European Commission

A **strategic approach** to EU agricultural **research & innovation**

final paper

Agriculture and Rural Development

FOREWORD

This paper presents the final outcome of the European Conference: 'Designing the path' - 26-28 January 2016, Brussels - and concludes a year long process of developing a strategic approach to EU agricultural research and innovation.

Foreword

Agricultural research and innovation have a major contribution to make in ensuring food security in the long term, addressing the environmental sustainability and resilience of competitive land-based primary production for food and non-food systems and boosting the sustainable growth of rural territories.

This paper presents the final outcome of a year-long process to develop a strategic approach to EU agricultural research and innovation.

To prepare this paper, we have collected inputs from a wide range of sources through, workshops and consultations which involved several hundred experts. The process was launched with a workshop at the Milan Expo[1] in June 2015 where a first background document was discussed. It continued with a targeted consultation on a first draft strategy document in November 2015. The process culminated with the conference "Designing the path, a strategic approach to EU agricultural research and innovation" which took place in Brussels on 26-28 January 2016. The final paper incorporates the outcomes of the conference.

It will guide us for the programming of Horizon 2020 for 2018-2020 and will serve as an input to the discussions related to research and innovation in the EU in the long term.

Jerzy Plewa
Director-General

[1] "Towards a long-term strategy for European agricultural research and innovation by 2020 and beyond" (Expo Milano, 19/06/2015)

CONTENTS

List of acronyms

CAP	Common Agricultural Policy of the EU
CGIAR	(formerly) Consultative Group for International Agricultural Research
EIP-AGRI	European Innovation Partnership “Agricultural Productivity and Sustainability
EJP	European Joint Programme
ERA	European Research Area
ERANET	European Research Area Network
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FET	Future and Emerging Technologies
GDP	Gross Domestic Product
ICT	Information and communication technologies
IFPRI	International Food Policy Research Institute
IRC	International Research Consortium
JPI	Joint Programming Initiative
MAA	Multi-Actor Approach
OECD	Organization for Economic Cooperation and Development
SCAR	Standing Committee on Agricultural Research
SDG	Sustainable Development Goal
SME	Small and Medium-Sized Enterprise
UN	United Nations

Executive Summary

1 Why do we need a strategic approach to agricultural research?

Research is expected to address immediate problems while at the same time anticipating future needs. Today's research will guide tomorrow's solutions and approaches in farming and forestry. Incorporating research and innovation activities into a long-term strategy will make it easier to identify strategic areas of short-, medium- and long-term interest, and thereby improve their overall consistency, sequencing and impact. By laying down strategic priorities for agricultural and forestry research in the EU it will be possible to reinforce synergies with Member States and non-EU research programmes.

The strategy aims to harness EU investments in the Framework Programme for Research and Innovation in view of the following main objectives: ensure food security in the long term; address the environmental sustainability and resilience of competitive land-based primary production for food and non-food systems; and boost the sustainable growth of rural territories. In addition, the strategy seeks to improve the delivery of research results for policy use.

2 What priority areas for research and innovation?

The strategy focuses on land-based primary production from agriculture and forestry and extends to food and non-food chains and the rural economy.

Five priority areas for research and innovation have been identified, and clustered under two thematic headings.

Creating value from land - sustainable primary production:

- Priority 1: Resource management (notably soil, water and biodiversity)
- Priority 2: Healthier plants and animals
- Priority 3: Integrated ecological approaches from farm to landscape level.

Enhancing rural innovation - modernising rural areas and policies:

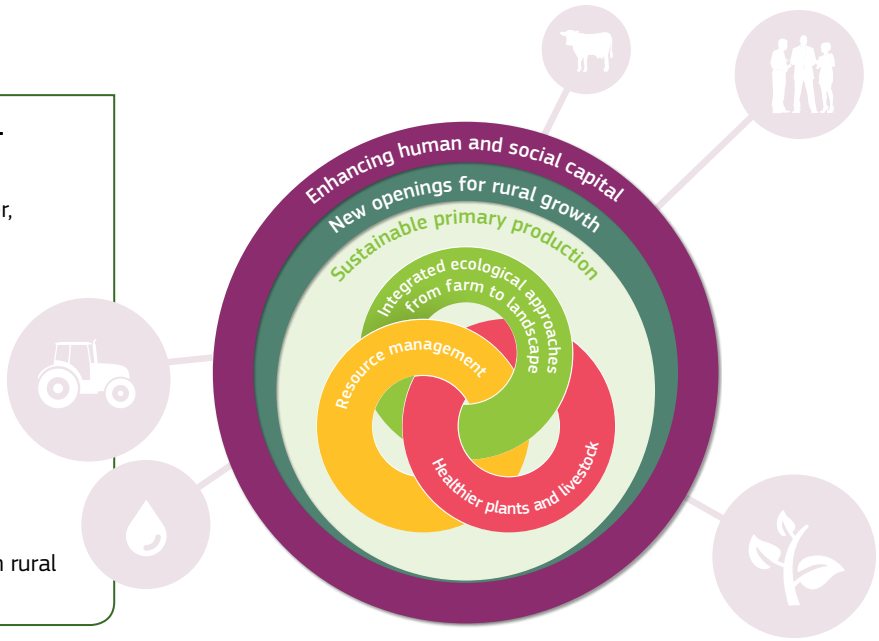
- Priority 4: New openings for rural growth
- Priority 5: Enhancing the human and social capital in rural areas.

Heading 1: Creating value from land - sustainable primary production:

- Resource management (notably soil, water, biodiversity)
- Healthier plants and animals
- Integrated ecological approaches from farm to landscape level

Heading 2: Enhancing rural innovation - modernising rural territories and policies:

- New openings for rural growth
- Enhancing the human and social capital in rural areas



Resource management (priority 1): a major objective will be to strike a proper balance between productivity and environmental goals in agriculture and forestry by ways of efficient resource use. This requires a thorough insight into the dynamic interactions between agro- and forest ecosystems, resource use and climate. Advances in technologies such as ICT are expected to open new avenues for site-specific and precise resource use. In addition, closely interlinked rural and urban resource flows will allow gaining value from residues and by-products in line with the principles of the circular economy. At the same time, a transition to resource-smart land use will enhance the potential in farming and forestry for mitigation of greenhouse gas emissions and adaptation to increasing climate variability.

Healthier plants and animals (priority 2): resilient agriculture and forestry systems require robust plants and animals with increased resistance to pests and diseases. Tackling numerous and highly dynamic biotic threats will require integrated approaches and the development of a wide range of tools for prevention, monitoring, control and management of pests and diseases along with risk management strategies. This includes seeking alternatives to contentious plant protection products and antimicrobials. The establishment of links between health and other disciplines and aspects of production will be sought. In the area of animal production, one-health approaches will receive particular attention.

Integrated ecological approaches from farm to landscape levels (priority 3): this priority provides the ground for better understanding and use the potential of ecosystem services for primary production. It will allow exploring the functional role of biodiversity in the delivery of ecosystem services to increase resilience at farm and landscape levels vis-à-vis biotic and abiotic threats. It thereby links the first two priorities and provides the knowledge base to develop, test and demonstrate specific farming systems such as organic and mixed farming systems or different forms of agroforestry. It also allows tackling the ecologically important interfaces between agriculture and forestry along with the related needs for management of multifunctional forests.

New openings for rural growth (priority 4): aiming to boost sustainable growth in rural territories, this priority will tackle the various factors, dynamics and policies which determine their development. It will look at food and non-food supply chains and systems from a territorial perspective. The deployment of ICT will be a crucial element within a wider strategy to sustain and boost rural economies. Attention will be paid to improve the valuation of a range of public goods and reward rural communities for delivering those goods.

Enhancing the human and social capital and rural areas (priority 5): this priority aims to support sustainable growth in rural areas by encouraging innovation. The first strand of activities will focus on skills, human and social capital of farmers, foresters and rural dwellers. The second strand will be devoted to the functioning of knowledge and innovation systems. Attention will be paid to all actors in the supply chain and rural economy and relevant links with urban areas will be established.

Five **cross-cutting issues** have been identified:

- **Systems approaches** are deemed to be crucial to tackle the manifold challenges of agricultural, food and non-food systems in an integrated manner, i.e. taking into account the dynamic interactions of the different components of production systems and value chains at various temporal and spatial scales.

- **Societal engagement** in research and innovation will ensure that research responds to society's needs and facilitate the implementation of research results. It requires novel mechanisms and types of cooperation between stakeholders in research, research policy and civil society to shape research priorities as well as the overall research and innovation cycle.

- **Information and Communication Technologies (ICT) as an enabler** – Digital technologies are developing rapidly and have the potential to transform production systems in agriculture, forestry and related food- and non-food value chains. They also provide considerable development opportunities for rural areas arising from better connectivity, increased social inclusiveness and openings for new business models.

- **Enabling research and infrastructures** – The time lag between knowledge creation, development and adoption of innovations requires that basic and applied research are well synchronised and contribute to common strategic objectives. Similarly, due attention needs to be paid to the development, access and maintenance of high quality research and innovation infrastructures as a key driver for enabling and/or collaborative research.

- The systems-based approach requires **socio-economic research** to be embedded across a wide range of research and innovation areas as it is indeed critical to the design and implementation of a range of policies impacting food and non-food systems and rural territories.

3 How will the strategy be implemented?

The five priorities of the strategy will be further detailed to develop specific lines of action. These will feed in Horizon 2020 programming activities for 2018-2020 and may be taken into consideration in the longer term. They will be reviewed in the light of new developments, foresights and consultations.

Building the European Research Area (ERA) is a key objective of Horizon 2020. Within this, encouraging **synergies** between Member States and the EU Framework Programme for Research and Innovation is essential to achieve greater impact and efficiency of funding activities.

Most of the issues dealt with in the strategy have a global dimension and require increased **international cooperation** to pool existing expertise and capacities in the most effective way. In the area of agriculture and forestry, international partnerships are particularly needed to capture the specificities of production systems under a wide range of geo-climatic, cultural and socio-economic conditions. This is particularly important in view of testing and replicating solutions. International cooperation contributes also to the competitiveness of European food and non-food systems in the global economy. Finally, international research cooperation in agriculture and forestry complements the EU's external policy, notably with regard to meeting commitments to Sustainable Development Goals and COP 21 objectives.

The strategy aims to boost demand-driven innovation and the **implementation of research,** creating synergies between EU policies. The European Innovation Partnership "Agricultural Productivity and Sustainability" has set in motion the **interactive innovation model,** which aims to increase project impacts through the establishment of a process of genuine co-creation of knowledge. This model is supported throughout a range of measures and instruments under the CAP and Horizon 2020. In particular the implementation of the **multi-actor approach** introduced under Horizon 2020 is key for generating impact and co-ownership of solutions. Knowledge exchange will speed up innovation and bring knowledge to the places where it is most useful and needed. Open data and open science, as well as EU knowledge and innovation infrastructures, have a key role to play in this strategy.

Synergies between public and private sector research activities are essential to make best use of different sources of research investments as well as to ensure that publicly-supported research and innovation activities fit sector needs. Public-private cooperation for example can promote the take-up of underpinning basic science by the private sector. In addition the private sector has a significant role to play in the development of new technologies and approaches for sustainable primary production. SMEs, which represent a large part in the agri-food chain, need to be given due attention.

CHAPTER 1

Why a strategy for agricultural research and innovation?

Evidence suggests that investment in agricultural research generates significant economic and wider societal returns notably through its impact on productivity[2] and food security. It also delivers environmental and social benefits even though these are harder to quantify.[3]

Despite its vital role, agricultural research has become a lower priority in high-income countries in recent decades compared with other areas.[4] Societies and policymakers were reminded of its importance in the late 2000s with the agricultural commodities price surge of 2007/08 and concerns over long-term food security arising from agricultural projections made by the Food and Agriculture Organization of the United Nations (FAO) and other institutes and agencies. Concerns are also raised about the long-term impact of climate change on agricultural production. As a result, there is now renewed interest in agricultural research and its potential to ensure environmental and basic societal needs in the context of the evolving challenges as described in this paper.

Similar trends apply to the area of forestry. The increased demand for biomass from forests and the particular role of forests in the climate debate have raised the visibility of the sector and triggered demands for increased research and innovation.

Research is expected to address immediate problems while at the same time anticipating future needs. Today's research will guide tomorrow's solutions in farming and forestry. Incorporating research and innovation activities into a long-term strategy[5] will make it easier to identify strategic areas of short-, medium- and long-term interest, and so improve their overall consistency, sequencing and impact. A long-term view on research questions and investment is particularly important given the time lag between the initiation of research, the delivery of results and their uptake by users and ultimate translation into mainstream practice. In agriculture this process may take decades[6] and is further complicated by the fact that the solutions proposed need to be adapted to the site-specific context. In forestry this process is even longer due to long production cycles and regional features of both production and management systems.

Laying down strategic priorities for agricultural and forestry research in the EU will make it possible to better coordinate the activities of different funding bodies and develop synergies with Member States and non-EU research programmes. Joint efforts should provide a solid basis for sustained investment in agricultural and forestry research and build critical know-how and capacity over a longer period of time.

The strategy is meant to influence programming the remaining three years (2018 to 2020) of Horizon 2020 and in guiding agricultural and forestry research and innovation activities after 2020.

1.1. Major challenges faced by agriculture, forestry and food systems in Europe and globally

Agricultural and forestry activities provide the basis for food and non-food production under a wide range of conditions. In doing so, they also drive development in rural areas, impact on ecological services and deliver wider public goods. These multiple functions are performed in the context of major demographic, economic and environmental challenges which are changing the landscape of food and non-food systems[7] in which land-based primary production is taking place.

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[2] See for example Alston J., The benefits from agricultural research and development, innovation and productivity growth, OECD, 2010.

[3] Measuring the Environmental Impacts of Agricultural Research: theory and Applications to CGIAR Research, CGIAR, 2011.

[4] In high-income countries, the average annual growth rate of public investments in agricultural research fell from 2.0% in the period 1981-1990 to 0.8% in the period 2000-2008 (see ASTI global assessment of agricultural research and development spending, IFPRI, 2012). In addition, low agricultural prices prior to 2007/2008 did not favour investments (including in research) in the sector.

[5] See Sustainable food consumption and production in a resource-constrained world, Standing Committee on Agricultural Research (SCAR), European Commission, 2011.

[6] A study by INRA estimates the duration between initiation of research and impact at 20 years (Analyse des impacts de la recherche agronomique publique, INRA, 2014). An estimate of an average time span at 30 years is provided in Alston J. et al., The Economics of Agricultural R&D, Annual Review of Resource Economics, 1, 2009, pp. 537-565.

[7] In this paper food system refers to the processes which describe how food from a farm ends up on the table of consumers. These processes include production, processing, distribution, consumption and disposal. Food supply chains are the main building blocks of a food system.

Food security[8]

World **population growth** will continue to put pressure on food production. Not only will there be more people to feed, but as the average income in many developing countries is expected to rise, the demand for higher quality food and processed food is likely to increase too. In addition the worldwide trend towards greater urbanisation is expected to continue over the next few decades, and this will also affect dietary patterns.[9]

The FAO has projected that agricultural production needs to rise by 60% by 2050 compared with 2007 levels to meet the projected demand for food and other uses. This figure is considerably lower than the increase achieved in the previous four decades (a projection of 1.1% annual average growth for the period 2007-2050 against 2.2% achieved in the last decades).[10] However, while past growth took place on the basis of considerable external inputs, production growth in the medium- to long-term will have to be achieved under more constrained conditions, e.g. as regards water availability and agricultural land.

The FAO's 60% projected increase would consist in a 77% increase in developing countries and a 24% increase in developed countries. Many of the developing countries (especially African countries) have the highest projected population growth by 2050 and their current production levels are far below their potential. Raising **agricultural productivity in a sustainable manner** is therefore necessary. Irrespective of changing global circumstances, the long-term projections for supply and demand in most developed countries, including in the European Union, suggest that it is possible to achieve the growth rates in supply that would ensure food security. Therefore, the critical issue in Europe is to boost all aspects of production sustainability, without underestimating the importance of maintaining a sufficient and dynamic production base in a changing world.[11]

It will be necessary to sustainably increase production at global level, yet this is only one aspect of the issue of food security. Although today's total food production at global level could theoretically feed the world's population, 800 million people still suffer from chronic under-nutrition.[12] Access to food should not, therefore, be overlooked. In addition, three quarters of undernourished people live in rural areas in developing countries and depend to a large extend on farming activity.

At the same time, there is an upward trend in **malnutrition** in both developing and developed countries, imposing a large cost burden on societies. Appropriate supply of **nutritious** and safe food along with balanced diets, is key to mitigate health problems related to malnutrition. The **safety** of food supply is mandatory for health, social and economic reasons. Finally, **food losses and waste** are estimated at around 30% of global food production,[13] therefore reducing waste is crucial in the context of global sustainability. This applies to all stages in the production, delivery and storage chain.

