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The Bio-Economy Concept and Knowledge Base in a Public Goods and Farmer Perspective

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Abstract. Currently an industrial perspective dominates the EU policy framework for a European bio-economy. The Commission's proposal on the bio-economy emphasises greater resource-efficiency, largely within an industrial perspective on global economic competitiveness, benefiting capital-intensive industries at higher levels of the value chain. However a responsible bio-economy must initially address the sustainable use of resources. Many farmers are not only commodity producers but also providers of quality food and managers of the eco-system. A public goods-oriented bio-economy emphasises agro-ecological methods, organic and low (external) input farming systems, ecosystem services, social innovation in multi-stakeholder collective practices and joint production of knowledge. The potential of farmers and SMEs to contribute to innovation must be fully recognised. This approach recognises the importance of local knowledge enhancing local capabilities, while also accommodating diversity and complexity. Therefore the bio-economy concept should have a much broader scope than the dominant one in European Commission innovation policy. Socio-economic research is needed to inform strategies, pathways and stakeholder cooperation towards sustainability goals.

Keywords. Bio-economy, public goods, European Union, agro-ecology, sustainable development, rural development

JEL-codes. Q20; Q57

1. Introduction

In February 2012 the European Commission announced its «Strategy for a sustainable bio-economy to ensure smart green growth in Europe». The strategy and action plan was called «Innovating for Sustainable Growth: a Bioeconomy for Europe». The goal is a more innovative, low-emissions economy which reconciles demands for sustainable agriculture and fisheries, food security and the sustainable use of renewable biological resources for industrial purposes, while also ensuring biodiversity and environmental protection. The plan focuses on three key aspects: developing new technologies and processes for the bio-

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economy; developing markets and competitiveness in bio-economy sectors; and pushing policymakers and stakeholders to work more closely together (European Commission, 2012a; 2012b; 2012c; 2012d).

EU strategy gives great importance to the bio-economy concept, so it is worth reflecting on what the concept really means. Across various scientific publications, papers, communications and comments of recent years, quite different definitions have been used for the bio-economy or the bio-based economy. The term bio-economy (synonymous with bioeconomy in this article) is used on its own, albeit with different meanings, as well as in conjunction with other terms like «innovation» or «knowledge base», e.g. Knowledge-Based Bio-Economy (KBBE). When looking at more recent statements of the European Commission, it seems that the bio-economy concept has had multiple meanings. Such diverse definitions make it difficult to understand which one is favoured by the European Commission's Strategy.

This paper will analyse those different definitions in order to identify aspects that are most relevant for a perspective favouring public goods, agro-ecological methods and farmers' knowledge. As we will demonstrate, there is a need to broaden and further develop the bio-economy concept along lines that give farmers' knowledge and public goods a more prominent role.

2. Defining the bio-economy

2.1 Definition of the bio-economy concept by the European Commission

According to an early definition, the bio-economy is «the sustainable, eco-efficient transformation of renewable biological resources into food, energy and other industrial products« (DG Research, 2005). This definition was used for the Knowledge-Based Bio-Economy (KBBE) in the Framework Programme 7 research agenda, especially in Theme 2 Cooperation: Food, Agriculture & Fisheries and Biotechnology (DG Research, 2006). Later the bio-economy concept was taken up for the Innovation Union, the economic growth model of the European Union, stating that the bio-economy represents only one but a very important sector (European Commission, 2010a).

The bio-economy is meant to achieve policy objectives that were listed in the first draft of the «European Strategy and Action plan towards a sustainable bio-based economy by 2020» (European Commission, 2010c). These objectives are in particular:

- reinforcing European leadership and creativity in the biosciences;
- optimising innovation and the systems for knowledge transfer;
- research into safe, nutritious and affordable food;
- making rural and coastal economies more sustainable;
- improving the efficiency of agricultural, food and industrial production and distribution systems;
- maintaining the competitiveness of European industry and agriculture;
- building low-carbon industries;
- reducing emissions of GHG and waste.

