the end of the distribution chain, either discarded by retailers or consumers. Best-before dates are a notorious source of waste and some research on better signalling of information to consumers is justified. What are the social and mental barriers to changing behaviour and how can they be modified?

It was suggested that it would be interesting to see the food industry studied from the demand-side starting from the question, “what are real needs”. This has been a fruitful methodology in, for example, energy efficiency. The approach was for a long-time opposed by industry, but eventually absorbed into their practice.

Links between challenges

There are many links among the grand challenges as presently conceived. They are all societal challenges so they all (including food security and the bio-economy) link to some degree to the cross-cutting challenge on Inclusive, innovative and secure societies. But food security and the bio-economy are also closely associated with almost every other grand challenge. It will be difficult to ensure the coherence of the work carried out in different challenges on contiguous areas of research. An accounting framework for externalities will help with environmental coherence, but there will be many other aspects that will have also to be managed.

Member states and international cooperation

Coordination between the research and innovation activities of the EU and those of the Member States (MSs) serves many useful purposes. It permits the building of synergies; it allows pooling of resources; it permits comparison of research agendas and can help to avoid duplication. The Commission is simply a facilitator of this coordination, but it gives considerable leverage to European Union research and innovation, because national programmes are far larger than those of the EU.

The Joint Programming Initiatives (JPI) are the main instrument of this coordination and were seen as valuable by all participants. The idea of the JPIs is that Member States agree common visions and strategic research agendas to address major societal challenges. Ten JPIs have been launched of which four are related to food security and the bio-economy: agriculture, food security and climate change; a healthy diet for a healthy life; water challenges; healthy & productive seas and oceans. The Commission intends to continue and strengthen the activity and this intention was supported without objection. The legal possibility exists for the MSs to enter into common Calls with the Commission, but the initiative must come from the MSs.

EU value-added is often especially high where the research has a strong public good character or where it supports European policies. Close to market, a sponsor is more likely to seek funding from national sources and national sources are more likely to want to supply it. The public good and policy dimensions are both evident in food security and the bio-economy.

A global challenge that receives little attention in the Green Paper is the urgent need to create favourable conditions for the development of the less advanced countries – not only for humanitarian reasons but also to contribute to EU 2020 strategy through global economic dynamism, better management of global natural resources, and greater global political and social stability and security. International development should be regarded as a key goal for the EU and this should be reflected in its research programmes. Research and innovation - and capacity building - in agriculture are among the driving forces of development. Development partnership is an opportunity for EU, not a burden. Strengthening scientific competence in developing countries will serve EU interests as well. International cooperation will be main-streamed into societal challenges, but much remains to be done to work out what this means.

International cooperation was generally agreed by participants to be valuable across all research and innovation activities; it should be continued and enhanced. In agriculture, there are many aspects of research where the emphasis should be placed from the very beginning at the international level. Studies show a strong positive correlation between research and innovation spending in agriculture and health and economic growth, but also research and innovation in agriculture in industrialized countries generates significant spillovers to less developed countries, notably through international trade. These strong spillovers provide a firm justification for publicly funded research. It has been suggested that the EU adopts agriculture research for development as a guiding principle and that mechanisms to facilitate the convergence between aid to development and cooperation in research are built into the Common Strategic Framework for Research and Innovation (CSFRI).

There are also market-based reasons why international collaboration is increasingly important for agriculture. The inescapable exposure of European agriculture to global markets through trade, and the immediacy and importance of the impacts that changes in global conditions can have on European agriculture can be disruptive for European farmers and consumers. Topics of immediate concern are the monitoring of markets and the production of reliable forecasts which can improve food security and help reduce price volatility.

There are many avenues for international cooperation that already exist. Recently a G20 meeting was dedicated to agriculture and it took the decision to launch an international initiative on genomics. European research has an important part to play in this international effort, including the conduct of joint calls with international partners.