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[8] We use the FAO definition of food security throughout this paper: "food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (World Food Summit, 1996). Food security has four main dimensions: food availability, food access, utilisation and stability. Food security is sometimes referred as food and nutrition security.

[9] See for example 'Global Food Security 2030', Foresight Series, Joint Research Centre, European Commission, 2015.

[10] See: Alexandratos, N. and Bruisma, J., World Agriculture towards 2030/2050, the 2012 Revision, FAO, 2012. According to the FAO, global annual production grew at 2.2% on average in the period 1961-2007. It is expected that the average annual rate of growth of agricultural production will decrease in response to a deceleration of demand growth, partly as a result of the slowdown in population growth. Nearly 90% of the increase in production is expecting to come from developing countries, this would raise their share in world agricultural production from 67% in 2005/2007 to 74% in 2050.

[11] It should not be forgotten that agricultural productivity varies quite significantly between and within Member States and has substantial potential growth in several of them. Furthermore, the plateauing of crop yields observed in Europe in recent decades (partly due to climate change) highlights the importance of maintaining or even increasing yields, and justifies substantial investments in breeding.

[12] The State of Food Insecurity in the world, 2015, FAO, 2015.

[13] Food wastage footprint, impact on natural resources, summary report, FAO, 2013.

Environment and climate change

Natural resources - such as soils, water and biodiversity - face strong pressures partly owing to inappropriate agricultural practices and overuse.[14] The State of the Environment Report of the European Environmental Agency shows that agricultural activities have a significant impact on the management of natural resources.[15] This report indicates how inappropriate farming practices can cause soil degradation, water contamination, reduction in the number and diversity of pollinators, loss of natural biological control of pests and diseases and of plant and animal genetic diversity. Unsustainable forest management can further contribute to degradation of natural resources.

In addition, **climate change** is a major global challenge. Agriculture accounts for about 10% of EU greenhouse gas emissions including more than half of the non-CO_2 gases.[16] Globally, agriculture and forestry are the source of 24% of emissions, including through tropical deforestation driven primarily by conversion to agricultural land.[17] The agricultural sector, together with forestry, will have to contribute to the reduction of greenhouse gas emissions and climate change mitigation while simultaneously adapting to climate change. Agriculture, forestry, environmental protection of natural resources and climate change need to be considered in an integrated manner.

Agriculture and forestry are increasingly affected by threats and adverse events attributed to climate change (e.g. the increasing occurrence of extreme weather events), plant and animal diseases and economic factors such as price volatility. Climate change and water scarcity contribute also to loss of agricultural land which exacerbates pressures on remaining land. Strengthening the **resilience of farming and forestry systems,** and beyond, food and non-food systems, is therefore essential.[18]

Finally, growing population, rising income and global shifts towards consumption patterns which are richer in animal proteins will further increase pressures on agricultural resources and forests. Therefore, dealing with the sustainability of consumption patterns will be necessary.

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[14] See Global Environmental Outlook, GEO-5, UNEP, 2012. In the case of the EU, several European Environment Agency publications have shown the extent of biodiversity losses in EU agro-ecosystems (for instance farmland birds). It is estimated that 75% of the utilised agricultural area is affected by erosion by water, of which almost 20% is subject to soil loss in excess of 10 tons / hectare / year. Water resources, of which agriculture uses more than one-third, are also under increasing pressure in the EU. For instance projects show that the number of river basins under water scarcity is expected to increase by up to 50% by 2030 (COM(2012) 672 final). Agriculture is also the source of 90-95% of ammonia emissions. Their reduction is one of the objectives of the Clean Air Policy Package adopted by the Commission in December 2013 (COM(2013) 918 final).

[15] SOER 2015 – The European environment: state and outlook, European Environment Agency, 2015. Http://www.eea.europa.eu/soer.

[16] Global figures: Climate change (2014) synthesis report, IPCC, 2014. For the EU: see Eurostat, Agriculture - greenhouse gas emission statistics.

[17] Fifth Assessment Report of the Intergovernmental Panel on Climate Change, agriculture and forestry contribute to GHG mainly and agricultural emissions from livestock, soil and nutrient management (CH4 and N2O emissions) and through deforestation. See: http://www.ipcc.ch/report/ar5/wg3/

[18] See Sustainable agriculture, forestry and fisheries in the bioeconomy – A challenge for Europe, Standing Committee on Agricultural Research, European Commission, 2015.

Growth and jobs in rural territories

The EU agri-food sector, including food retail and services, currently employs 44 million people – many in rural and remote areas – and relies on an agricultural sector capable of ensuring a steady supply of raw materials. The EU's 10.8 million farms provide full-time equivalent employment to 9.8 million persons and generate €164 billion of value added.[19] The farming sector has to meet consumer demands within a system where the upstream (e.g. input suppliers) and downstream (e.g. food industry, retail trade) sectors are increasingly concentrated and where **competition on global markets** is increasing. The farming sector is characterised by fragmented structures and producer income levels which remain, on average, significantly below income levels in the rest of the economy. It is facing significant structural adjustment (e.g. the decreasing number of farms, ageing of farmers, the development of salaried work, and the diversification of activities). **Economic viability** of farming and attractiveness to the younger generation are a prerequisite for food security. On-farm working conditions are evolving constantly and **social conditions** in the farming sector deserve appropriate attention.

The forest-based industries[20] represent 8% of manufacturing added value in the EU, provide income for almost 16 million forest owners and have a workforce of over three million people.[21] Over 90% of the raw wood processed into materials and products each year by the EU's forest-based industries come from domestic forests.

Primary production interfaces with upstream and downstream sectors which both contribute significantly to jobs and growth creation.[22] Agriculture and the forest-based sector are also major producers of biomass for uses other than food or feed, such as biofuels, biochemicals and biomaterials and as such they are important contributors to the **bioeconomy**.[23] New value chains offer additional opportunities for agricultural and forestry production and activities in the rural economy to shift from a fossil-based to a bio-based economy. Avoiding additional pressure on resources will be necessary to seize these opportunities sustainably. The contribution of international trade to the EU economy should not be overlooked: research and innovation can contribute significantly to the competitiveness of EU food and non-food systems on export markets.

It is important not to forget the **territorial dimension** of agricultural, forestry and related upstream and downstream activities. Rural areas, which still account as a whole[24] for 55% of EU jobs and 46% of gross added value, are going through a period of profound economic, demographic and institutional transformation, in the EU as well as in the rest of the world. Globalisation, decentralisation, urbanisation, migration trends and the emergence of new product and service markets present new challenges and opportunities. Rural areas are endowed with assets (e.g. natural resources or cultural resources) that could contribute to boosting growth and reducing the economic divide with other regions. However, despite sustained growth in rural areas, there is still a gap between rural areas on the one hand and urban and intermediate areas on the other: in 2010, the GDP per capita in predominantly rural regions stood at 70% of the EU average.[25] Recent research has however highlighted positive trends in rural growth[26] and significant variations between rural areas, with some areas growing faster than some urban areas, while others are in decline. Encouraging **cohesion and convergence** among different regions is one of the EU's core objectives. Sustainable growth and a balanced territorial development are needed to achieve the objective of "**jobs, growth and investments**" of the European Commission. Working conditions on farms and forest holdings are evolving constantly and social conditions in the farming sector deserve appropriate attention.

1.2. Contribution of agricultural research and innovation to the objectives of EU policies

Horizon 2020 aims to strengthen EU scientific and technological bases by, in particular, encouraging the EU to advance towards a knowledge-based society and to become a more competitive and sustainable economy. Horizon 2020 has been assigned a central role in supporting the Europe 2020 strategy for smart, sustainable and inclusive growth, highlighting the role

[19] See Agriculture, forestry and fishery statistics, 2015 Edition, Eurostat, 2015. The number of farms and employment concerns 2013 and 2014 respectively, agricultural gross value added (at producer prices) is an average of 2012-2014. Employment in agriculture, forestry, fisheries and hunting (primary sector) represents 5.2% of EU total employment in 2013.

[20] As defined by "A blueprint for the EU forest-based industries", SWD (2013) 343

[21] Strategic research and innovation agenda, Forest-based Technology Platform, 2013.

[22] The food sector generates €225 billion value added in 2010-2012 and is a net exporter of high-value added products. Source: Eurostat, elaboration DG AGRI (reports Rural Development in the European Union - Statistical and economic information available at: http://ec.europa.eu/agriculture/statistics/rural-development/2013/index_en.htm).

[23] COM(2012) 60 final.

[24] If we consider together predominantly rural areas and intermediate areas.

[25] Eurostat data, elaboration DG AGRI. Available at: http://ec.europa.eu/agriculture/statistics/rural-development/2013/full-text_en.pdf.

[26] Rural-urban partnerships, OECD Rural policy reviews, OECD, 2013.

of research and innovation as key drivers of social and economic prosperity and of environmental sustainability.

Research plays a crucial role in contributing to the design and implementation of EU policy by providing a sound evidence base. In particular, research can provide the knowledge base for long-term decision-making and planning which is necessary to cope with the challenges faced. As part of the Horizon 2020's Societal Challenge 2 ('Food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bioeconomy'), agricultural and forestry research and innovation is integrated into and provides support for a range of EU policies, including the Common Agricultural Policy (CAP), the EU Forest Strategy[27], international development, health, environmental policies, climate action and waste reduction policy.[28]

Evidently, the way in which research supports policies must take account of how policies change over time. For example, the following initiatives will have a significant bearing on agricultural and forestry research: the Energy Union Package adopted in 2015, the outcome of the 2015 Paris climate conference, the EU's 2030 climate framework, the Circular Economy Package[29], the review of the EU's Bioeconomy Strategy, the mid-term review of the Biodiversity Strategy and, of course, the CAP.

This strategy will contribute to the implementation of the Sustainable Development Goals (SDGs) adopted in September 2015 by the UN General Assembly, for both domestic and external policies of the EU. Most of the targets under Goal 2 'End hunger, achieve food security and improved nutrition and promote sustainable agriculture' are relevant for agricultural research.[30] The strategy will contribute in particular to the achievement of the following SDGs:

- SDG 12 'Ensure sustainable consumption and production patterns'
- SDG 13 'Take urgent action to combat climate change and its impacts'
- SDG 15 'Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss'

[27] COM(2013) 0659 final.

[28] See description of Societal Challenge 2 in Annex I of Regulation (EU) No 1291/2013 of the European Parliament and of the Council of 11 December 2013 establishing Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020).

[29] Closing the loop - An EU action plan for the Circular Economy (COM(2015) 614/2).

[30] 'End hunger and all forms of malnutrition; double agricultural productivity and incomes of small-scale food producers; ensure sustainable food production systems and implement resilient agricultural practices; maintain genetic diversity; increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries.'

In the recent years, the synergies between Horizon 2020 and the CAP have been strengthened. Agricultural research and innovation under Horizon 2020 aims to support the main objectives of the CAP in the areas of viable food production, sustainable management of resources and climate action and a balanced territorial development.[31] To achieve these goals it is important to bridge the gap between theory and practice to enable the agriculture sector and rural areas to become more sustainable and competitive and capable of adapting to new challenges. Innovation – together with climate change and environment – is a cross-cutting objective under the Rural Development pillar of the CAP. The European Innovation Partnership 'Agricultural Productivity and Sustainability' (EIP-AGRI) relies on both policies to encourage innovation and support knowledge-based agriculture. In particular it provides support to rural actors to exchange knowledge and join forces to solve particular problems.

In a nutshell, EU agricultural research and innovation will support transition pathways towards resilient, sustainable and climate-friendly farming systems and value chains. It has the ambition to spur the delivery of knowledge, technologies and management solutions to secure the long-term supply of healthy and nutritious food.

Beyond food production, the strategy addresses the increasing role of non-food products and services emerging from farm activities. It looks at overall opportunities for innovation in rural areas, also by means of enhancing the social human and social capital.

The strategy promotes a comprehensive approach to land management and expands to forests to optimise synergies between forestry and agricultural activities in rural areas.

[31] COM(2010) 672 final.

CHAPTER 2

What priority areas for research and innovation?

2.1. Scope of the research and innovation strategy and interface with other research areas

The strategy focuses on land-based primary production, centred around agriculture and forestry, but also extends to food and non-food chains and the rural economy. It considers relevant interfaces with other sub-sections of Societal Challenge 2 (e.g. marine research) and with other parts of Horizon 2020.[32]

Close links will be established with the part of Societal Challenge 2 dealing with food, reflecting the integrated nature of the Societal Challenge. This will concern in particular aspects such as **food safety** and **food quality** with the aim to producing better quality, healthier and more nutritious food that meets consumer needs. In addition, the strategy will be strongly linked to the initiative Food 2030, which will aim to ensure coherence of all research and innovation efforts in the field of sustainable food systems.

2.2. Priority areas

There are five priority areas for research and innovation, clustered under two thematic headings.

Creating value from land - sustainable primary production

- Priority 1: resource management (notably soil, water, biodiversity)
- Priority 2: healthier plants[33] and animals
- Priority 3: integrated ecological approaches from farm to landscape level

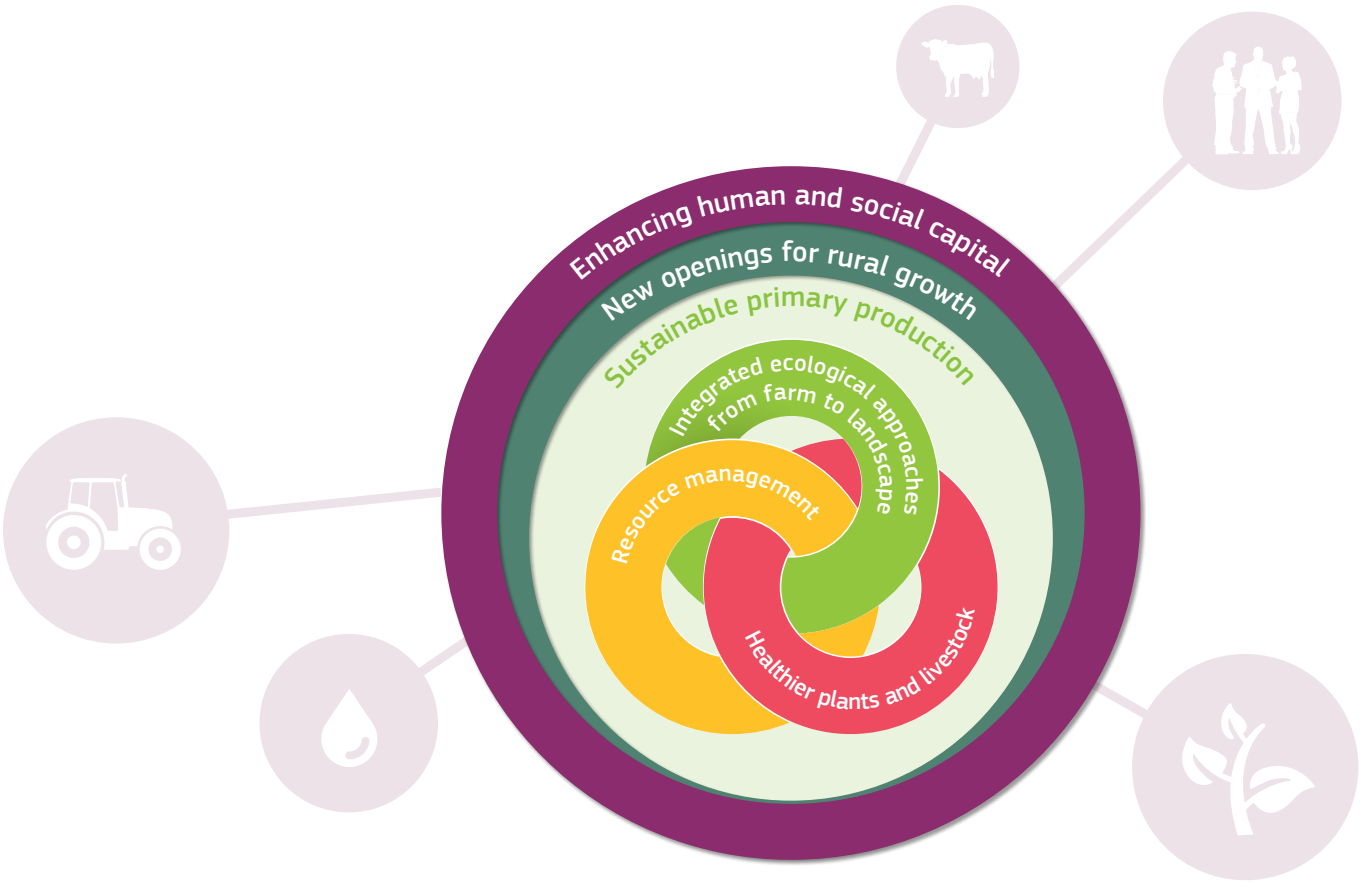
Enhancing rural innovation - modernising rural territories and policies

- Priority 4: new openings for rural growth
- Priority 5: enhancing the human and social capital in rural areas

The five priority areas are not meant to be separate blocks but in fact reflect the interconnections between challenges and solutions. For example, some of the research orientations proposed under 'healthier plants and animals' will contribute to 'resource management'. Thus there are obviously some overlaps between these five priorities, and research on specific issues may be carried out under several priorities but from different angles. Research topics will take this into consideration and, if necessary, will cut across several priorities so as to integrate all important aspects.