In order to prepare and to concretize the bio-economy strategy, the European Commission undertook several activities, such as an on-line consultation in spring 2011[1]. Furthermore, as mentioned in the Commission staff working document accompanying the document «A Bioeconomy for Europe», two independent experts groups produced crucial background information on the social, environmental and economic impacts of the bio-economy, as well as on skills (2012c: 8). The skills were identified as a key element to support the development of the bio-economy in Europe.

Several conferences and workshops on the bio-economy concept were organised in 2010-2011 by the European Commission and by European Technology Platforms, with the Commission's sponsorship.

The result of these activities appear in the Commission's February 2012 Communication entitled «Innovating for Sustainable Growth: a Bioeconomy for Europe» (European Commission, 2012c). This is one of the operational proposals of the Europe 2020 Strategy and its flagship initiative, «An Innovation Union», also contributing to other flagships such as «A Resource Efficient Europe». The Multi-annual Financial Framework for 2014-2020, and some of its key proposals, such as Horizon 2020 and the Common Agricultural Policy (CAP) post-2013, duly takes into account the bio-economy (European Commission, 2012c).

The Europe 2020 Strategy calls for a bio-economy as a key element for 'smart, sustainable and inclusive growth' in Europe (European Commission, 2010d). Advances in bio-economy research and innovation uptake are expected to allow Europe to improve the management of its renewable biological resources and to open new, diversified markets in food and bio-based products. Establishing a bio-economy in Europe holds a great potential: it can maintain and create economic growth and jobs in rural, coastal and industrial areas, reduce fossil fuel dependence and improve the economic and environmental sustainability of primary production and processing industries.

The Commission's 2012 Bioeconomy Strategy and its Action Plan aim to promote a more innovative, resource-efficient and competitive society that reconciles food security with the sustainable use of renewable resources for industrial purposes, while ensuring environmental protection (European Commission, 2012c). For the term 'bio-economy', the European Commission's public communication uses the following definition in their Bioeconomy NEWSLETTER February 2012:

> The term 'Bioeconomy' means an economy using biological resources from the land and sea as well as waste, including food wastes, as inputs to industry and energy production. It also covers the use of bio-based processes to green industries (European Commission, 2012b).

This definition emphasises biological resources and biomass as inputs to other industries, while omitting food as a major output, which was in the 2005-2006 definitions for FP7.

The Strategy and Bioeconomy Action Plan 2012 has been further developed since its first draft in 2010. Research and innovation are key components of the cross-cutting nature of the bio-economy, which is meant to address inter-connected societal challenges – including food security, natural resource scarcity, fossil resource dependence and climate change – in a comprehensive manner, while also achieving sustainable economic

[1] http://ec.europa.eu/research/consultations/bioeconomy/consultation_en.htm

growth. A key priority, for example, is «improving the knowledge base and fostering innovation for producing quality biomass (e.g. industrial crops) at a competitive price». This complements the pervasive emphasis on «enabling and industrial technologies», e.g. life sciences, biotechnology, nanotechnology and ICT (European Commission, 2012c: 4, 6; also 2012d: 5, 14).

In the Communication «Innovating for Sustainable Growth: A Bioeconomy for Europe», the Bioeconomy Action Plan 2012 rests on three main pillars:

1. investments in research, innovation and skills aimed at ensuring substantial EU and national funding, in synergy with Cohesion funds and CAP, as well as private investment;
2. reinforced policy interaction and stakeholder's engagement, through the creation of a Bioeconomy Panel, a Bioeconomy Observatory and regular Stakeholders Conferences that will contribute to enhancing synergies and coherence throughout the whole value chain;
3. enhancement of markets and competitiveness in bio-economy sectors by a sustainable intensification of primary production, a cascading use of biomass and waste streams as well as mutual learning mechanisms for improved resource efficiency (European Commission, 2012c).

EU intervention «is essential to provide the level of excellence and critical mass for research and innovation, which will play a fundamental role in the development of the Bioeconomy» (European Commission, 2012b).