Fish are a naturally international resource as they move around; some of the first organised international cooperation in research took place in fishing and it is still a priority. Apart from the need to cooperate to manage the resources, there are also strong practical reasons to cooperate. The sea is a large-scale feature and it is expensive to research; sharing of equipment and facilities is an attractive option to reduce costs.

International cooperation is important in biotechnology also for more classical reasons; it is a very fast moving field and the cross-fertilization of ideas among researchers is an important driver.

Thematic priorities

Detailed prioritisation of themes for research and innovation cannot be made until the final shape of the strategic map is agreed, but there is some iteration to the process of definition and a provisional discussion of details can inform the mapping. The account of the discussion given below does not pretend in any way to be exhaustive, but simply notes some of the interesting ideas put forward during the two days of discussion.

Food is an area where publicly-funded research could make a big difference. The food industry is the largest manufacturing sector in the EU and the leading employer, characterised by a highly fragmented company landscape with a large number of SMEs; it generates only 2% of value-added and is responsible for only 0.37% of research expenditures. So, it is a low value-added, low research content industry and it generates much waste. There are opportunities to improve the performance both in product offer and production processes. Research can support the development of new food products answering to the preference, acceptance and needs of consumers and can reduce costs through improved efficiency and better use of production capacity. A new emphasis on consumer needs and behaviour is desirable; research should make it easier for consumers to make a healthy choice; it should deliver a better understanding of nutrition related needs and above all propose ways of delivering better and personalised advice to consumers on the implications of their choices. Scope for improved resource efficiency includes: lower consumption of energy and water; development of new processing technologies; waste minimisation/ management; process intensification.

Attention was drawn to the High Level Forum organised by DG Enterprise and Industry concerning the food supply chain and the competitiveness of the agro-food industry. The Forum included representatives from farm to consumer and their report emphasised the need for improved innovation throughout the food supply chain; it made many recommendations that bear on the selection of research topics.

Also the need for further support for facilitating the market access of bio-based products (pre-and co-normative research for the development of new and improvement of existing standards, support to information and knowledge transfer in the area of public procurement, awareness rising and communication activities, exchange of best practises between Member States, setting up integrated and diversified biorefinery demonstration plants for bio-based products manufacturing, etc.) has been mentioned as one of the main recommendations which have been agreed and progressed upon in the frame of the Lead Market Initiative for Bio-based products led by DG Enterprise and Industry.

Some possibilities for future research in forestry were proposed. There are several existing value chains in forestry, but also opportunities to integrate them in the expectation of being more resource efficient. Research into the possibilities of integration, the barriers and the remedies would be helpful. For example the recycling of construction timber is limited at

present by the toxicity of materials with which it is impregnated. There may be alternatives approaches that would allow more effective use of the resource. Another interesting line of research is into the macromolecules naturally present in wood and the ways in which they might be used, for example in bio-degradable packing.

Suggestions for thematic priorities for research and innovation in fishing fell into three categories: the interaction of man with the resource; the interaction of government with the resource (governance); and international cooperation. For fisheries sustainability must be a first priority. The capture of wild fish depends on the performance of the natural eco-system; there is little that man can do to enhance that, but plenty to damage it. The research priority is to understand the basis of the eco-system that is exploited for production. As a part of this it is necessary to develop better descriptions and insight into large-scale ecosystems, such as the North Sea, the Baltic or the Mediterranean and how they link to the small-scale systems that are often the focus of fishing. Some countries, it was suggested, are already struggling to meet their obligations for eco-systems research obliged by the Marine Strategy, so support from Horizon 2020 would be helpful. Research will be needed into the evolutionary impact of fishing; environmental stresses of the importance imposed by man on the sea will surely have detectable evolutionary consequences. The need for good scientific evidence to support cooperative fishing policies was widely recognised.