[32] For instance ICT (under pillar II of Horizon 2020) or Societal Challenges such as 'Health, demographic change and well-being' (Societal Challenge 1) or 'Climate action, environment, resource efficiency and raw materials' (Societal Challenge 5).

[33] Throughout this paper, the term "plant" includes trees and shrubs.



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- New openings for rural growth
- Enhancing the human and social capital in rural areas

While the first three priorities mainly address primary production systems and supporting ecosystems services, the priority four on 'new openings for rural growth' looks at food and non-food supply chains and systems from a territorial perspective. Priority five finally takes up the development of human and social capital in rural areas.

In many cases, research has already been carried out in the above-mentioned areas. The objective is not to duplicate existing knowledge but to take it further and to facilitate its implementation.

2.2.1.Creating value from land: Sustainable Primary Production

Agriculture has evolved over thousands of years into a range of often highly specialised and high yield production systems which reflect the diversity of climatic and geographic conditions, cultural specificities and ever-changing consumer demands. However, advances in productivity have not been distributed evenly and often have come at a significant environmental cost, thereby leading to growing concerns over the sustainability of current ways of production.[34] The environmental and social dimensions of agricultural production are coming under further scrutiny as a result of increasing evidence of the links between food production, nutrition, climate and human health.

This part of the strategy focuses on resource management (with a focus on soils, water and genetic resources), plant and animal health and underpinning ecological approaches in the context of agriculture and forestry. It tackles the interfaces between primary production systems, food/non-food products and the

[34] See Short version of 2012 UN report: Sustainable Development in 21st century. Food and Agriculture: The future of sustainability https://sustainabledevelopment.un.org/content/documents/1443sd21brief.pdf.

environment to explore how research can support pathways for the creation of economic, environmental and social value from land.

2.2.1.1. Resource management

Activities in the primary sector depend heavily on the **availability and quality of natural resources** such as land, nutrients, water and biodiversity. At the same time the primary sector impacts directly and indirectly on the integrity of these resources and contributes to their depletion.[35] Natural resources are under further pressure from increased environmental variations linked to climate change, to which agriculture in particular is also contributing.

Research in the area of the use of resources will serve to strike a proper balance between productivity and environmental goals in agriculture and forestry. It will take into account the dynamic interactions between land use, climate and ecosystems services and address: the medium- to long-term impacts of climatic variations on land-based primary production; strategies for adaptation of the farming and forestry sectors; and the contribution of agriculture and forestry to mitigation of greenhouse gas emissions.

The livestock sector is facing its own challenges. While it is a source of high quality nutrients, firmly embedded in human diet and potentially providing important ecosystems services, current methods of livestock production require significant amounts of land, energy and water resources and contribute significantly to greenhouse gas emissions. New approaches are needed to reduce these trade-offs and improve resource efficiency of livestock production.

Research and innovation priorities will tackle the various dimensions of resource use, looking at approaches at the level of plants and animals, of agro-ecosystems and throughout value chains. At a broader level, in relation to land use, cooperation between farms and forest holdings or rural-urban areas will provide opportunities for better connecting urban and rural resource flows (e.g. water and waste - see also section 2.2.2 on rural innovation). These synergies are likely to expand as the concept of a **circular economy** gains momentum. Implementation of circular economy principles will lead to better ways of valorising and using residues and by-products by farms (e.g. feed for livestock, fertiliser from manure), forest holdings and bio-based industries. It is also expected to change farm and forest management and result in a reduction of natural resource inputs.

With regard to technology, expectations are high that the increased availability of data and their use through of **ICT, predictive tools and precision technologies** will allow to target resource-use in farms and forests more effectively. The combined use of prediction models and monitoring sensors for example, can support precision irrigation and the management of nutrient, weed and pest. Together with measures such as crop rotation, intercropping or the integration of trees in farms these tools can lead to significant improvements in nutrient and water management in primary production.[36] Furthermore, a more efficient use of external inputs, such as fertilisers will reduce climate relevant nitrous oxide emissions and benefit human health through improved water and air quality. In livestock, precision technologies have the potential to improve efficiency in the management of animals as well as to reduce greenhouse gas emissions, for example through precision feeding, or monitoring animal health and welfare.

In forest management, technology requirements are set over a longer timeframe, terrain constraints and environmental considerations. Efficiency can be improved by innovative decision support systems for forest owners, managers, operators and forest-based industries.

[36] Draft report of EIP Focus group on Water & Agriculture: Adaptive strategies at farm level.

[37] On average, 44% of total water abstraction in Europe is used for agriculture (with levels going up to about 65% in Southern Europe); http://ec.europa.eu/agriculture/envir/water/index_en.htm.

As agricultural activities are increasingly moving outside rural areas, attention will be given to **urban farming** and its potential to deliver multiple social, environmental and economic benefits. Urban farms are well placed to implement circular closed-loops production patterns, to re-use abandoned land and develop new producer-consumer relationships. Knowledge, technologies and social innovations are further required to fully exploit this potential.

Research is crucial to better understand, monitor and measure the specific effects of agricultural and forestry activities on **soils and its various productive and ecosystems functions**. It will address soil fertility and the above-mentioned functions by optimising its biological, chemical and physical properties. This will include measures to increase soil carbon content and soil biodiversity as well as to reduce soil erosion. Adapted machinery and tools to monitor the status of soils will further support soil conservation in agriculture and forestry. New avenues for soil and crop management are emerging from an increased understanding of the "soil-food web", i.e. complex interactions between plants and soils which support water and nutrient uptake by plants or increase resistance against pest and diseases. The knowledge and tools developed will serve to further develop soil enhancing production systems and enhance the role of livestock in soil management. Research efforts serve to enhance the function of soils as carbon and nitrogen sinks, thereby supporting the role of agriculture and forestry in mitigation of greenhouse gas emissions, combating desertification and land degradation. Attention needs to be given to the specificities of forest soils and the particular challenges posed in forest management, amongst others by the use of heavy machinery.

Knowledge and innovation are urgently required in the area of **agricultural water use and management to** lower consumption of this increasingly scarce resource[37] and reduce water pollution from agriculture. Research will tackle on-farm water resources in a comprehensive manner, also exploiting synergies between water, soil and land management. Activities will help for example to make better use of the genetic variation of plants and animals to support breeding for increased water use efficiency and tolerance to water stress. They will further promote water smart farming systems through novel precision technologies, computerised tools and models to guide farmers in their day-to-day operations. The specific needs of water management in forests will equally be taken into account. But water stewardship goes beyond the level of farms or forest sites: Its regional dimension, including policies, economic instruments and participatory tools, will be dealt with under the 'enhancing rural innovation' priority.

Genetic resources underpin production in agriculture and forestry and are a prerequisite for ensuring food security in a range of (changing) environments. Current food and non-food systems rely increasingly on a small number of crops and breeds.[38] By preserving genetic resources it will be possible to support breeding and diversification and meet future demands in farming, forestry and consumption. Research activities will promote the *in-situ* and *ex-situ* conservation of a wide range of plant and animal genetic resources (including underutilised plant and animal breeds) and help to improve the links between these two. They will take particular account of the challenges posed by climate change to the reservoir and management of these resources.[39] Activities will improve the characterisation, information and access to genetic resources to support

[38] Of more than 50 000 edible plant species in the world, only a few hundred contribute significantly to food supplies. Just 15 crop plants provide 90 percent of the world's food energy intake, with three rice, maize and wheat - making up two-thirds of this: http://www.fao.org/docrep/u8480e/u8480e07.htm.

[39] Coping with climate change – the roles of genetic resources for food and agriculture, FAO, 2015

their use by breeders, farmers, foresters and in value chains for food and non-food products. Various breeding approaches are in place and new methods are rapidly evolving as a result of increased insight into the molecular basis of plants and animals as well as into the dynamic interactions between genes, the environment and management. Research activities will support their further development and use to benefit diversity and build resilience into productive farming and forestry systems.

2.2.1.2. Healthier plants and animals

Plant and animal production are under mounting pressure due to the increasing number and frequency of new and re-emerging pests and pathogens resulting from intensification, globalisation, trade development and climate change which increase their potential to establish themselves and spread. European agriculture needs to be granted sufficient means to cope with the above-mentioned threats to ensure its vital functions, avoid trade disruptions and ensure consumer confidence in food by mitigating the potential risks to plant, animal and human health (including food-borne zoonoses). Tackling numerous and highly dynamic biotic threats will require integrated approaches and the development of a wide range of tools for prevention, monitoring, control and management of pests and diseases along with risk management strategies.

Plant and animal pests and diseases can have multifactorial origins resulting from inappropriate production conditions. For this reason, **animal and plant health must be examined using a systems-based approach** which includes the various elements of production (breeding, management, animal and plant nutrition) and the environment including the use of functional biodiversity for pest and disease control. Increasing resilience and robustness is a key objective for animal and plant production and requires attention not only to transmissible diseases but also to other pathologies and animal welfare.

Transmissible animal and plant diseases (and the measures necessary to control them) can have devastating impact on agricultural sustainability as they can cause production losses, reduced efficiency, generate trade disruptions and affect the whole economy. This has been experienced with epidemic diseases (e.g. foot-and-mouth disease, avian influenza in animal production), but also emerging or endemic diseases (e.g. Porcine Reproductive and Respiratory Syndrome). Pests and pathogens can have a serious impact on human health and food safety either directly (e.g. zoonoses, i.e. diseases that can be transmitted between animals and humans), indirectly (e.g. chemical residues) or both (e.g. antimicrobial resistance[40]). In the animal sector, diseases are detrimental to animal welfare and their control is key to improving overall production efficiency and thereby decreasing the carbon footprint of production systems. Regarding trees, several diseases have had devastating effects on EU's tree population (e.g. Oak Wilk or Pinewood Nematode). Concerted EU-wide research is a prerequisite for any effort meant to prevent and control diseases.

Comprehensive measures will be promoted to fight diseases, in particular considering a '**One Health**' approach. There is no single definition of One Health.[41] According to the FAO, it is a 'collaborative, international, cross-sectoral, multidisciplinary mechanism to address threats and reduce risks of detrimental infectious diseases at the animal-human-ecosystem interface'[42] and focuses not only on transmission disruption but also on the drivers of disease emergence. A broader definition refers to attaining optimal health for people, animals and the environment. This would go beyond infectious animal diseases and could include, for example, chemical contaminants and plant health.

The **societal dimension** of animal and plant health needs to be tackled, whether it concerns food safety and quality, animal welfare or perception of disease control measures and new technologies. Societal engagement on proposed approaches and measures needs to be sought from the outset.

[40] For the purpose of this document, antimicrobial resistance includes resistance to treatments against helminths (worms)

[41] http://veterinaryrecord.bmj.com/content/174/4/85.full

[42] http://www.fao.org/ag/againfo/home/en/news_archive/2010_one-health.html

Disease prevention is better than cure: research into measures that can reduce the risk of introduction and spread of pests and diseases in a farm/establishment or in a region, will contribute greatly to the objectives of sustainable production and human health. As regards livestock production, biosecurity measures including technologies, best practices and farmer behaviour are essential and health and welfare indicators should be developed. The development of vaccines is a key component of the preventive fight against diseases in animals and, to a lesser extent, crops. Other products/approaches, including environmental ones, contributing to disease prevention or the control of affected animals/plants will need to be considered. The policy implications of prevention approaches will be investigated.

Tools to control pests and diseases need to be strengthened beyond the above (vaccines, alternatives treatments, biosecurity). This includes operational early detection systems (in particular for pathogens with pandemic potential); the assessment of sources; assessing the burden and impact of pests and diseases in order to develop cost-effective surveillance and control approaches/measures; developing monitoring and forecasting tools that make use of ICT developments, making use of big data combined with autonomous farming systems; and innovative approaches to treat diseased animals/plants.

Addressing the issues related to the uses of pesticides in the plant sector and **antimicrobials** in the animal sector is essential to protect human health (e.g. to tackle problems associated with pesticide residues and antimicrobial resistance), animal health (e.g. to address antibiotic resistance) and for environmental reasons (e.g. avoiding water pollution, protecting biodiversity and wild pollinators). It is also important for safeguarding the long-term sustainability of the sector. In the plant sector, the implementation of Regulation (EC) 1107/2009[43] will lead to a reduction in the range of active substances available, which means that alternatives must be found. The slowdown in the development of new antimicrobials for human health is constraining the availability and use of antimicrobials for animals, in particular critical molecules. Research is necessary to provide producers with alternative approaches (enabling them to reduce the use of pesticides and antimicrobials) and/or facilitate their uptake, and to support the implementation of the Sustainable Use of Pesticides Directive, including integrated pest management[44] and the Action Plan against rising threats from Antimicrobial Resistance[45]. This research is even more vital in niche sectors that have been somewhat neglected by public and private research, e.g. the so-called minor crops and minor animal species sectors (e.g. goats, rabbits, or bees).

Dealing with **emerging risks** is a priority and ensuring preparedness is a challenge. In a number of cases, emerging diseases in animals often have their source in wild animals; they are zoonotic and outbreak may be first diagnosed in humans. Vector-borne diseases (transmitted by living organisms, e.g. mosquitoes, ticks, flies) are a growing problem in animals, partly because climate change is increasing the geographical distribution and prevalence of vectors.

In the livestock sector, the relationship between **animal feed and feeding** and health needs to be further investigated. In addition, the possibilities for improving **animal welfare,** e.g. through more appropriate management (including human-animal relationship in farming), need to be further explored.

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[43] Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market (OJ L309 24/11/2009 p.1).

[44] Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides (OJ L 309 24/11/2009 p.71).

[45] COM(2011) 748.

Strengthening **basic research** is necessary on a variety of domains, including: the biology and ecology of pests and pathogens; animal/plant genetic make-up and biology (especially the microbiome and immunology); host-pathogen interactions (including plant-soil-microbe interactions); the connection between genotype and phenotype; systems biology; biomarkers; and epidemiological modelling.

2.2.1.3.Integrated ecological approaches from farm to landscape[46] level

Agriculture and forestry have to meet the changing needs of society not only in terms of consumption (food security, food safety, non-food products, etc.), but also address the environmental issues relating to primary production (e.g. biodiversity, habitats, water quality and quantity, climate change, air quality).

A deeper understanding of ecological principles is changing the perceptions on the functioning of primary production systems and will make it possible to use ecosystem services[47] to benefit sustainable production. While advances in agriculture have often resulted from innovations in a single area (such as breeding, chemical inputs, or irrigation technology), future solutions are expected to arise also from the optimisation of systems, i.e. the optimisation of the interplay between system components and between those components and ecosystems. **Integrated ecological approaches** are a promising area of research and innovation; a better use of ecosystem services is expected to strengthen the sustainability and resilience of land use systems without jeopardising profitability. Synergies and trade-offs between the different environmental challenges and productivity and profitability aspects have to be considered in order to create win-win situations and design pathways to innovative and resilient ecological farming and forestry systems.

Functional ecology and community ecology are key scientific disciplines that need to be further developed to support what could be called 'precision ecology'. Biodiversity and various ecosystems provide many different services to primary production, not all of which are well known. These include pollination, biological pest control, maintenance of soil structure and fertility, nutrient cycling and hydrological services. It is important to explore the functional role of biodiversity in the delivery of ecosystem services. This includes the interactions between plants and/or animals and other organisms as well as the interactions in the soil. To develop agricultural and forestry systems that maximise ecosystem services, a leap in knowledge is required. This can be supported by various scientific areas, **from developing farming and forestry practices to technologies**. Ecological disciplines can be strengthened by a range of approaches from molecular level (supported by the various –omics techniques) to landscape level.

Research is needed to underpin ecological approaches to shift from the study of individual species in relation to their environment to the study of groups of organisms or polycultures in relation to each other and their environment. It will look at optimising the use of ecosystem services and the **landscape level design of forest and agroecosystems**. More specifically, more insight is needed into the synergetic effects of combinations of ecosystem service processes, as

[46] There is no single definition of 'landscape'. The term 'landscape' is often used to refer to processes that cover a large area, usually addressing a range of ecosystem processes, conservation objectives and land uses. A landscape is usually smaller than a territory.

[47] The concept of ecosystem services arose from ecological science. 'Ecosystem services are the benefits people obtain from ecosystems' (MEA, 2005). Numerous studies and research projects have come up with different ways to classify ecosystem services and the concept is further evolving. The most widespread classification system arose from the UN Millenium Ecosystem Assessment (MEA, 2005) and the CICES classification which identify respectively four and three types of ecosystems: provisioning (e.g. water availability), regulating (e.g. disease and pest reduction), supporting services (e.g. nutrient cycling) [regulation and maintenance are combined in CICES] and cultural services (e.g. ecotourism).

current research mainly addresses how single service processes work in isolation. This approach would consider the full range of production systems and would require a transdisciplinary approach.

