Detailed scope

1. Background and overall challenges

Global food security, the use of renewable raw materials and production of energy from biomass are three of the "Great Challenges" for the 21st century:

- The world population is expected to grow to up to 9.5 billion people in 2050. Combined with changing consumer demands, global food security will certainly remain a major challenge.
- The environmental footprint of agriculture (e.g. on water and air quality, and from waste, pollutants and greenhouse gas (GHG) emissions) must be reduced and natural capital maintained (e.g. soil, biodiversity) while simultaneously managing the transition from non-renewable to renewable energy sources.

The main land cover types in Europe are forest, arable, pasture and semi-natural vegetation. These land covers provide different types of biomass and contribute to food, feed and fibre production. The finite nature of fossil fuel resources will increase the demand for renewable materials and bio-based chemicals for industrial applications as well as for renewable energy. To enhance resource efficient use of limited natural resources, more consideration to the whole value chain of different sorts of biomass is needed from focused, cutting edge research to enterprises promoting new technology and innovations and their integration within and across landscapes.

<u>The vision of a European "bioeconomy"</u>

In line with the European Bioeconomy Strategy[1], better use of biomass and waste from plant and animal terrestrial and aquatic production systems is a fundamental aim to fulfil human needs while preserving natural resources and biodiversity. All economic actors that produce, manage and otherwise exploit biological resources, including agricultural and other land based activity *in its widest sense*, such as in the food, animal feed, farmed fish and forest-based chains, as well as parts of the chemical, biotechnological and energy industries, should be considered as a whole in the bioeconomy. The concept extends beyond technological innovation to present new opportunities for organisational innovation in the development of novel production chains that will contribute to improving life for all. In this way, rural and coastal communities will be given greater opportunities for diversification at different spatial scales in line with local and regional development plans.

Food and non-food systems encompassing agricultural businesses, agri-industrial infrastructures, institutions and the associated policies and practices located in, or associated with, the European Union (EU) are in scope, where they enable food and bio-based raw materials and products to be delivered to EU consumers. The current food system was created in response to meeting food production targets in the post-war era. It represents decades of investment in infrastructure and the creation of institutional arrangements that reflect the political and economic priorities of recent decades, up to and including the globalisation of food systems. However, in the past few years it

[1] COM (2012) 60 final : Innovating for Sustainable Growth : A Bioeconomy for Europe

has become clear that a managed transition towards radically improved food and non-food systems by 2050 will be needed to make the most efficient and sustainable use of land and other natural resources across the EU.

This transition has already begun. Economic partnerships between agricultural, forestry and biochemical innovators are emerging. Such partnerships challenge the way we traditionally look at the agricultural sector. Classic economic analysis of agricultural production chains looks at the vertical relationship between the different stages of the production and transformation processes, from the field to the final product. However, the bioeconomy operates more holistically by exploiting the options for utilising all the biomass from agricultural land, uncultivated land and forestry. For example, some biomass can be reconstituted through biorefining into a large range of final food and non-food products. Similarly, the treatment of co-products and by-products recovered from some food or non-food bio-based production activities creates a mechanism for cascading the major elements N (nitrogen), P (phosphorus) and K (potassium) back into agricultural systems by returning it to the soil and at the same time releasing CO_2 into systems that can be utilised for enhancing photosynthesis (e.g. in glasshouses). So, fractionation and conversion of one bio-based product into another and cascading of nutrients, sometimes known collectively as the “circular bio-economy”, presents a new way of describing biological production and processing systems. New bio-technologies and industrial processes need to be developed and traditional relationships between actors in the various food and non-food production chains will need to change to accommodate such innovations leading to a radical reorganisation of the agri-industrial sector and the emergence of a reformed bioeconomy. Industrial reorganisation is an ongoing process driven by the market and the growing demand for bio-based products, but the needs and opportunities of SMEs and intermediate sized businesses should not be overlooked.