We will next look how the EU's bio-economy concept is seen by different stakeholder groups and how it has evolved. Then we will explore linkages of the bio-economy concept with a public goods perspective on farming, social innovation, knowledge systems and rural development.

2.2 Towards a broader definition

In recent years the scientific and political arena has had lively discussions on the concept of 'bio-economy'. Basically there are two main views – one from an industrial perspective, and one from a public goods perspective – each promoting different futures for agricultural systems and farmers' roles.

A bio-economy perspective on further industrialising agriculture has come from the OECD and multinational companies. According to an OECD report on *The Bio-economy to 2030 – Designing a Policy Agenda,* the application means «transforming life science knowledge into new, sustainable, eco-efficient and competitive products» (OECD, 2008). A common definition has also been developed by several European Technology Platforms through the BECOTEPS project:

> The bio-economy is the sustainable production and conversion of biomass, for a range of food, health, fibre and industrial products and energy. Renewable biomass encompasses any biological material to be used as raw material (EPSO, 2011: 5).

Biomass including organic waste (broadly defined) is sought as a substitute for fossil fuels, and as a plant-based resource whose economic value must be extracted and trans-

formed. Plant structures are seen as a barrier which must be overcome, especially through genetic changes. Such views have resonance among some European Commission staff who see genetically redesigned biomass as an *El Dorado*, i.e. as a cornucopia linking renewable resources with intellectual property (original interview quotes in Levidow et al., 2012).

Also outside Europe there are political and commercial initiatives linked to the bio-economy and bio-based products such as in the United States, Japan, China, India and Brazil. In particular in the USA many research institutes and companies are dealing with biomass and biofuels (for references see USDA National library, http://www.nal.usda.gov). In September 2011 a report of the USDA was published on Bio-based Economy Indicators, which proposes indicators to assess various aspects of growth, profitability and uncertainty in the bio-economy. The definition of the bio-economy in this report is relatively narrow and relates to the «production and distribution of bio-based products». A definition of bio-based products was provided by the US Congress in the Farm Security and Rural Investment Act of 2002. Congress later modified the definition in the Food, Conservation, and Energy Act of 2008, stating:

> The term 'bio-based product' means a product to be a commercial or industrial product (other than food or feed) that is— (A) composed, in whole or in significant part, of biological products, including renewable domestic agricultural materials and forestry materials; or (B) an intermediate ingredient or feedstock (USDA, 2011).

However, focusing on bio-mass and bio-technology (in particular, based on genetic modification) constrains the development of the bio-economy by omitting industrial and economic sectors that produce, manage and otherwise exploit biological resources and related services, supply or consumer industries (such as agriculture, food, fisheries, forestry) and their associated industries (European Commission, 2009a).

Dominant industrial definitions have been criticised as too narrow, especially by downgrading the output of agriculture to biomass and/or emphasising novel food. The dominant perspective promotes food 'quality' as defined by measurable compositional characteristics, as in «functional food» (Levidow et al., 2012). This perspective neglects the contribution that agriculture makes to quality-food production (including speciality and traditional foods), the strong scientific advancement of traditional agronomic and food science, the contribution of farmers to rural development through social and organisational innovations, as well as public goods and the multiple ecosystem and social services that agriculture is delivering (e.g., Cooper et al. 2009). The Standing Committee on Agricultural Research (SCAR) financed a Third Foresight exercise which makes a similar criticism:

> In the KBBE concept, the human factor disappears, industry is considered the main player of the bio-economy and rural territories are only mentioned as beneficiaries. In other words, the framework built around KBBE covers only a part of what agriculture is and should be. On this regard one can detect several contradictions with recent EU elaboration around agriculture and rural development (Freibauer et al., 2011: 7).

To ensure the long-term economic growth of the Bioeconomy, the definition should be non-restrictive. A former Agricultural Commissioner, Franz Fischler, defined the Knowledge-Based Bio-Economy more broadly as:

Production paradigms that rely on biological processes and, as with natural ecosystems, use natural inputs, expend minimum amounts of energy and do not produce waste as all materials discarded by one process are inputs for another process and are re-used in the ecosystem (European Commission, 2010b).