Specific types of farming systems that implement ecological approaches have developed in Europe, and they have their own research needs. These include the organic sector, which is the largest such farming system with a dedicated regulatory framework and an action plan which calls for strengthened research.[48] The role of livestock, wild plants, animals as well as forestry in ecological approaches should also be examined in systems such as mixed farming (plant/animal, agro-forestry, intercropping, etc.) or small holder land used with agricultural and forest land. The development of new farming systems (permaculture, insects, vertical farming, etc.) should also be considered. Research developed into these specific approaches has the potential to be extended to other systems.

Quantification and comparative analysis of ecosystems services of forests and other types of land use are important for strategic land use planning. The evaluation of socio-economic benefits is needed to identify trade-offs at landscape level and for agricultural and forestry target setting and management schemes.

The understanding of forest biodiversity development (both intraspecific genetic diversity and species diversity, including aboveground and belowground food webs) in managed forests has to be improved, and also its role for the production and variety of raw materials (quantity and quality), prevention of pests and diseases and generation of other eco-system services)

Collaboration with other parts of the food and non-food supply chain is necessary to develop effective, new creative solutions and business models especially for radical eco-innovations. Annual reports by the Eco-Innovation Observatory[49] highlight the benefits of cooperation between the agricultural sector and other sectors like the food and beverage industry, retail and the water and waste management sector. When adopting and promoting ecological approaches, it is also important to take into account the role of consumers and end-users. The organisation of sustainable food and non-food supply chains and the governance of ecological approaches are tackled in section 2.2.2.1 "*new openings for rural growth*". In this area, transition pathways will be developed that take account of constraints and 'lock-in' effects.

Knowledge relating to agro and forest ecosystems is site-specific and evolving. Ecological approaches are knowledge-intensive and depend on combining formal and practical knowledge with modern technologies. Innovations are expected to capitalise on local conditions and provide tailor-made

[48] Action Plan for the future of organic production in the European Union (COM(2014) 179 final).

[49] http://www.eco-innovation.eu/

solutions rather than solutions with a broad application. Long-term experiments and an appropriate research infrastructure need to be developed to meet the specific needs of ecological approaches in relation to a particular landscape level and its evolution over a longer period of time (e.g. systems that include forestry). Appropriate metrics will be necessary to assess the environmental trade-offs and impacts of various systems in different geographic and time scales.

2.2.2. Enhancing rural innovation: modernising rural territories and policies

Rural areas across the EU have undergone profound changes in the last few decades. The most pervasive ones are probably the sectoral shift and the decline of the relative importance of agriculture and forestry in the rural economies of Europe. Agricultural employment has dropped considerably driven largely by productivity increase. The services sector appears to be the primary job provider and one of the main drivers of economic growth in rural areas, along with upstream and downstream industries and the retail sector. New activities have developed, including tourism, small-scale and niche manufacturing and food production and business services. ICT developments partially solve the problem of remoteness and offer a wide range of new business opportunities.

While economic diversification away from primary production was an important objective of rural policies in recent decades, the food security agenda and the increasing demand for biomass for a variety of bio-based applications have again raised new interest in the economic opportunities related to primary production and the associated food and non-food value chains. This new interest is combined with stakeholder concerns over the capacity of rural areas to cater sustainably for all these needs while providing essential ecosystem services, amidst increasing urbanisation (and soil sealing) and the pressure on land resources caused by climate change. There are also important questions around the impact that different types of value chains or renewed urban-rural linkages could have on local development and job creation.

Evidence and knowledge can help policy-makers overcome challenges described earlier and seize new opportunities by helping them to develop the most appropriate policies and governance approaches.

2.2.2.1. New openings for rural growth

Rural areas supply food, feed, wood, fibre and other biomass, energy, water and a range of ecosystem services and public goods. Yet society's demand for products and services based on natural resources is growing and the capacity of rural areas to match this demand will contribute to shaping their future economic growth and social progress. Building on a solid analysis of **territorial dynamics**, research and innovation activities under this priority can contribute to identify new avenues for rural growth in relation to **1) food and non-food value chains, 2) the delivery and economics of public goods, 3) other key economic sectors** such as services, infrastructure, logistics and digital activities which enable or facilitate innovation and socioeconomic development in all sectors. The focus should be on integrated and place-based approaches which look across sectors and take into account local assets and limitations. Activities should be **clearly impact-oriented** with strong **dissemination requirements**, in particular towards **policymakers,** informal governance bodies and local development groups who are involved in deciding on policies at different levels.

Understanding territorial dynamics and modernising policies

Exploring the conditions for **sustainable growth in rural areas** will be one cross-cutting activity under this priority. Economic policies supporting growth in rural areas reflect to some extent the underlying theoretical models that prevailed at the time they were implemented. Thus, over the decades, explanatory frameworks have switched from exogenous growth (i.e. development underpinned primarily by external factors) to endogenous growth (i.e. encouraged by an area's own endowment of resources). Current thinking acknowledges the contribution of mixed approaches which aim to harness rural area's own capital (natural, human and social) without neglecting potential support and synergies originating from outside these rural areas. In addition, policies focusing on specific sectors have given way to integrated approaches at territorial level which take account of local circumstances ('place-based approaches'). In parallel, policies designed to cope with overarching objectives (such as climate change, biodiversity, trade) have direct and indirect impacts on the primary sector and more generally on rural areas.

To understand the dynamics of development in rural areas, research activities should capture major trends affecting rural areas both economically and socially and should differentiate between types of areas characterised by different environments and varying degrees of remoteness. These will include trends related to **demography** (ageing, migration between countries and between different areas in one country, selective migration of women and young people, lifestyles), **market dynamics** (including rural financing, market power and concentration in upstream and downstream industries), changing structures, land ownership and employment patterns (in particular in farming), **climate change**, trends in **services or digital development and their impact on the attractiveness of the primary sector**. Research will also aim to cover the **social aspects that underpin** rural development (e.g. the role of networks, citizen's engagement in local decisions and policies). **Scenario** types of projects and **foresight activities** will be useful for establishing the impact of these trends on rural territories and policies.

Attention has been placed recently on **territorial linkages** (urban-rural, rural-rural, land-sea) and their contribution to sustainable growth.[50] Some stakeholders have argued against putting too much effort into delineating boundaries between different types of territories as these are constantly changing.[51] Various aspects of these linkages can however be investigated: the analytical framework can be clarified, governance approaches which enhance synergies between rural and urban development and between economic sectors in concerned territories can be analysed and avenues for new business developments building on these linkages can be identified and up-scaled, including social innovation and regional branding. Beyond those linkages, holistic analytical frameworks can be developed, together with the necessary analytical tools and indicators, which would allow a thorough assessment of synergies and trade-offs between sectors and biomass uses, taking into consideration the delivery of ecosystem services, circular economy approaches, job creation and added value as well as land use management. Territorial linkages should be understood in a broad sense and not only as the relationship between an urban area and its immediate periphery.[52] There are new kinds of settlement-landscape patterns emerging in extended peri-urban areas, and also in the greening of cities and urbanisation of the countryside.[53]

[50] Rural-urban partnerships, OECD Rural policy reviews, OECD, 2013.

[51] http://ec.europa.eu/newsroom/horizon2020/document.cfm?doc_id=10857.

[52] https://ec.europa.eu/programmes/horizon2020/sites/horizon2020/files/20150219_Workshop_Rural_Empowerment_report_final.pdf.

[53] Strategic Foresight - Towards the third strategic programme of Horizon 2020, European Commission, DG RTD, 2015

Organising sustainable food and non-food value chains under changing conditions

Sustainable, diverse and resilient food systems are a prerequisite for sustainable rural growth and for food security. Research has a role to play in unravelling the links between the complexity of food systems and their efficiency, resilience and sustainability.

Food supply chains operate in an increasingly complex and dynamic environment characterised by new demands, new technologies - sometimes game-changing -, changing structures and cooperation modes. Food demand by consumers is evolving in terms of various quality attributes (authenticity, standards, certification, origin, healthiness, local or regional supply, etc.). Through the use of new business models, this can generate higher incomes for producers both in Europe and in developing countries (especially small-scale farmers), while keeping consumer prices affordable. Encouraging food chain competitiveness, sustainability and resilience requires an understanding of food chain dynamics (and of individual components of the chain) and the interactions between them and with non-food chains. All dimensions of sustainability will be investigated: **environmental** (resource management, waste reduction at various levels, climate change mitigation and adaptation, biodiversity conservation), **economic** (competitiveness, business approaches, incentives and behaviours, traceability and certification, transparency and balance of market power, distribution of added value and income along the supply chain, impact on local economy) and **social** (contribution to the quality of life and rural revitalisation, i.e. in terms of food availability and various dimensions of quality and health, jobs and working conditions, gender and cultural aspects). Emerging approaches (such as short-supply chains, new business models) deserve attention as they may provide solutions for improving sustainability and providing territorial benefits. Cooperative and other collective approaches can for example deliver multiple benefits (increased market power, logistics, etc.). Research and innovation activities should contribute to designing appropriate business models and up-scaling them.

The **role of consumers** needs to be studied as it has a strong bearing on the whole food system and how it works, in particular in the context of emerging urban food policies and urban farming, the development of regional or sustainability labels or sustainable public procurement which can impact primary production. **Drivers of sustainable consumption** need to be better understood (for example when it comes to promoting "integrated ecological approaches", as mentioned in section 2.2.1.3, or "sustainable diets"). Beyond achieving better understanding, research and innovation activities need to engage consumers so as to facilitate the necessary changes.

The role of the **upstream industry** also needs to be scrutinised, as a provider of essential inputs (seeds and breeds, fertilisers, plant and animal health products), a driver of farm practices in particular through advice and as a provider of growth and jobs.

Similarly, **policies that shape food value chains should be analysed**, exploring how interventions could have an impact on environmental, economic and social sustainability as described above.

Farmers and foresters have for a long time produced non-food products, whether for **energy** (e.g. fuel wood) or **industrial purposes** (e.g. raw material for construction, paper or textiles). However, there is now the need to decarbonise the energy sector to meet climate change goals, compounded with considerations of resource efficiency, a rapidly changing energy landscape and an **increasing interest in green chemicals and green growth**. Taken together, all these issues underlie

the importance of channeling renewed attention to diverse uses of land and biomass driven by scientific and technological progress and the related promising markets.

Research and innovation activities in this area will address **low-carbon short-chain delivery systems for innovative and sustainable bio-based applications** (e.g. bioenergy, biochemical, biomaterials) while using a systems-based approach for the provision of biomass for all uses (food, feed and industrial applications, traditional and new uses) and preserving the delivery of other ecosystem services. Emphasis will be placed on **integrated and diverse production systems and agronomic or forestry practices to increase the overall productivity of land for food and non-food applications**. Other opportunities can be generated by growing biomass crops on less-productive or abandoned lands (while avoiding biodiversity losses), by afforestation and reforestation and through the use of residues, co-products and waste on-farm and along the value chains, using **resource-efficient and circular approaches**. Appropriate solutions are necessary to minimise adverse environmental impacts, such as the establishment of closed circuits of nutrients, as mentioned under section 2.2.1.1. New business processes and products will have implications for the design of farms and forest holdings, their management, the income generated and for the availability of food, feed and non-food products in value chains. It will require research with close connections between natural, engineering and socioeconomic sciences. Activities will focus on biomass production and **infrastructure and logistical improvement** to foster existing and novel biomass supply chains for non-food applications while considering the sustainability of related land-use systems and integration or synergies with food systems. Innovation strategies developed at local or regional level will be complemented by cross-sectoral activities on a larger geographic scale. Research will extend to the tools, indicators and forward-looking activities which are necessary for all stakeholders to identify, implement and monitor relevant strategies, policies and legislation targeting rural areas in view of optimising the sustainable management of natural resources at territorial level and the creation of jobs and added value in rural areas.

Better rewarding the provision of public goods

The increasing value assigned by society to the environment, culture and heritage of rural areas can be a driver of their sustainable growth. This has materialised to a certain extent for public goods related to culture and heritage, e.g. tourism based on traditional landscapes or traditional food products. However, the situation is less favourable for most **environmental public goods** such as water and air quality or biodiversity. Delivery of these goods is widely reckoned to be insufficient and is one of the areas covered by the United Nations Sustainable Development Goals (SDGs) adopted in September 2015. Farmers and foresters are responsible for the management of most land in the EU and, depending on practices used, can indeed be sources of a wealth of environmental public goods or can threaten them, thereby constraining the long-term sustainable growth of rural areas and the benefit from these public goods to the whole society. Research will address the main environmental public goods individually to examine specific stakeholder behaviour and market mechanisms, while also considering combined delivery and integrated approaches to tackle synergies and trade-offs between different public goods and users.

Attention will be directed to **policy and socioeconomic dimensions**, including consistency with the development, implementation and impact assessment of new policy instruments and delivery mechanisms as well as the necessary decision-making and monitoring

tools. This will include, for example, progressing towards the **valuation and pricing of public goods**[54] and creation of **policy and market-based mechanisms**. Societal involvement in the development of such mechanisms will be particularly important. Potential economic spin-offs related to the delivery of public goods will be analysed along with possibilities for developing collective approaches to the provision of public goods.

Taking advantage of the digital revolution

ICT can help to reduce problems of remoteness of rural areas and enhance their capacity for social inclusion. Digital technologies bring opportunities to develop new businesses and are likely to raise rural attractiveness, in particular to younger generations, if sufficient infrastructures are in place. ICT offer opportunities to renew business models in the food and non-food value chains by connecting producers to consumers, for example setting-up innovative marketing channels, such as new types of short food supply chains, or improving logistics. They bring innovative solutions which can help to modernise the provision of services and make services more efficient for both providers and citizens in areas of lower population density. ICT can also support a greater involvement of rural dwellers in policy-making, networking and collective initiatives, thus enabling modern approaches to governance. Research and innovation activities under this priority will explore and upscale business and governance models which can boost rural economies on the basis of digital applications.

2.2.2.2. Enhancing the human and social capital in rural areas

The need to speed up innovation in agriculture has been repeatedly emphasised in recent years. Agricultural activity has never taken place in a static context. Yet, in the last decades, this context has become more complex owing to more restrictive environmental consideration and more open economic conditions and associated opportunities and risks. The same applies to forestry. Beyond the primary sector, innovation in rural areas can play an important role in stimulating green and socially inclusive economic growth, mitigating geographic isolation and avoiding economic and social marginalisation. Human capital (i.e. individual skills that enable actors to perform or initiate economic activities) and social capital, i.e. the links, incentives, shared values and norms that underpin the capacity of actors to trust each other and cooperate, are essential to successful rural innovation.

Innovation has been assigned a key role by the Commission to meet the objectives of the 'Europe 2020' strategy. Horizon 2020 has consequently been aligned with the objective of encouraging innovation. European Innovation Partnerships (EIPs) have been established in various areas, linking existing instruments and policies to tackle major societal challenges, pool expertise and resources and boost the competitiveness of EU industry. Among these, the EIP 'Agricultural Productivity and Sustainability' (EIP-AGRI) tackles innovation in agriculture and rural areas and is implemented through both Horizon 2020 and the rural development pillar of the CAP. In broad terms, the EIP-AGRI aims at fostering all three dimensions of sustainability of the farming activity, creating synergies between the two policies.[55]

The complex environment outlined above does not call for simple solutions developed across the board but for a variety of solutions adapted to a variety of actors, contexts and regional circumstances. Hence, the so-called linear approach, whereby solutions developed by researchers were transferred and implemented uniformly by producers with the support of advisory services and relevant policies, is no longer sufficient.[56] Dealing with complexity requires the harnessing of all types of available knowledge, including tacit knowledge at farm and business level. It also requires the involvement of all relevant actors (farmers, foresters, advisors cooperatives and industry, etc.) in a process

[54] See for instance the EU initiative on Mapping and Assessment of Ecosystems and their Services (MAES). Http://biodiversity.europa.eu/maes.

[55] COM(2012) 79 final.

[56] See for instance Commission staff working paper, impact assessment of the Common Agricultural Policy towards 2020 - Annex 7: Research and Innovation (SEC(2011) 1153 final/2).

of knowledge co-creation with practitioners engaging from the very beginning of the research and innovation process. This intensification of co-ownership is what we refer to as the **interactive innovation model**.

Activities under this priority will aim to support sustainable growth in rural areas by encouraging innovation. They will have two main strands. The first will investigate the **skills, human and social capital** of producers and rural dwellers which are essential to enable them to develop their activity in the complex environment referred to above. The second will look at the **knowledge and innovation systems** and aim to improve their delivery and integration at European, national and regional levels.