Aquaculture is performed mainly by SMEs and they do not individually have the research capacity and funding to bring new species of fish to the market. This is long-term research that proceeds from the selection of species, through commercial proto-types to marketing. Support from Horizon 2020 is required to support this process. There is also a need to look at an interactive approach between the market and supply chains. Structural funds could be used to help the industry develop the biological and commercial prototypes.

On the basis of this stronger science, the next priority is to design appropriate harvesting strategies; present strategies are destructive to the environment and damaging to stocks. New concepts and new techniques need to be developed. Methods are needed that are more selective among species and methods that are intrinsically less damaging to the environment, especially the benthic environment. Technical and policy measures to reduce discards will be essential.

There is also a concern in aquaculture that warming of the seas will lead to the development or expression of new diseases. There will probably be a need to react quickly to these problems when they become manifest and the Horizon 2020 needs to foresee mechanisms for delivering the necessary research promptly.

Improved governance depends on better integration of marine policies and more effective implementation; It will requires also a more inclusive approach to stakeholders in the marine environment and the co-optation into integrated assessments for which much evidence is still lacking. This inclusive spirit of governance can then form the basis for a better targeted and more diffuse responsibility.

Focus areas for agriculture reflected the view of most, but not all, that agricultural innovation should focus on sustainable intensification. Means must be found to improve resource use efficiency throughout the sector. Inputs of fossil fuels, water, fertilisers and pesticides must be reduced. Nutrient efficiency is especially important. The eco-systems on which agriculture depends need to be better understood and technologies and practices to reduce the environmental impacts of agriculture on these systems must be researched. Research is needed into how to mitigate climate change in the sector and how to adapt to it.

Better links need to be built between research and agricultural extension policies. This is a complex process that involves a range of actors including a range of scientific disciplines and commercial actors along the food chain, but especially farmers. For innovation to be effective trust and communication are vital. The proposed European Innovation Partnership

in Agriculture (EIP-A) is intended to create better communication between researchers, users and citizens and will be a useful tool for in ensuring good use of innovation.

4. Exploitation of results

The third and final session was devoted to the question as to how to ensure that the results of research are used for innovation as well as for policy making.

FP project results do lead to innovation

An ex post impact assessment of the KBBE area in FP5/6/7 has been performed and was reported to the workshops. The assessment found that 104 patents had been applied in FP5/6 for a corresponding investment of 1.7 billion euros. Most of the patents cited were in biotechnology (51%), followed by agriculture (38%) and then food (8%). Most of the later were in the area of food processing/ technology. This is a gearing of 1 patent per 16 million euros. Additionally, in FP6, 16% of projects were reported to have patents applied for, mainly in technical areas, but these accounted for 34% of funding.

Other types of innovation were also reported: 28% of projects claimed at least one product 37% of projects claimed at least one technological process innovation and about 40% of projects claimed innovation such as new models, new methods and new data sets. Around 65% of projects reported policy related innovations such as decision making tools and similar and this accounted for 58% of funds.

So there is a prima facie case that innovation is generated by research under the FP, but patents and products are only partial indicators. There is a need to determine more comprehensive and accurate measures of innovation and to learn to apply them. If we cannot measure innovation then we cannot know whether we have achieved it and the ability to manage the process of delivery is compromised. The CSF Green Paper states the need to consider broader concepts of innovation, rather than just technological, so this question is significant.

The assessment determined that small projects such as specific targeted research projects (STREPS) are often very productive in terms of scientific and technical impacts; in some cases more than larger instruments, but projects, that have a high scientific and technical impact do not necessarily correlate well with innovation impact and less make less societal impact. ETPs, although not funding instruments, were perceived as fostering innovation and significant benefits were obtained by clustering them. The ERANETS and ERANET+ programmes were also seen as having significant added value.

A route to exploitation should be discernable from the outset

There was considerable agreement that the production and exploitation of innovation are not easily separated and that exploitation should be at least partially visible from the outset of research; this vision should be shared by different partners along the innovation chain. A particularity of the bio-economy is that few value chains exist at present and new value chains for different end-users need to be created.