A holistic view across research disciplines is a prerequisite of any research into the relationship between food and non-food systems: the interconnections between them lead to a weakening of the boundaries between production and product transformation. It is apparent that most published models consider food chains with no reference to non-food value chains or bioenergy production. Conversely bioenergy models do not generally take account of the quantity, quality and diversity of plant and animal production needed to meet nutritional needs. The choice of scale (local, national, regional or world) is also important. For example, at local scales, it is necessary to take into account seasonal fluctuations in crop production, when considering food or non-food security whereas at larger scales this is less of an issue as the production of one region may compensate for a deficit in another.

The need for sustainable intensification of agricultural production

Alongside the increased demand for biomass for a variety of products, the world’s available agricultural land area is steadily decreasing as a result of soil degradation and expansion of residential areas. Furthermore, climate change will increasingly affect agricultural productivity. All this impacts on the resilience of agricultural food and non-food systems and their ability to tolerate and adapt to external disturbances in order to deliver a continuous supply of affordable food and bio-based products to consumers. A resilient system should be able to speedily recover from climatic shocks and biological stress (e.g. pathogens) and should provide alternative means for satisfying services and needs in the event of changed external circumstances. Only resilient agricultural systems allowing growth and intensification of agriculture under the increasing stress of climate change, new pests and disease outbreaks and other environmental pressures will address these challenges adequately. To achieve increased productivity in an environmentally sustainable manner considering all relevant inputs e.g. pesticides, fertilisers, veterinary products and water, preserving biodiversity and considering ecosystem services, a new, joint programme of multi-disciplinary research and innovation is required across the EU and globally.

Furthermore, creating resilience requires more focus on establishing diverse sources of supply and reinforcing infrastructures. Modeling is necessary in this space to develop insights into the range of possible agricultural solutions and the resulting systems of production for any given agro-climatic zone and land typology. This implies the measurement of agronomic, environmental and economic trade-offs between, for example, the use of multi-purpose plant species versus specialised cropping versus pluri-annual production (e.g. through short rotation coppices). There is also a need for environmental sustainability indicators to assess other trade-offs between environmental and production deliverables for any particular agricultural system as biomass production increases under sustainable intensification.

Long term modeling is characterised by deep uncertainty over a range of drivers including soils, resources, technological developments, behavioural changes and the prevailing policy mechanisms. This underlines the importance of robust sensitivity analyses across a range of variables.

Moreover, transitions in farming systems towards sustainable intensification, and/or high nature value need to be integrated into the broader perspective of a bioeconomy that will combine the simultaneous production of food, fibres, feed, bio-chemicals, raw materials and bio-energy from biomass over a territory, the recycling of wastes and the utilisation of by-products and co-products. Holistic value chains need to be developed through the integration of industries across rural regions and cities. Alternative agricultural systems which are currently being developed and studied in (and outside) Europe should be compared with each other and networks of study sites developed to test holistic sustainable intensification metrics at farm, landscape and national scales.

FACCE-JPI is contributing to this ambitious endeavour through 21 EU Member States and associated countries joining forces in the field of agricultural research under the challenges of climate change and limited natural resources. Founded in 2010, FACCE-JPI has since launched a Strategic Research Agenda (SRA) in 2012 outlining its main activity under 5 core themes. In order to implement this SRA and as a first activity under Core Theme 2 (environmentally sustainable growth and intensification of agriculture), JPI partners are jointly preparing a common Call under the ERA-Net Co-fund “Sustainable and resilient agriculture for food and non-food systems”.

2. Objectives of FACCE SURPLUS

- To improve collaboration and cooperation across the European Research Area in the fields of diverse, but integrated, food and non-food biomass production and transformation systems, including biorefining.
- To link up and create a network of research institutions and platforms, enterprises and clusters of enterprises (as associations of family farms, sme's etc...) and facilities/research infrastructures across Europe working on the sustainable intensification of agriculture as well as focusing on innovation for increased, resilient and sustainable biomass production and product transformation processes for added value creation.
- To support innovation and value creation from biomass and biorefineries in synergy with the environmentally sustainable intensification of agricultural and other biomass production taking into account the required economic, environmental and social conditions and resilience to climate change.
- To fund and organise a joint call between funding bodies from Member States and the European Commission.