The dynamics of economic activities in rural areas are heavily dependent on their **social and human capital**. Enhancing innovation implies, on the one hand, understanding the values that can encourage or constrain social capital (such as attitudes towards networking, gender values, inclusion of younger generations and migrants, equal opportunities, etc.). This necessitates knowing better who the actors (farmers, foresters, entrepreneurs, rural dwellers) are and will be in the future and what their current and future needs are. On the other hand enhancing innovation implies providing the necessary hard and soft (e.g. entrepreneurial) skills. This is why **education and training** need to be at the heart of any endeavour to boost knowledge and innovation in rural areas. This goes well beyond initial education and training as skills increasingly need to be maintained and updated to keep pace with societal and technological change.

Horizon 2020 and its succeeding Framework Programme will be used to provide insight on the functioning of the **knowledge and innovation systems** with the objective of improving their delivery in rural areas, including recent approaches such as the EIP-AGRI. This will cover all parts of the systems (science, education and training, advisory services, private business management), categories of actors (knowledge producers, users and intermediaries between the two, networks, clusters), types of innovation (technological, social, organisational, etc.) and policies (CAP, research and innovation, regional and education policies). The encouragement of participatory systems-based approaches will only deliver if the knowledge and innovation system provides the necessary facilitating environment. Research and innovation actions will cover aspects such as the integration of new demands and technologies; increasing the impact of participatory research; skills and rewarding of multi-actor research and more broadly evaluation of researchers.

Attention will not be limited to innovation at primary production level but will extend to all actors in the supply chain – generating co-ownership and improving the impact of solutions built - or, more generally, in the rural economy. Links with innovation processes in urban and peri-urban areas and the capacity of policymakers to deal with innovation processes will also be investigated. As approaches to innovation are strongly influenced by social and economic circumstances, and differ widely across the EU, benchmarking and the exchange of experience between national and regional level knowledge and innovation systems in the EU will be encouraged. Beyond European borders, the capacity of knowledge and innovation systems to facilitate convergence between research and practice to better respond to global challenges should be properly looked at.

2.3. Cross-cutting issues

2.3.1. Systems approach, interdisciplinarity and transdisciplinarity

The need for a **systems-based approach** towards research has been emphasised in several reports by different bodies[57] (e.g. the third and fourth Standing Committee on Agricultural Research (SCAR) Foresight reports, the International assessment of agricultural knowledge, science and technology for development (IAASTD) and the Expo 2015 EU Scientific Steering Committee). Meeting the challenges facing the agricultural and food and non-food systems means dealing with complexity and working in an integrated manner so that the proposed solutions are fit for both the problem they address and the main objectives being pursued for the system as a whole. This systems-based approach can be of various scales, from farm to landscape or, beyond, at the level of the food/non-food system. In addition such an approach should help better understand the role played by the various actors on the other parts of the system (e.g. the role of consumer preferences in the food chain) as well as the impact of proposed changes on the different concerned actors. This requires the encouragement of **interdisciplinary**[58] (as recommended by the Expo 2015 EU scientific steering committee) or even **transdisciplinary**[59] (as recommended by the fourth SCAR Foresight report) approaches.

A systems-based approach will be implemented in relevant areas in order to ensure that activities carried out take account of both the immediate objectives they target and the wider objectives of the research programme. The system-based approach implies to go beyond the research undertaken at the level of the components of the system to better understand the interactions between those components. Therefore it is necessary to take due account of the different spatial and temporal scales. This implies also the development of metrics and methods enabling integrated assessments of system performance across, space, time and the full range of benefits (economic, environmental and social).

Such approach will be implemented at both project (or cluster of projects) and programme levels. At project level, the wider context in which projects are being carried

out will be taken into consideration. This is already put into practice, as the activities under a series of projects from the Horizon 2020 work programme 2014/2015 and topics from work programme 2016/2017 extend beyond the primary sector to the ecosystem services linked to agriculture and forestry and, to the food and non-food supply chain. In addition, **interdisciplinary** and **transdisciplinary** approaches will be encouraged **wherever relevant**. Finally the involvement of the concerned actors, from farmers to consumers, will be sought through participatory approaches.

At programme level, the strategic management of the portfolio of activities will ensure the proper alignment of the various activities with the overarching objectives. Regular foresights and horizon scanning will be performed to allow a better fit between research questions and objectives and projected long-term system needs (desirable futures). Finally, implementing **nexus approaches**, i.e. involving research and innovation in several sectors, such as food, water, energy and biodiversity will be sought. Such approaches allow reducing trade-offs and develop synergies between sectors.

2.3.2. Societal engagement

Societal engagement is key to ensure that research responds to society's needs but also to facilitate innovation and the implementation of research results. The involvement of the society needs to take place at all major steps of the process, from agenda setting to research activities and to the dissemination of outcomes. The multi-actor approach implemented in many research and innovation projects already responds partly to this as it engages with end-users and actors directly involved in the development of the innovation process. Overall, long-lasting interfaces will need to be established between research and broader society.

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[57] Agriculture at a crossroads, International assessment of agricultural knowledge, science and technology for development, IAASTD, 2009; Sustainable food consumption and production in a resource-constrained world, SCAR, European Commission, 2011; Sustainable agriculture, forestry and fisheries in the bioeconomy – A challenge for Europe, SCAR, European Commission, 2015; Global Food Security 2030, Foresight Series, Joint Research Centre, European Commission, 2015; The role of research in global food and nutrition security and The European research and innovation agenda for global food and nutrition security, Expo 2015 EU Scientific Steering Committee, 2015.

[58] Interdisciplinary research involves closer and more frequent collaborative exchanges among researchers drawn from different fields who are working together on a common problem.

[59] Transdisciplinarity is a specific form of interdisciplinarity in which boundaries between and beyond disciplines are transcended and knowledge and perspectives from different scientific disciplines as well as knowledge from societal stakeholders are integrated.

2.3.3. Information and communication technologies (ICT) as enabling technologies for research and innovation

Smart and mobile technologies are hailed as one of the most important recent innovations for all actors in food and non-food supply chains all over the world allowing access to a host of services from real-time market information to crop disease identification. Beyond assisting in primary production (e.g. precision farming/ forestry), digital technologies has immense potential to support many elements of the rural economy, from food and non-food supply chain management to new business development.[60] Research is necessary at three main levels: (1) the 'infrastructure' level (interoperability of data and information systems) to facilitate the use of ICT; (2) the 'systems' level (smart sensors and actuators deployed within robotic and automated systems); and (3) the 'application' level in various parts of the rural economy. Private and public goods and services will be sought from opportunities created by the internet of things and big data approaches although unresolved issues such as data ownership and user rights will have to be taken into account. Digital technologies will also be enablers in the research process (e.g. the generation, use and sharing of research data and crowd science).

2.3.4. Enabling sciences and infrastructures

Public funding is important for basic research and infrastructures. These are areas where private funding is more difficult to obtain as it tends to be channelled into applied research.

Enabling sciences have a key role to play for fundamental understanding of biological processes, from molecular biology to cells, organisms, populations and ecosystems. Enabling sciences include genomics, statistical modelling, pilot systems facilitating the collection of data and information to support evidence-based, science-informed policies, decision-making and technology development. Basic research needs to be granted sufficient freedom to widen the range of potential solutions. On the other hand, the potential implementation of basic research needs to be anticipated, which implies to strengthen the links between basic and applied research.

A reflection needs to take place together with Member States on infrastructures needed to facilitate research and innovation at EU level. This reflection would include e-infrastructures (to facilitate data use and sharing and to curate research outputs) and infrastructures that link experimental and demonstration farms or demonstration sites for forest management.

2.3.5. Socioeconomic research and support for EU policies

The system-based approach requires socioeconomic research to be embedded in all relevant research and innovation activities. Indeed socioeconomic research is critical to the design and implementation of efficient and effective **policies** affecting rural territories and food and non-food systems. This concerns a range of policies, not just the CAP, and requires attention at various levels (from the individual to the society and from local to global, from sectoral land use type to integrated landscape management). In addition, research has a strong role to play in contributing to the development of the analytical tools and models which are necessary for assessing the EU policies concerned. In view of the various objectives that apply to policies targeting agriculture, forestry as well as rural economies and societies at large (environmental, economic and social objectives), it is important that these analytical tools and models are able to cover a large range of issues at various geographical scales. This may necessitate a greater integration of models and data. Socio-economic research needs to be harnessed to assess the economic sustainability of the various activities relevant in rural areas, including farming and forestry activities, taking due account of the social and environmental dimensions. The development of suitable standards to measure, assess, monitor and ensure a healthy functioning of the food or non-food supply chains will be given due attention.

[60] Several recent foresights assign a major importance to the role that ICT can play, see in particular the fourth SCAR foresight which speaks of an ICT revolution.

CHAPTER 3

How will the strategy be implemented?

3.1.Strategic programming and programme management

The main priorities of the strategy will be further detailed in terms of developing more specific lines of action which will feed into the overall Horizon 2020 strategic programming for 2018-2020 and beyond when moving towards the next Framework Programme. These specific lines of action should take account of the EIP-AGRI and the research and innovation agendas of relevant European Technology Platforms as well as outcomes of stakeholder engagement processes and science-society-policy fora. Genuine societal engagement is necessary to ensure full societal relevance of research priorities.

A reflection on funding mechanisms and types of instruments used will need to be encouraged so as to reconcile rather short-term financing cycles with the longer term character of research and of some of the challenges it addresses which would require sustained support. Furthermore, the implementation of systems research and innovation would require flexible approaches combining large inter / transdisciplinary projects with smaller activities working on more narrow issues.

The implementation of the strategy through the various calls will require close monitoring of the funded activities (in particular from the various parts of Horizon 2020) and their mapping against the strategy's priorities and the policy objectives to which research and innovation should contribute.

Furthermore, the strategy will need to be reviewed periodically in the light of findings and recommendations of new foresight reports (from the SCAR and others), stakeholder consultations and policy needs.

3.2. Encouraging synergies with Member State research and innovation activities and the development of the European Research Area

Although resources allocated to agricultural and forestry research (and more generally to the bioeconomy) have increased significantly in Horizon 2020 in comparison with the previous programme for 2007-2013 (Framework Programme 7), they still amount to a fraction of Member State investments[61]. Building the **European Research Area** (ERA) is a key objective of Horizon 2020[62]. Within this, encouraging synergies between Member States and between the latter and the EU Framework Programme is essential for impact and efficiency. European Research Area Networks (ERANETs), Joint Programming Initiatives (JPIs), Article 185 initiatives can all contribute to coordination and integration of research between Member States and the Framework Programme to different extents. Other instruments may also be used to respond to these objectives, for instance the European Joint Programmes (EJPs). Synergies will be developed with relevant JPIs such as FACCE (agriculture, food security and climate change) with a view to strengthening the European integration of their programmes.

Building the ERA is a long-term process. It still stands at an early stage with limited alignment and synergies between national programmes. A process of reflection needs to be engaged with Member States with the objective to strengthen the ERA. -

The aim of encouraging alignment of research agendas and integration of research needs to be carefully balanced with the objective to develop inclusive partnerships involving as many Member States as possible in the various activities of Horizon 2020. Some Member States may find themselves unable to take part

[61] A rough comparison can be made through GBAORD data from Eurostat. They suggest that EU investments correspond to around 8% of Member State spending. Yet it is important to remember that the nature of what is being compared is not exactly the same: EU investments are project investments whereas Member States investments also have to cover the running costs of the research and innovation activities. In addition, the multinational nature of Horizon 2020 activities offers added value to activities implemented at national level. Finally, taking account of research and innovation activities financed through the Structural Funds, the share of EU-financed agricultural research may well increase to about 15% of Member State investments.

[62] COM(2012) 392 final.

in some coordination activities (for instance ERANETs) due to resource constraints, despite having a research capacity that could add value to these activities.

The European Regional Development Fund provides significant support to research and innovation in Member States at the regional level[63] within Research and Innovation Strategies for Smart Specialisation (RIS3 strategies). As part of these strategies a significant number of regions are investing in the agri-food and forestry-wood sector. The challenge lies in coordinating research and innovation efforts across the different policies so as to improve the linkages between regionally-funded, nationally-funded and EU-funded activities.

3.3. The international cooperation dimension

International cooperation is a core feature of the EU Framework Programme. Participation is open to entities from around the world (with automatic funding for developing countries).

International cooperation has a role to play in boosting the **competitiveness** of European economy and the capacity of the European research and innovation system itself. Moreover, international cooperation can make a strong contribution to supporting the EU's external policy dimension and ensuring coordination and leveraging effect in addressing challenges which should be tackled internationally, not least because of the scale of necessary resources. In addition, international cooperation can help bridge the current geographic disconnect between expected increase in food demand and levels of investments in agricultural research and development.

EU agriculture and food systems contribute to **food security** not only in the EU but also at a global level. Demographic, dietary and income trends, climate change, environmental sustainability, domestic trade and food distribution policies are perceived as the major drivers that shape current and future food security. The EU forest based sector faces similar opportunities and challenges. It is strongly cross-linked with global markets for roundwood and wood-based materials and products. Most of these issues have an obvious **global dimension**. Therefore, in line with the strategy for **international cooperation** in research and innovation,[64] international activities are an integral part of this strategy. This means that the EU will strengthen its dialogue and cooperation with key international partners[65] and regions (e.g. Africa, China, the Mediterranean region) and with international organisations,[66] the private sector and global initiatives with a view to building a critical mass and developing synergies to address global challenges. The alignment with other research agendas and programmes will be sought for the benefit of knowledge exchange between different regions and research areas. The recently adopted SDGs will be guiding objectives in multilateral and bilateral cooperation, in particular SDG 2 (sustainable food and nutrition security), SDG 12 (sustainable consumption and production patterns), SDG 13 (climate change) and SDG 15 (ecosystems and biodiversity).

Activities related to **agricultural research for development** will aim to achieve wider EU development objectives and complement and establish new synergies with other investments made by the EU in this area, taking into account the lessons learned from previous and on-going cooperation. Key initiatives will focus on sustainable agricultural production and on food security in particular in Sub-Saharan Africa and in the

[63] Regulation (EU) No 1301/2013 of the European Parliament and of the Council of 17 December 2013.

[64] COM(2012) 497 final.

[65] In particular G-20 discussions on agricultural research as part of the Meetings of the Agricultural Chief Scientists (MACS). Both G-7 and G-20 have assigned a primary role for agricultural research to foster sustainable food production and food security.

[66] E.g. the Consortium of International Agricultural Research Centres (CGIAR), the FAO, the Global Forum for Agricultural Research (GFAR), the International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM), World Agroforestry Centre (ICRAF), Centre for International Forestry Research (CIFOR).

[67] Research and innovation – Food and nutrition security / sustainable agriculture, Directorate General for International Cooperation and Development, European Commission, 2014.

Mediterranean region. Fostering triangular cooperation, i.e. involving North-South and South-South cooperation, will be sought in relevant activities. Activities will also seek to provide coherence and synergies with the approach to agricultural research for development of the European Commission.[67]

At multilateral level, activities will be sought in key areas that help support sustainable agriculture and food security, for instance animal and plant health, sustainable and ecological intensification, genetic resources, soils or sustainable forest management. Boosting resilience and dealing with climate change will also be given due consideration. Supporting flexible platforms such as the one that is proposed on animal health under the Horizon 2020 work programme 2016/2017[68] will contribute to implement international cooperation. Complementarity and synergies will be sought with the activities of the CGIAR and initiatives such as the Belmont Forum[69] and Future Earth[70]. Bilateral partnerships will complement multilateral approaches.

To a certain extent, ERA instruments such as ERANETs, JPIs, EJPs, Article 185 initiatives[71], can be used to foster international cooperation inasmuch as they are consistent with the issues tackled, the objectives and the geographic coverage. Additional tools for international coordination include International Research Consortia (IRCs), and genuinely multilateral soft coordination mechanisms for research funders (with a focus on common objectives, coordinated research activities and concrete outputs). These tools are not EU funding instruments, but the Commission has been active in setting up and contributing financially to several of them primarily in the field of human health. Such IRCs or other appropriate forms of structured international collaboration will be considered in relevant areas.

3.4. Providing more space to new approaches and technologies

Enough space needs to be granted for new approaches and solutions to be developed bottom up (ground-breaking solutions, social innovation). Various instruments can be utilised, for instance inducement prizes, living labs[72], citizen science[73] or an instrument such as Future and Emerging Technologies (FET).

3.5. Developing complementarities and synergies with private sector research

Involvement of the private sector, which plays an increasing role, in particular in high and medium income countries, will be encouraged so as to extend the leverage of Horizon 2020 investments and to foster the development of new technologies that help meet sustainable primary production objectives. The private sector already plays a significant role in the interactive-innovation model, which is supported by Horizon 2020 and the CAP (via the EIP-AGRI). However, as the private sector devotes most of its research and innovation effort to areas where there is a short- or medium-term return on investment, businesses may need to collaborate with public research on certain long-term projects, especially if they do not have the necessary in-house expertise or knowledge.