In the model used by the “Cluster Industrielle Biotechnologie”, clusters of relevant actors are created, (mainly SMEs, but also research institutes, universities and larger industrial companies) and then located along the value chain. Business support is delivered by potential investors, owners of infrastructure and specialists of business development; advice on law and intellectual property is available. The coherence of research is governed by an overall business plan that describes a commercially viable business plan and communication among actors is promoted. It is important that communication includes users and regional development agencies. This is a model that might be adapted to broader challenges within the bio-economy; the essential features are the overall business plan that indicates

commercial feasibility, the communication, the clustering of suitably skilled actors and the incorporation of the user into the design phase of the project.

A powerful tool to improve dissemination is to soften the distinction between research and dissemination by including stakeholders in the definition of research. This approach is applicable both to research for technical or social innovation and to policy-driven research. The Co-operative Research Action for Technology (CRAFT) programme in Germany was cited as an example of this approach.

Several options for bringing venture capital and innovative ideas together have been tried and some might be explored further in Horizon 2020. One possibility is a mechanism to bring business angels supplying risk capital together with the owners of innovative Intellectual Property Rights (IPR). "Innovation brokers" have been successfully employed for innovation diffusion in the Netherlands. Innovation support centres might be financed as part of Horizon 2020 to speed up innovation.

The Enterprise Europe Network (EEN) already performs this function to some extent; it maintains a “technology market” in which offers of technology and demands for technology can be posted and there is already an active market in agro-food-related technology. It was suggested that the remit of the EEN could be expanded in Horizon 2020; supplementary activities might be financed through the cohesion instruments in close cooperation with the research activity.

The most important resource for innovation is the people who have ideas and do the research, create the new business models, ensure communication, assess and accept risk, build and operate facilities. The framework programme until now has been concerned mainly with the first of these needs. The European Research Council (ERC) and Marie Curie are generally considered to be successful contributions to the formation of young researchers and the collaborative research programmes also contribute to upgrading research skills. The other areas are to a greater or lesser extent neglected. There is a need to encourage entrepreneurial skills and to ensure the availability of an appropriate skilled workforce; there is a need for “hybrid” figures that can move between disciplines, from industry to research and can talk to users, investors and development agencies.

The Multi-annual Financial Framework indicates that Horizon 2020 will integrate innovation actions such as support to public procurement and market uptake on innovation. Such tools will be important for innovation in the bio-economy. For instance, small-size experimental projects could be offered directly to qualified stakeholders for certain priority areas on a fast-track and in a flexible manner, for example, to the first technically qualified applicants (e.g. first-come-first-serve).

More can be done to disseminate results effectively

Dissemination of results under FP7 was thought by participants to be weak in many fundamental aspects: poor final reports, superficial websites badly maintained, and ineffectual dissemination outside of academia. Ways of improving dissemination that were proposed included: more open access; dissemination of results from clusters of projects; more extensive use of professional disseminators; collaboration with European Technology Platforms (ETPs) and European Innovation Partnerships (EIPs).

There was strong support from a wide range of participants for the proposition that easier public access and reliable long-term access to results should be guaranteed. There should be a mechanism within Horizon 2020 to improve knowledge circulation and ensure easy public access and long-term availability of research results, for example through free online access to scientific results, analysis and data and through the creation of databanks. Some participants suggested that historic results from FP5 to FP7 should be consolidated and made available to end-users. It was recognised that there was a need to strike a balance between the public good character of research results and legitimate expectations of

researchers to protect IPR, but there was also a sentiment that for publicly funded research, especially in social science, wider access might be considered and publication of results should be the default option.