3. Scope

Funding is provided for transnational research and development projects (R&D projects) which have been selected within the framework of a competition.

The scientific scope is for collaborative projects in three research areas which are incorporated into the following three subthemes of this call, namely:

1. Spatial targeting of land use to stimulate the growth of systems for the efficient utilisation of green (plant) biomass cascading through novel transformation processes for improved economic, environmental and social outcomes.
2. Identifying and developing markets for a wide range of products and services generated through integrated food and non-food systems.
3. Developing integrated, systems-based approaches to land management to encourage the sustainable intensification of agricultural production systems.

Subtheme 1: Spatial targeting of land use to increase biomass production and transformation includes:

- Developing a bio-based economy starts with optimising the yield of green (plant) biomass per unit area of land. New approaches for spatially targeting innovative agricultural production systems are needed to produce sufficient green biomass to meet increasing demand from strategically located, bio-refining chains producing bioenergy, a range of bio-based products and soil nutrients. The following are included:
    - High throughput phenotyping of appropriate species using plant biotechnology coupled to bioinformatics, quality assessment at the field/forest level and a selected process for each different use from the same batch of biomass.
    - Efficient exploitation of plant genetic resources and product-oriented breeding.
    - Integration of novel agronomic practices into agricultural systems, such as double cropping, improving yields of existing plant species and diversification of the outputs from different harvested parts of the plant to generate multiple uses for the various plant fractions,.
- Innovations in the design and siting of environmentally advanced, minimum waste biorefineries, associated with locally integrated production systems for food, feed, fibre and biomass for biorefining, making full use of agricultural and other organic products, by-products and wastes, as they cascade through the production and processing system, in order to better close the cycling of the major nutrients (N, P and K).
- Integrated approaches, including the economic, environmental and social conditions necessary for the primary production of green biomass as part of the whole biomass production and processing chain. What are the optimal opportunities for transforming local biomass production in the field into food, feed, energy, and other bio-based products? Spatial strategic choices for novel agricultural systems concern the selection of the most appropriate plant and animal production combinations in terrestrial and aquatic systems or a mixture of both. What are the spatial consequences when primary biomass production for food, feed and fibre is combined with biomass transformation on farm or at landscape level into energy and other bio-based products?
- Demonstrating how the resilience of agriculture and agro-forestry results from a range of spatial and temporal solutions across the same land area by exploiting variations in growing periods, from months for annual crops, up to decades for perennial species in short rotation coppices. What are the short (waste management) and long term (programming agricultural systems) perspectives?
- How can biomass, including wastes and losses, and product expectations best be evaluated and modeled, using a systemic approach and how may these be assessed integrating social, economic and environmental perspectives including resilience and sustainability?
- Evaluating the synergy between ecosystem services and biomass harvesting from locally specialised crops, including those adapted to marginal lands and semi-natural grasslands. How can bio-refining create high value products and bioenergy while at the same time enhancing the natural environment and biodiversity?

Subtheme 2: Developing markets, including:

- Designing new business models for biomass production and its transformation requires the development of innovative marketing strategies taking into account the flexibility, the trade-offs and the risks associated with the emergence of new markets. How do these vary at local, national, European and global levels?
- Conducting foresight exercises on the regulatory framework for integrated food and non-food agricultural systems associated with the sustainable intensification of green biomass production. The evolution of successful markets relies on a level regulatory playing field and fair trading conditions for new markets starting with clear definitions and rules on “waste”, “reusability of biomass products”, “manure”, etc. New potential markets for biomass production and transformation demand updated definitions. This implies a need for:
  - Transition paths to ensure economic viability throughout the transition phase. Development of farm decision support frameworks to identify specific opportunities and risks around adopting systems for greater resource use efficiency.
  - Analyses of business models for all stakeholders in the emerging value chains from farmers to agro-industrials: for example is there opportunity of reward for reducing GHG emissions along the chain? What is the impact of new markets on existing value chains? How will the market reflect the true cost and price of novel agricultural practices? How will any added-value in the chain be redistributed (across local areas)? How will the markets connect at local and global scales?