Public-private collaboration is most relevant where supported research and innovation activities pursue long-term objectives and the delivery of public benefits that would not otherwise be taken into account by private businesses. Such collaboration can play a role in better ensuring that publicly-supported research and innovation activities address sector needs. Moreover, it can explore areas insufficiently covered by underpinning basic science or pre-competitive research and which is not taken-up by the industry otherwise.

Small and medium-sized enterprises (SMEs) participation in research and innovation activities is often difficult, for many reasons, including limited human, financial and infrastructure resources. Yet, these are valuable partners, with clear needs for research and innovation support and a major component of the sector. It is therefore a priority to actively incentivise the creativity of SMEs by encouraging further their participation in research and innovation activities and to develop flexible instruments adapted to the reality and diversity of agri-food SMEs. Different instruments will be explored in addition to the Horizon 2020 SME instrument, in particular, the role of financial instruments in helping start-ups and SMEs to develop new technologies and approaches (e.g. the biocontrol industry, ICT in agriculture, animal health, etc.).

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[68] See topic SFS-12-2016 'Support for international research on animal health'.

[69] http://www.belmontforum.org/

[70] http://www.futureearth.org/

[71] Article 185 of the Treaty on the Functioning of the European Union (TFEU) enables the EU to participate in research programmes undertaken jointly by several Member States, including participation in the structures created for the execution of national programmes.

[72] The concept of living labs is based on a systematic use of co-creation integrating research and innovation processes. They are integrated through the co-creation, exploration, experimentation and evaluation of innovative ideas, scenarios, concepts and related technological artefacts in real life use cases. These living labs involve the user communities.

[73] "Citizen science is defined as scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions", Oxford English dictionary.

3.6. Boosting the implementation of research and innovation

With the EIP-AGRI, the interactive innovation model is set in motion by a variety of measures or instruments under the CAP (at local and regional level) and Horizon 2020 (at transnational level). Operational Groups are the cornerstone of the EIP-AGRI under the CAP and support the development of innovations by groups of relevant actors.

With Horizon 2020 the focus is set on the one hand on the implementation of the so-called **multi-actor approach**[74] (MAA) in collaborative projects, aiming to involve all the actors in a process of **genuine co-creation of knowledge** (e.g. farmers, foresters, industry, product users or consumers) across all the phases of project formulation and activities. A substantial part of topics under work programmes 2014/2015 and 2016/2017 involves the MAA and this approach will be continued (with any necessary adjustments) in the coming years. On the other hand, **knowledge exchange** should be facilitated by boosting requirements for focused outreach activities and providing support to transnational networks such as thematic networks that target particular sectors or issues and networks of experimental and demonstration farms and forest sites. These networks strengthen connections between the relevant actors and facilitate the inventory and use of knowledge as well as the collection of tacit knowledge.

They also provide inspiration for the actors, providing EU added value by stimulating peer-to-peer exchanges and reinforcing long-term connections and mutual trust between rural actors in the various Member States. Joint activities of researchers with advisors, innovation support services, farmer / foresters and their groups and other private actors will be crucial to facilitate knowledge exchange.

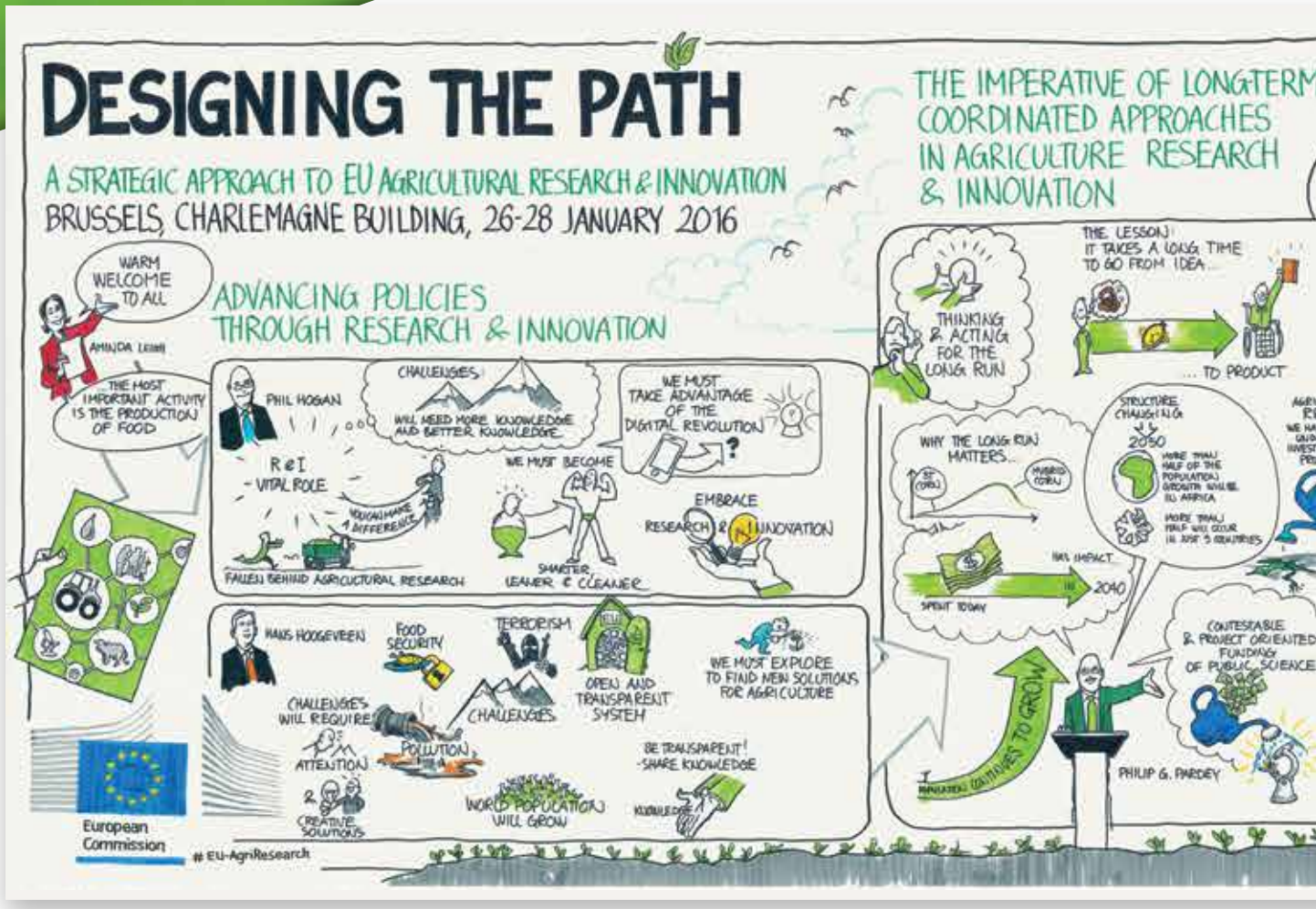
The implementation of knowledge and solutions on the ground is highly conditional upon the **feasibility of proposed solutions**. This aspect needs to be better mainstreamed into research and innovation activities. How scientists can be encouraged towards this through renewed evaluation and reward systems, is a further issue for investigation.

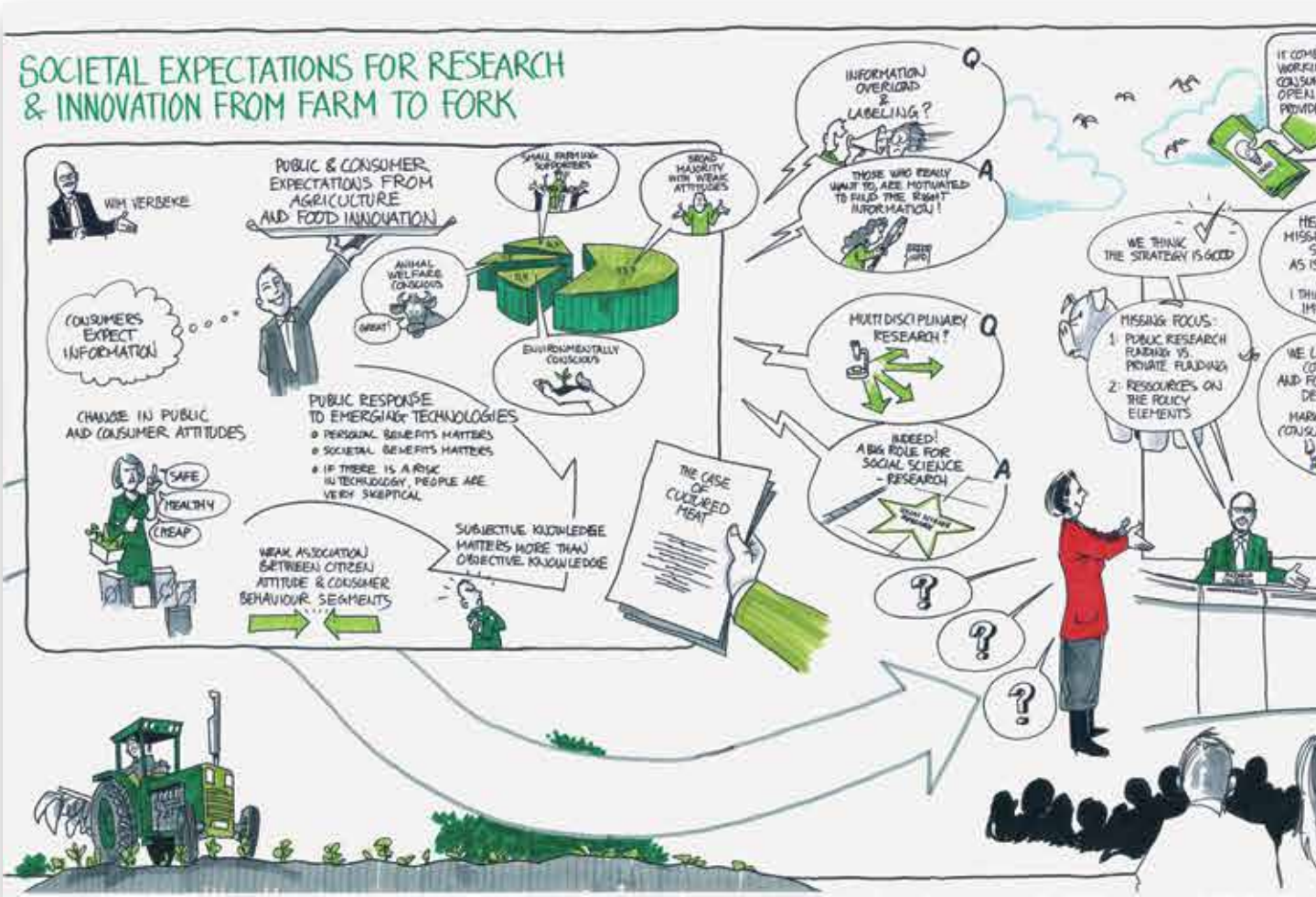
Access to past and current framework programme project results needs to be facilitated for all potential uses (innovation, further research, policy work, etc.). As indicated in section 2.3.4, e-infrastructures could play an important role in facilitating access to produced knowledge.

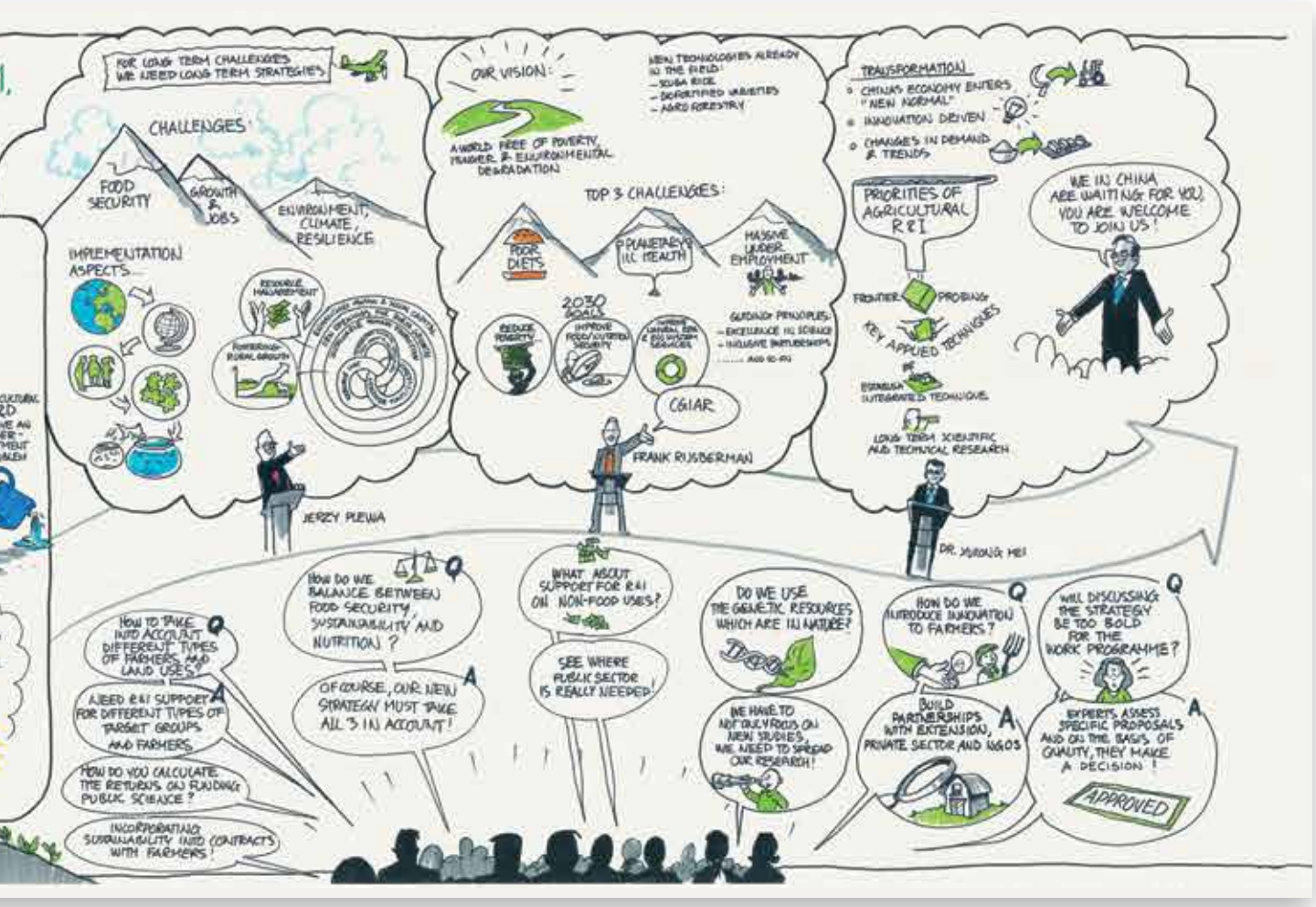
Beyond this, the **circulation of knowledge** needs to be boosted to speed up the innovation process and to make it available in the places where it is most needed, taking into account the diversity of actors involved. **Open data and open science** should become the default standard as they will be critical in coping with the challenges the primary sector and the food/non-food chains face.