Research scientists are not necessarily the best placed to disseminate results. Professional disseminators might better align material with target groups and create more attractive and effective events. The activities of professional disseminators might be linked to the technology platforms that already are associated with projects and that can help identify and attract the right audience. ETPs might also be better placed than individual researchers to suggest which results might be of interest to different target groups; not all research results are necessarily of interest to industry, policy-makers or the public. Other options proposed were: the use of specific communication projects and events where results from clusters of projects were presented for critical review and where proceedings including discussion were summarised and published in a formal manner.

The European Innovation Partnerships may also offer novel routes for dissemination. Specifically, within agriculture the EIP-A offers an excellent opportunity for dissemination of best practice as determined by research. In some Member States national institutions have disinvested from extension working; the EIP-A should construct better communication with farmers. Furthermore, the Farm Advisory System (FAS) of the CAP is an instrument which will be given a larger scope. These measures will be a major investment in dissemination of innovation financed from the CAP.

Research and innovation programmes implemented within the Research Policy of the EU could complement the "grass-roots" activities pursued under the EIP-A which will work mainly within the boundaries of programme regions in the Member States. There will be needs for complementary interregional and EU level actions as well as cross-sector actions (clustering, etc.) offered by RTD policies. This is a “win-win” option contributing directly to the implementation of the EIP-A and to the dissemination of research. To be effective it will require skilful packaging of information.

5. Making the transition to Horizon 2020

The workshop was designed to examine the specificities of “Food security and the bio-economy”, but some of the ideas discussed were relevant to the important general question as to how to make a transition from a project based research programme to a comprehensive programme of research and innovation. This is an important practical concern and therefore this closing section assembles some pertinent points that have been recorded above, but which it may be helpful to collect here. The points covered are: the coordination with other actors; the planning of a scheme of related work; coordination with other policies; creation of market incentives for innovation; dissemination and the imperative of continuity.

Innovation is closer to market than research; it is evidently important to coordinate with the private sector, because it is private actors who will eventually market and sell products, but it also makes more important the already important need to coordinate more closely with MSs. Private actors, especially SMEs, are generally grounded in a single MS and would be more likely to seek funding for close-to-market applications from funding agencies of their own Member State. Accordingly, there was much support for the strengthening and extension of JPIs and the creation of common research agendas. Equally the ETPs in Horizon 2020 have an important part to play in focusing government and private capital on a common strategic research agenda. These instruments of coordination can only become more significant in a programme that addresses the full innovation cycle.

At an administrative level, the most important practical question is how to coordinate disparate activities in research and innovation along the full innovation chain. The elements

of a response from several participants were that projects needed to be clustered along a pre-defined value chain according to a pre-defined vision of success. For the more business inclined projects this vision would be a business plan. For others perhaps it would be less overtly commercial, although the necessary and inevitable need for sanction of innovation by commercial interests was acknowledged.

If a research programme is to be extended in a serious manner to cover also innovation then it comes up inevitably against operational policies. Sectoral policies, through their legal and regulatory interventions shape the commercial environment into which innovation is injected and therefore can make or break innovations for contingent reasons that were not intended when polices were implemented. Of the respondents to the public consultation on the bio-economy, 73% thought that insufficient links between policies related to bio-economy were a major obstacle to progress. Coordination of policies to remove obstacles and discontinuities across policy frontiers and to promote innovations that are relevant to societal challenges is necessary. One important aspect of policy coordination that deserves special mention is the use of public procurement policy to promote innovation.

The traditional research chain concludes with dissemination, but in programmes of research and innovation it is usual to see dissemination as an aspect of research design. Research and innovation do not constitute a chain, but a cycle. The market, simply conceived, is the final judge of innovation, but it is also the starting point to plan the next improvement. This brings the discussion back to the idea of activities and actors clustered around a clear strategy in which dissemination, or utilisation, is not left to chance, but is a part of the design.

Lastly, there were many pleas for a degree of continuity. Programmes such as the European Research Council (ERC) and Marie Curie, generally thought excellent, should not be adversely affected. Excellent, on-going programmes of research should be as far as possible respected.