Subtheme 3: The sustainable intensification of integrated food and non-food systems of agriculture, including:

- Development of system-based approaches for the integration of food and non-food agricultural production systems with improved use of nutrients, water and land under climate change, and improved soil fertility for higher resilience against climate stress. New models for mixed cropping systems for high biomass production including useful elements to create higher added value through the production and transformation of green biomass into novel products. Evaluating the benefit of introducing plant species with higher yields of biomass, including new species for biomass production.
- Evaluation of the synergies and trade-offs between increasing yields and biomass production for food and non-food uses and the impacts on air quality, water quality, GHG emissions, biodiversity and other environmental outcomes. The development of sustainability indicators for different agricultural systems and a network of study sites across Europe to develop standardised sustainable intensification metrics applicable across a variety of integrated food and non-food systems.
- Development of new agricultural systems in crop rotations to exploit seasonal growth cycles through intercropping, at farm level and at landscape scale, the integration of annual cropping with mixed perennial crops such as agroforestry that may lead to a broadening of the range of plant fractions to be delivered by agricultural and forestry systems.

Demonstration of consequences of land use changes, for preservation of biodiversity while securing sufficient food and biomass production through the diversity of species and varieties grown and therefore agricultural products harvested.

- How may the harvesting and increased use of biomass for biorefining in marginal agricultural areas and semi-natural grasslands create synergy between economic value addition and the preservation of High Nature Value areas?
- How can the integrated modelling of water, biomass, bioenergy, food, and chemicals in the production and transformation of biomass follow the requirements of environmental sustainability (such as the closed cycling loops for N, P and K, water recycling, etc.)? How can sensitivity analysis of the variables reduce uncertainty in the models?
- Systems approaches assessing novel utilisation of agricultural products and exploring their potential for value creation linking scientific-technical and socio-economic aspects.
- Economic and environmental assessment of integrated food and biomass systems under different agro-ecological conditions and whole chain economic and environmental sustainability assessment of the cascading of agricultural products and other green biomass through the biorefinery system.

4. Project structure and funding recipients

Each research project proposal must include a proposal for disseminating the results to achieve higher levels of technological readiness. Research projects in the fields of the three subthemes will often combine field research with modelling, scenario development and/or pilots. Where appropriate it is recommended that reference is made to the models developed in the Knowledge Hub MACSUR.

Cross-disciplinary projects will be given priority. Instead of focusing on individual features, projects should, for example, not only encompass methodologies for increasing yield and productivity, but also include other components essential for further processing agricultural outputs into high-quality marketable products and incorporating aspects of environmentally sustainable production (soil fertility, water quality, biodiversity etc.) as integral aspects of the project. If possible, inclusion of SMEs in the consortia is favourable in order to strengthen comprehensive value chain approach.

Funding will be provided for collaborative projects in which, depending on the project's orientation and national funding rules, universities, non-university research establishments, and/or companies or associations of enterprises from partner countries of this ERA-NET Cofund are involved. Partners in collaborative projects receive funding from the respective national funder(s) participating in the call according to national regulations of the funder(s).

Research providers from countries not participating in the ERA-NET Cofund can participate in collaborative projects if they have their own project funds or separate source of funding. Evidence of the commitment of these must be provided upon submitting the application.

All proposed projects must be structured in such a way that the project objectives can be reached within a maximum of three years. Furthermore, the proposals should strive to be balanced between the countries involved in the project as far as the volume of work is concerned.