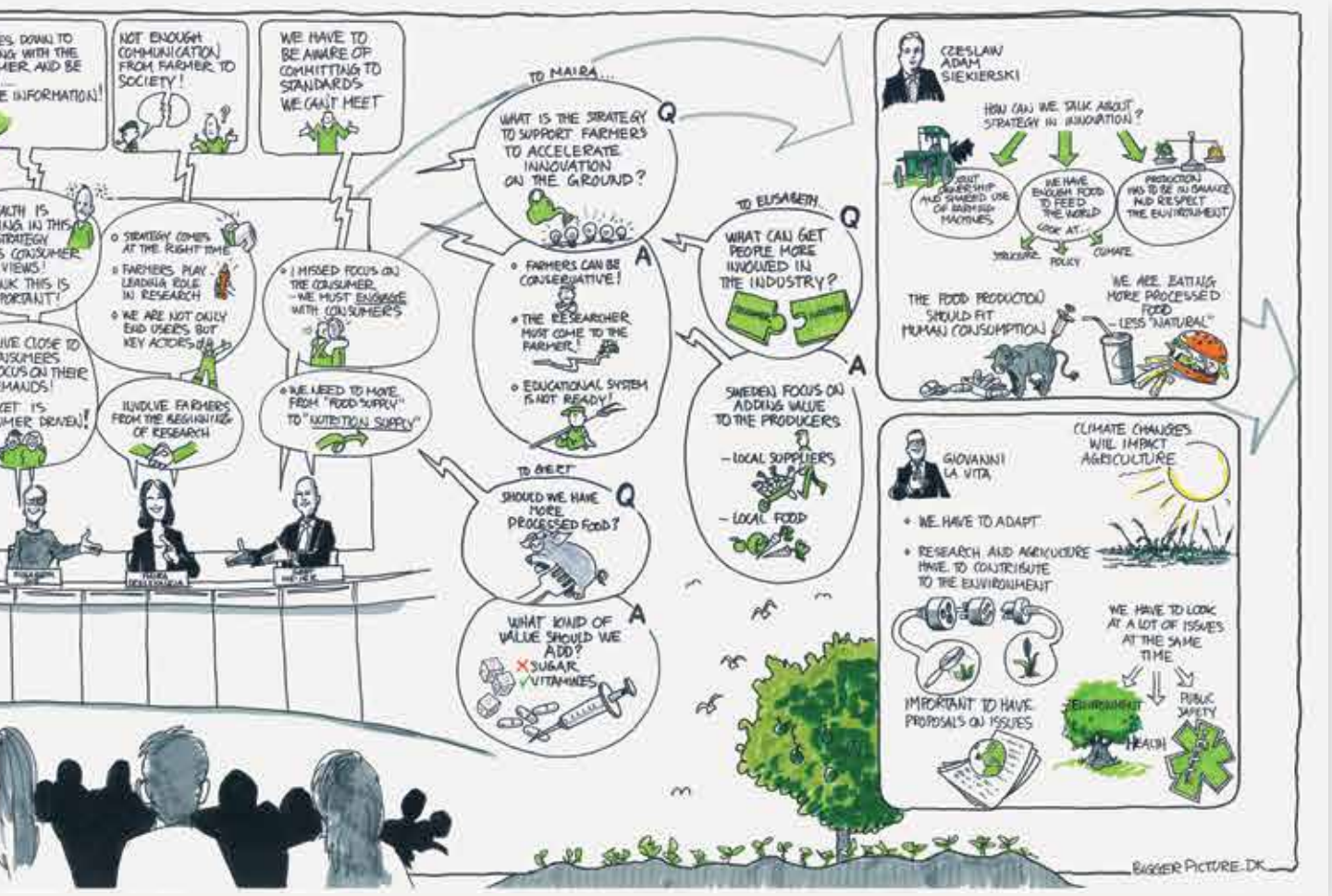
Finally appropriate interfaces are necessary to strengthen connections between evidence producers and evidence users for better policy-making. They would facilitate the involvement of policymakers, and all other relevant actors, in policy-relevant projects and provide for sufficient outreach.

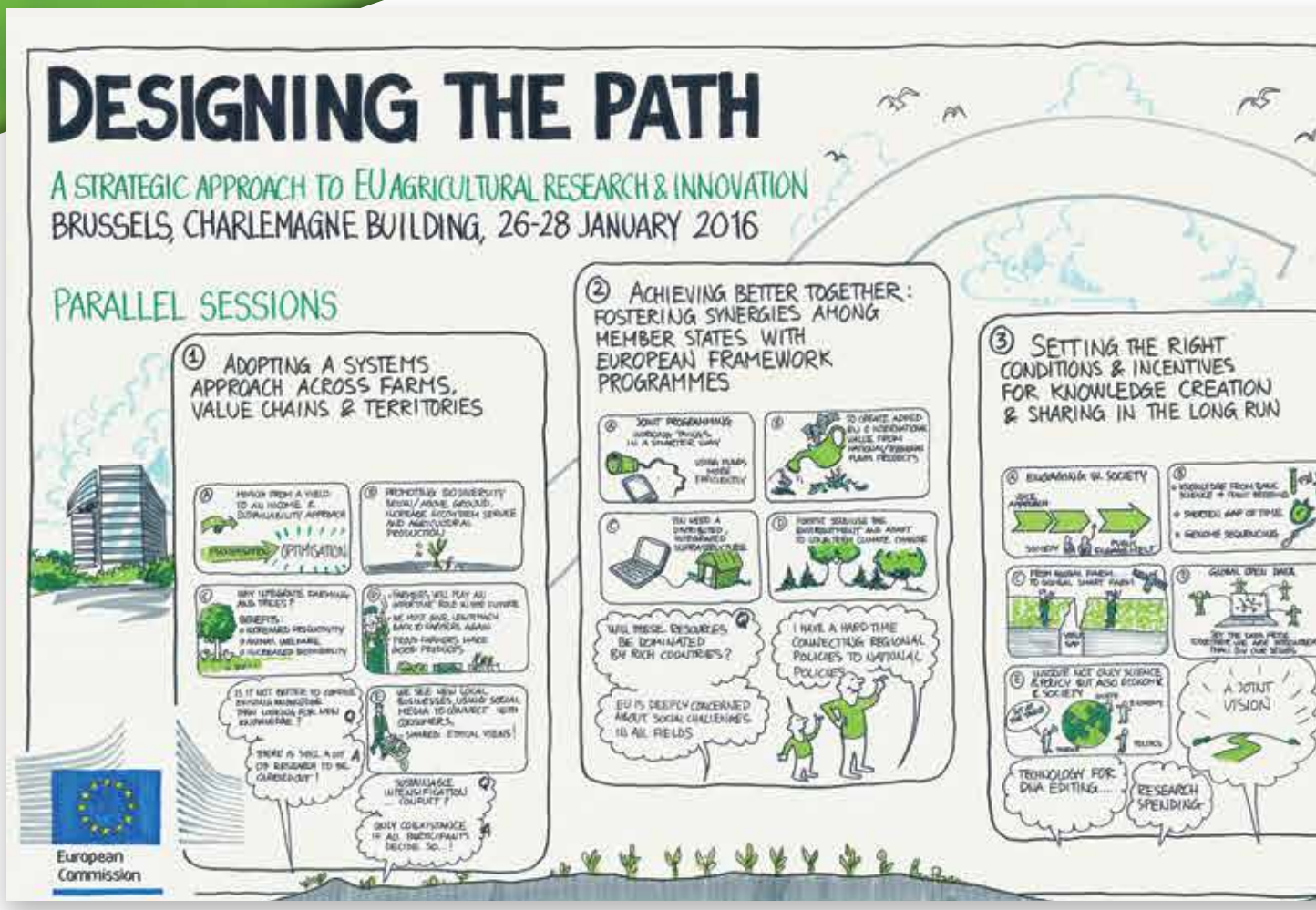
[74] The multi-actor approach is described in Horizon 2020 Work Programme 2016/2017 of Societal Challenge 2 pp. 11-12, see: http://ec.europa.eu/research/participants/data/ref/h2020/wp/2016_2017/main/h2020-wp1617-food_en.pdf

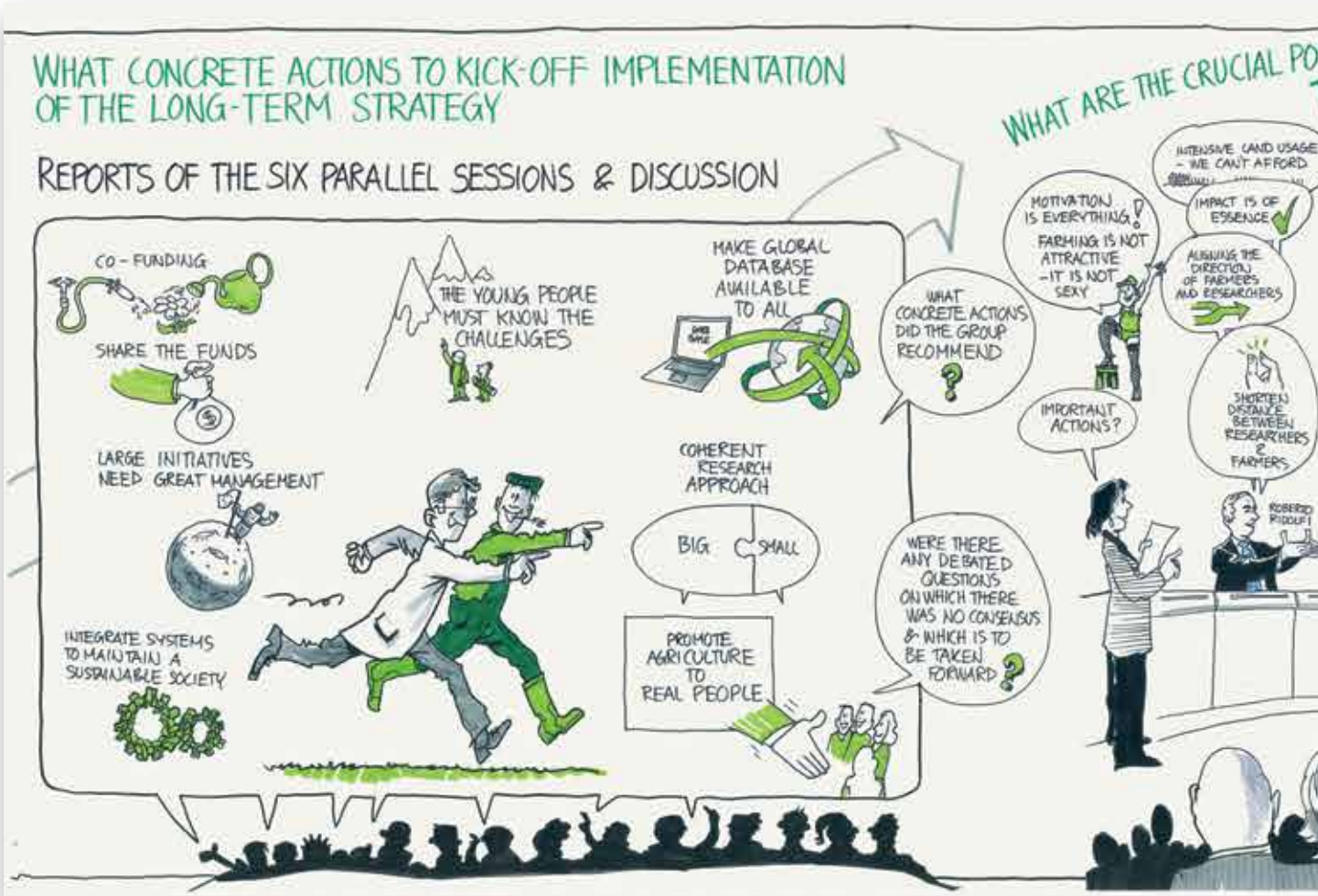

DESIGNING THE PATH
A STRATEGIC APPROACH TO EU AGRICULTURAL RESEARCH & INNOVATION
BRUSSELS, CHARLEMAGNE BUILDING, 26-28 JANUARY 2016
THE IMPERATIVE OF LONG-TERM COORDINATED APPROACHES IN AGRICULTURE RESEARCH & INNOVATION
ADVANCING POLICIES THROUGH RESEARCH & INNOVATION
WARM WELCOME TO ALL
AMANDA LEAH
THE MOST IMPORTANT ACTIVITY IS THE PRODUCTION OF FOOD
PHIL HOGAN
CHALLENGES
WILL NEED MORE KNOWLEDGE AND BETTER KNOWLEDGE
WE MUST TAKE ADVANTAGE OF THE DIGITAL REVOLUTION
R&I - VITAL ROLE
YOU CAN MAKE A DIFFERENCE
WE MUST BECOME
EMBRACE RESEARCH & INNOVATION
FALLEN BEHIND AGRICULTURAL RESEARCH
SMARTER, LEANER & CLEANER
HANS HOOGEVEEN
FOOD SECURITY
TERRORISM
OPEN AND TRANSPARENT SYSTEM
WE MUST EXPLORE TO FIND NEW SOLUTIONS FOR AGRICULTURE
CHALLENGES WILL REQUIRE
ATTENTION
CHALLENGES
POLLUTION
BE TRANSPARENT! - SHARE KNOWLEDGE
CREATIVE SOLUTIONS
WORLD POPULATION WILL GROW
KNOWLEDGE
European Commission
#EU-AgriResearch
THE LESSON: IT TAKES A LONG TIME TO GO FROM IDEA ... TO PRODUCT
THINKING & ACTING FOR THE LONG RUN
WHY THE LONG RUN MATTERS...
STRUCTURE CHANGE(S)
2050
MORE THAN HALF OF THE POPULATION GROWTH WILL BE IN AFRICA
MORE THAN HALF WILL OCCUR IN JUST 9 COUNTRIES
SPENT TODAY
HAS IMPACT IN
2040
INNOVATION CAPACITIES TO GROW
CONTESTABLE & PROJECT ORIENTED FUNDING OF PUBLIC SCIENCE
PHILIP G. PARDEY

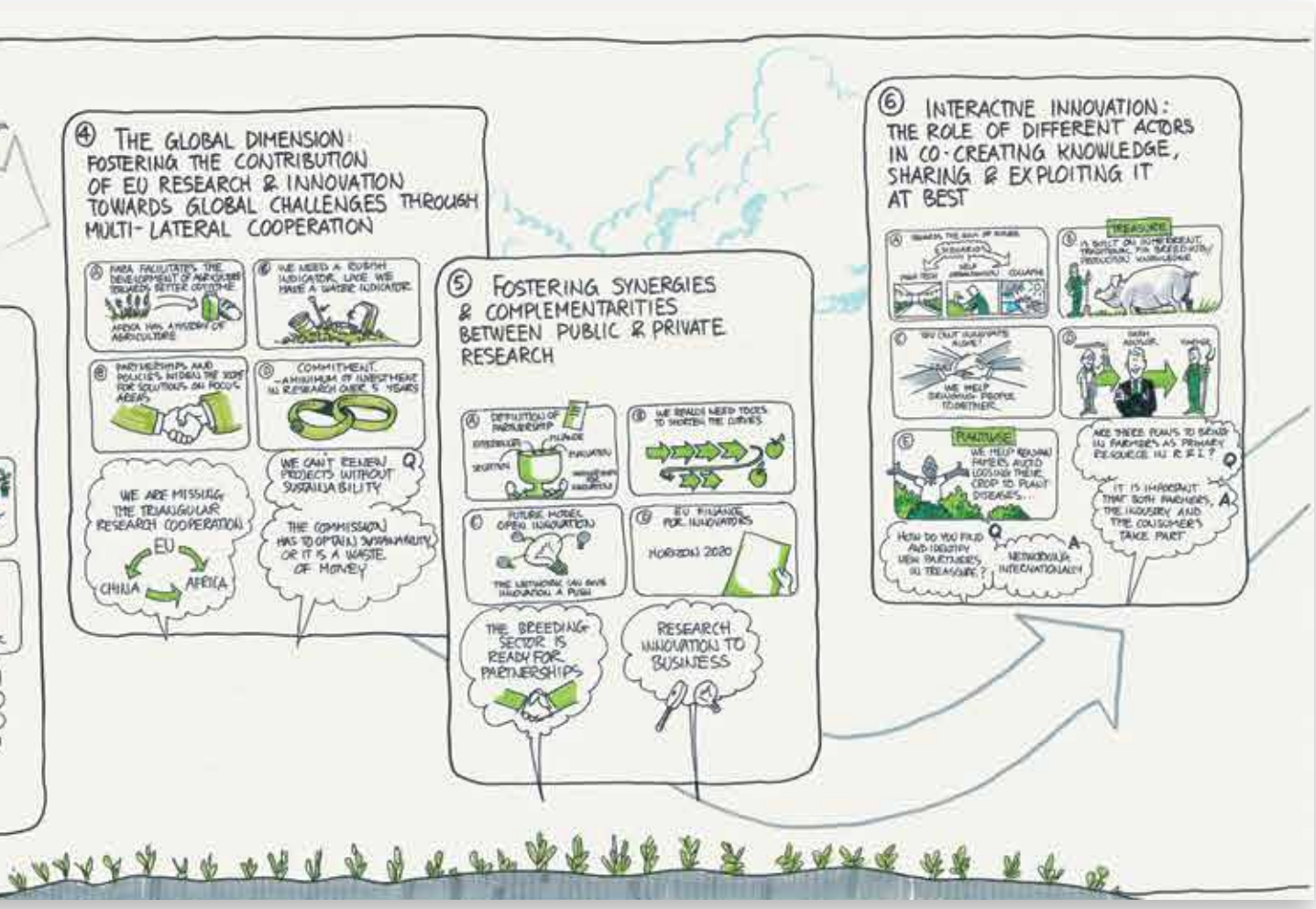

SOCIETAL EXPECTATIONS FOR RESEARCH & INNOVATION FROM FARM TO FORK
WIM VERBEKE
PUBLIC & CONSUMER EXPECTATIONS FROM AGRICULTURE AND FOOD INNOVATION
SMALL FARMING SUPPORTERS
BROAD MAJORITY WITH WEAK ATTITUDES
ANIMAL WELFARE CONSCIOUS
GREAT
ENVIRONMENTALLY CONSCIOUS
CONSUMERS EXPECT INFORMATION
CHANGE IN PUBLIC AND CONSUMER ATTITUDES
SAFE
HEALTHY
CHEAP
PUBLIC RESPONSE TO EMERGING TECHNOLOGIES
PERSONAL BENEFITS MATTERS
SOCIETAL BENEFITS MATTERS
IF THERE IS A RISK IN TECHNOLOGY, PEOPLE ARE VERY SKEPTICAL
WEAK ASSOCIATION BETWEEN CITIZEN ATTITUDE & CONSUMER BEHAVIOUR SEGMENTS
SUBJECTIVE KNOWLEDGE MATTERS MORE THAN OBJECTIVE KNOWLEDGE
THE CASE OF CULTURED MEAT
INFORMATION OVERLOAD & LABELING?
THOSE WHO REALLY WANT TO, ARE MOTIVATED TO FIND THE RIGHT INFORMATION!
MULTI DISCIPLINARY RESEARCH?
INDEED! A BIG ROLE FOR SOCIAL SCIENCE - RESEARCH
WE THINK THE STRATEGY IS GOOD
MISSING FOCUS:
1. PUBLIC RESEARCH FUNDING VS. PRIVATE FUNDING
2. RESOURCES ON THE POLICY ELEMENTS

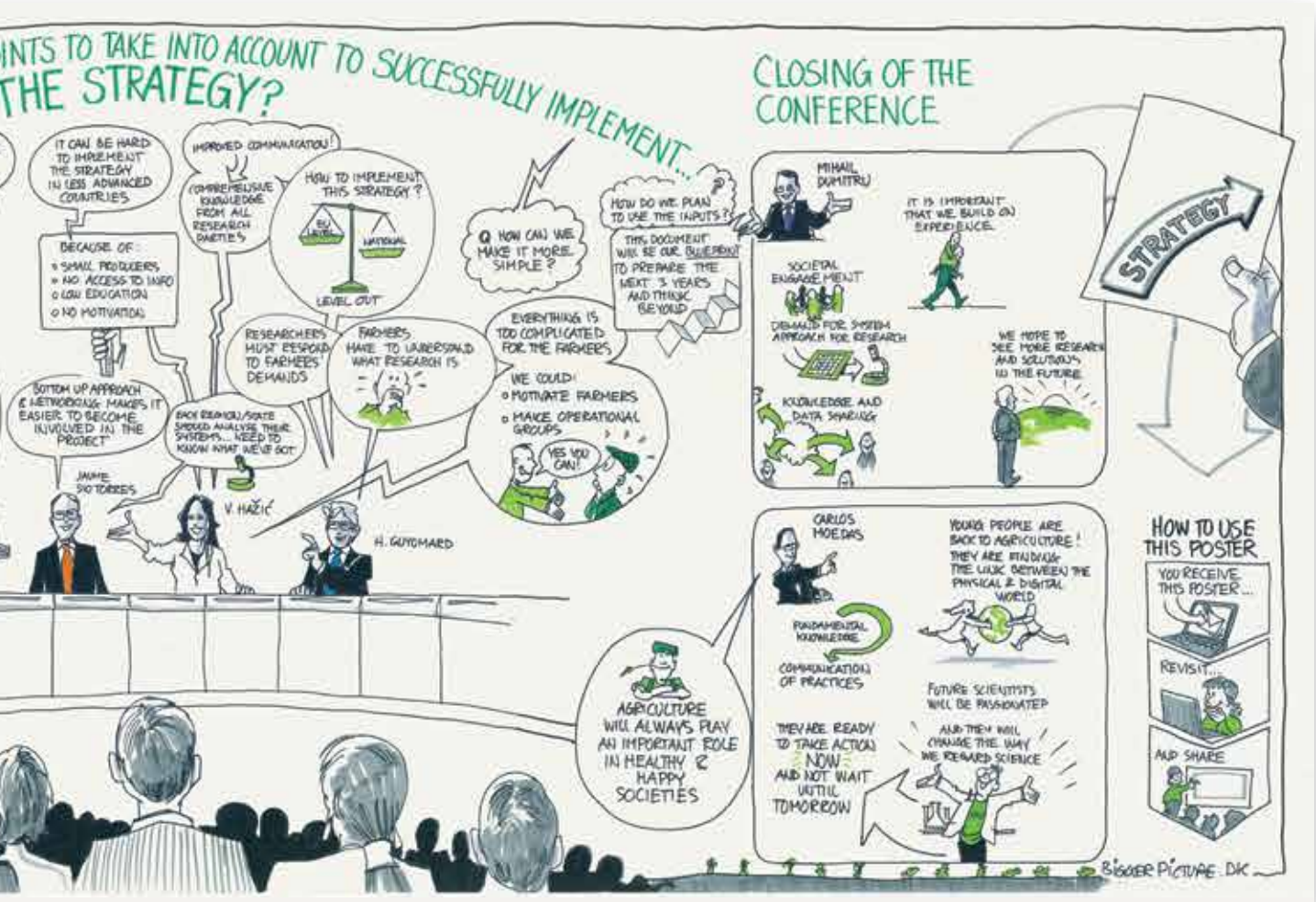

FOR LONG TERM CHALLENGES WE NEED LONG TERM STRATEGIES
CHALLENGES
FOOD SECURITY
GROWTH & JOBS
ENVIRONMENT, CLIMATE, RESILIENCE
IMPLEMENTATION ASPECTS
JERZY PLEWA
OUR VISION:
A WORLD FREE OF POVERTY, HUNGER & ENVIRONMENTAL DEGRADATION
NEW TECHNOLOGIES ALREADY IN THE FIELD:
- SUSAI RICE
- BIOFORTIFIED VARIETIES
- AGRO FORESTRY
TOP 3 CHALLENGES:
POOR DIETS
PLANETARY ILL HEALTH
MASSIVE UNDER EMPLOYMENT
2030 GOALS
REDUCE POVERTY
IMPROVE FOOD/NUTRITION SECURITY
GUIDING PRINCIPLES:
- EXCELLENCE IN SCIENCE
- INCLUSIVE PARTNERSHIPS
CGIAR
FRANK RIJSBERMAN
TRANSFORMATION
- CHINA'S ECONOMY ENTERS "NEW NORMAL"
- INNOVATION DRIVEN
- CHANGES IN DEMAND & TRENDS
PRIORITIES OF AGRICULTURAL R&I
FRONTIER
PROBING
KEY APPLIED TECHNIQUES
ESTABLISH INTEGRATED TECHNIQUE
LONG TERM SCIENTIFIC AND TECHNICAL RESEARCH
DR. YURONG MEI
WE IN CHINA ARE WAITING FOR YOU, YOU ARE WELCOME TO JOIN US!
HOW DO WE BALANCE BETWEEN FOOD SECURITY, SUSTAINABILITY AND NUTRITION?
OF COURSE, OUR NEW STRATEGY MUST TAKE ALL 3 IN ACCOUNT!
HOW TO TAKE INTO ACCOUNT DIFFERENT TYPES OF FARMERS AND LAND USES?
A NEED R&I SUPPORT FOR DIFFERENT TYPES OF TARGET GROUPS AND FARMERS
HOW DO YOU CALCULATE THE RETURNS ON FUNDING PUBLIC SCIENCE?
INCORPORATING SUSTAINABILITY INTO CONTRACTS WITH FARMERS!
WHAT ABOUT SUPPORT FOR R&I ON NON-FOOD USES?
SEE WHERE PUBLIC SECTOR IS REALLY NEEDED!
DO WE USE THE GENETIC RESOURCES WHICH ARE IN NATURE?
WE HAVE TO NOT ONLY FOCUS ON NEW STUDIES, WE NEED TO SPREAD OUR RESEARCH!
HOW DO WE INTRODUCE INNOVATION TO FARMERS?
BUILD PARTNERSHIPS WITH EXTENSION, PRIVATE SECTOR AND NGOS
WILL DISCUSSING THE STRATEGY BE TOO BOLD FOR THE WORK PROGRAMME?
EXPERTS ASSESS SPECIFIC PROPOSALS AND ON THE BASIS OF QUALITY, THEY MAKE A DECISION!
APPROVED


NOT ENOUGH COMMUNICATION FROM FARMER TO SOCIETY!
WE HAVE TO BE AWARE OF COMMITTING TO STANDARDS WE CAN'T MEET
TO MAIRA...
WHAT IS THE STRATEGY TO SUPPORT FARMERS TO ACCELERATE INNOVATION ON THE GROUND?
- FARMERS CAN BE CONSERVATIVE!
- THE RESEARCHER MUST COME TO THE FARMER!
- EDUCATIONAL SYSTEM IS NOT READY!
- STRATEGY COMES AT THE RIGHT TIME
- FARMERS PLAY LEADING ROLE IN RESEARCH
- WE ARE NOT ONLY END USERS, BUT KEY ACTORS
- I MISSED FOCUS ON THE CONSUMER - WE MUST ENGAGE WITH CONSUMERS
- WE NEED TO MOVE FROM "FOOD SUPPLY" TO "NUTRITION SUPPLY"
INVOLVE FARMERS FROM THE BEGINNING OF RESEARCH
TO ELISABETH...
WHAT CAN GET PEOPLE MORE INVOLVED IN THE INDUSTRY?
SWEDEN FOCUS ON ADDING VALUE TO THE PRODUCERS
- LOCAL SUPPLIERS
- LOCAL FOOD
TO BRET...
SHOULD WE HAVE MORE PROCESSED FOOD?
WHAT KIND OF VALUE SHOULD WE ADD?
SUGAR
VITAMINES
CZESLAW ADAM SIEKIERSKI
HOW CAN WE TALK ABOUT STRATEGY IN INNOVATION?
WE HAVE ENOUGH FOOD TO FEED THE WORLD
PRODUCTION HAS TO BE IN BALANCE AND RESPECT THE ENVIRONMENT
LOOK AT...
POLICY
CLIMATE
THE FOOD PRODUCTION SHOULD FIT HUMAN CONSUMPTION
WE ARE EATING MORE PROCESSED FOOD - LESS "NATURAL"
GIOVANNI LA VITA
CLIMATE CHANGES WILL IMPACT AGRICULTURE
- WE HAVE TO ADAPT
- RESEARCH AND AGRICULTURE HAVE TO CONTRIBUTE TO THE ENVIRONMENT
IMPORTANT TO HAVE PROPOSALS ON ISSUES
WE HAVE TO LOOK AT A LOT OF ISSUES AT THE SAME TIME
ENVIRONMENT
PUBLIC SAFETY
HEALTH
BIGGER PICTURE.DK


DESIGNING THE PATH
A STRATEGIC APPROACH TO EU AGRICULTURAL RESEARCH & INNOVATION
BRUSSELS, CHARLEMAGNE BUILDING, 26-28 JANUARY 2016
PARALLEL SESSIONS
① ADOPTING A SYSTEMS APPROACH ACROSS FARMS, VALUE CHAINS & TERRITORIES
② ACHIEVING BETTER TOGETHER: FOSTERING SYNERGIES AMONG MEMBER STATES WITH EUROPEAN FRAMEWORK PROGRAMMES
③ SETTING THE RIGHT CONDITIONS & INCENTIVES FOR KNOWLEDGE CREATION & SHARING IN THE LONG RUN
WILL THESE RESOURCES BE DOMINATED BY RICH COUNTRIES?
I HAVE A HARD TIME CONNECTING REGIONAL POLICIES TO NATIONAL POLICIES
EU IS DEEPLY CONCERNED ABOUT SOCIAL CHALLENGES IN ALL FIELDS
A JOINT VISION
TECHNOLOGY FOR DNA EDITING...
RESEARCH SPENDING
European Commission


WHAT CONCRETE ACTIONS TO KICK-OFF IMPLEMENTATION OF THE LONG-TERM STRATEGY
REPORTS OF THE SIX PARALLEL SESSIONS & DISCUSSION
WHAT ARE THE CRUCIAL PO
CO - FUNDING
SHARE THE FUNDS
THE YOUNG PEOPLE MUST KNOW THE CHALLENGES
MAKE GLOBAL DATABASE AVAILABLE TO ALL
LARGE INITIATIVES NEED GREAT MANAGEMENT
INTEGRATE SYSTEMS TO MAINTAIN A SUSTAINABLE SOCIETY
COHERENT RESEARCH APPROACH
BIG
SMALL
PROMOTE AGRICULTURE TO REAL PEOPLE
WHAT CONCRETE ACTIONS DID THE GROUP RECOMMEND ?
WERE THERE ANY DEBATED QUESTIONS ON WHICH THERE WAS NO CONSENSUS & WHICH IS TO BE TAKEN FORWARD ?
MOTIVATION IS EVERYTHING ! FARMING IS NOT ATTRACTIVE - IT IS NOT SEXY
IMPORTANT ACTIONS ?
INTENSIVE LAND USAGE - WE CAN'T AFFORD
IMPACT IS OF ESSENCE
ALIGNING THE DIRECTION OF FARMERS AND RESEARCHERS
SHORTEN DISTANCE BETWEEN RESEARCHERS & FARMERS


④ THE GLOBAL DIMENSION: FOSTERING THE CONTRIBUTION OF EU RESEARCH & INNOVATION TOWARDS GLOBAL CHALLENGES THROUGH MULTI-LATERAL COOPERATION
WE ARE MISSING THE TRIANGULAR RESEARCH COOPERATION
EU
CHINA
AFRICA
WE CAN'T FUND PROJECTS WITHOUT SUSTAINABILITY
THE COMMISSION HAS TO OPTIMIZE SUSTAINABILITY OR IT IS A WASTE OF MONEY
⑤ FOSTERING SYNERGIES & COMPLEMENTARITIES BETWEEN PUBLIC & PRIVATE RESEARCH
THE BREEDING SECTOR IS READY FOR PARTNERSHIPS
RESEARCH INNOVATION TO BUSINESS
⑥ INTERACTIVE INNOVATION: THE ROLE OF DIFFERENT ACTORS IN CO-CREATING KNOWLEDGE, SHARING & EXPLOITING IT AT BEST
TREASURE
PARTNERS
HOW DO YOU FIND AND IDENTIFY NEW PARTNERS, OR TREASURE?
NETWORKING INTERNATIONALLY
WE HELP BREEDING FARMERS AVOID LOOSING THEIR CROP TO PLANT DISEASES...
WE HELP BRINGING PEOPLE TOGETHER
WE THINK PLANTS TO BENEFIT OF FARMERS AS PRIMARY RESOURCE OR IS IT?
IT IS IMPORTANT THAT BOTH FARMERS, THE INDUSTRY AND THE CONSUMERS TAKE PART


INTS TO TAKE INTO ACCOUNT TO SUCCESSFULLY IMPLEMENT... THE STRATEGY?
IT CAN BE HARD TO IMPLEMENT THE STRATEGY IN LESS ADVANCED COUNTRIES
BECAUSE OF:
SMALL PRODUCERS
NO ACCESS TO INFO
LOW EDUCATION
NO MOTIVATION
IMPROVED COMMUNICATION!
COMPREHENSIVE KNOWLEDGE FROM ALL RESEARCH PARTIES
HOW TO IMPLEMENT THIS STRATEGY?
EU LEVEL
NATIONAL
LEVEL OUT
Q HOW CAN WE MAKE IT MORE SIMPLE?
HOW DO WE PLAN TO USE THE INPUTS?
THIS DOCUMENT WILL BE OUR BLUEPRINT TO PREPARE THE NEXT 3 YEARS AND THINK BEYOND
RESEARCHERS MUST RESPOND TO FARMERS DEMANDS
FARMERS HAVE TO UNDERSTAND WHAT RESEARCH IS
EVERYTHING IS TOO COMPLICATED FOR THE FARMERS
WE COULD:
MOTIVATE FARMERS
MAKE OPERATIONAL GROUPS
YES YOU CAN!
BOTTOM UP APPROACH & METHODOLOGY MAKES IT EASIER TO BECOME INVOLVED IN THE PROJECT
BACK (EUROPEAN) STATE SHOULD ANALYSE THEIR SYSTEMS... NEED TO KNOW WHAT WE'VE GOT
JAIME SILVA TORRES
V. HAJIĆ
H. GUYOMARD
AGRICULTURE WILL ALWAYS PLAY AN IMPORTANT ROLE IN HEALTHY & HAPPY SOCIETIES
CLOSING OF THE CONFERENCE
MIHAIL DUMITRU
IT IS IMPORTANT THAT WE BUILD ON EXPERIENCE
SOCIETAL ENGAGEMENT
DEMANDS FOR SYSTEM APPROACH FOR RESEARCH
KNOWLEDGE AND DATA SHARING
WE HOPE TO SEE MORE RESEARCH AND SOLUTIONS IN THE FUTURE
STRATEGY
CARLOS MOEDAS
FUNDAMENTAL KNOWLEDGE
COMMUNICATION OF PRACTICES
YOUNG PEOPLE ARE BACK TO AGRICULTURE! THEY ARE BUILDING THE LINK BETWEEN THE PHYSICAL & DIGITAL WORLD
FUTURE SCIENTISTS WILL BE PASSIONATE!
AND THEY WILL CHANGE THE WAY WE REGARD SCIENCE
THEY ARE READY TO TAKE ACTION NOW AND NOT WAIT UNTIL TOMORROW
HOW TO USE THIS POSTER
YOU RECEIVE THIS POSTER...
REVISIT...
AND SHARE
BIGGER PICTURE .DK

Designing the path

A **strategic approach** to EU agricultural **research & innovation**

#EU_AgriResearch