This definition explicitly considers recycling within the production process itself, not only the output.

2.3 Synergies and inconsistencies between different approaches

A more detailed literature analysis shows that there are tensions among different definitions, concepts and emphases of the 'bio-economy', even within European Commission documents. The tensions are illustrated by the following examples:

- A broad concept is being promoted at the public-relations level, e.g. emphasising 'local and tacit knowledge' and social sciences (European Commission, 2012a: 1). The importance of social innovation, public goods and farmers is emphasised in the Staff Working Document accompanying the Bioeconomy Strategy (2012d), yet this is not the case in the Bioeconomy Action Plan (2012c). But a narrower definition apparently guides R&D priorities, especially for Horizon 2020, the successor to Framework Programme 7.
- Definitions favouring biomass production and transformation emphasise capital-intensive inputs for agriculture and biomass processing technologies. These favour the upper levels of value chains, while devaluing the knowledge and capabilities of farmers, who become mere recipients of lab knowledge and its products.
- The potential of farmers and SMEs to contribute to innovation is not fully recognised in all relevant documents. Rarely mentioned is the importance of local knowledge and local capabilities to better accommodate diversity and complexity.
- The Commission's definitions also seek to feed expanding global markets for agri-inputs and outputs, thus reinforcing pressures on renewable resources.
- Bio-economy has been linked with the concepts of eco-efficiency and/or resource efficiency, which likewise have diverse meanings: unstated is which efficiency, by what means, and for what aims.
- Policy documents sometimes mention public goods – the concept itself and/or specific examples. But only some definitions of the bio-economy give priority to maintaining public goods. And that priority conflicts with a definition that emphasises industrial biomass development.

A wider working definition of bio-based economy was used in the report of one of the external expert group of DG Research of EU Commission on social, economic and environmental implications of a bio-based economy (Menrad et al., 2011: 6). The report looked more at synergies between the different concepts:

The bio-economy covers, in principle, all production systems involving biophysical and biochemical processes, and thus includes all of the life sciences and related generic technologies necessary to make useful products. It responds to the innovation needs of a broad range of farming systems, including fish farming, supports developments such as low input organic and conservation agri-

culture and fisheries, precision farming and production in urban and peri-urban environments. It includes the promotion of healthy food derived from sustainable systems that exploit technology to produce efficiently while maintaining our environment and protecting biodiversity. Applications of biotechnology in agriculture and industry, such for bio-refineries, bio-energy and bio-chemicals, are an integral part of the bio-based economy. It also includes novel forms of land and sea usage (such as those enhancing ecosystems services and other public goods) as well as the use of materials currently considered as wastes .

On those grounds, as the report further argues, the European bio-based economy has to be broadly defined:

- one based on the full range of ecosystems, land and sea resources, biodiversity and biological materials (plant, animal and microbe), food processing, and food consumption;
- encompassing existing sectors of agriculture, forestry, fisheries, food, biotechnology and chemical industry and
- contributing to the sustainable growth and production of food, feed, energy and renewable materials as well to the development of rural and coastal areas (Menrad et al., 2011: 6).

A partially broader bio-economy concept appears in the European Commission Communication of February 2012 on the «Bio-economy for Europe» and especially in the related Staff Working Document (2012d), which incorporates views from the public consultation and the expert impact assessment. The latter document mentions that the bio-economy strategy will support ecosystem-based management and that it will seek synergies with the Common Agriculture Policy (CAP) Common Fisheries Policy (CFP), Integrated Maritime Policy (IMP), the Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD). Mentioned also are the EU environmental policies on resource efficiency, sustainable use of natural resources, protection of biodiversity and habitats and provision of ecosystem services. However the full potential of an integrated bio-economy needs to be developed more through linkages with public goods and a more prominent role for farmers.

3. Concepts of food quality and public goods: linkages with the bio-economy

Although the 'bio-economy' concept dates only from 2005, relevant components in the agriculture sector have a very long history. A lot of knowledge, understanding, traditional technologies and infrastructure have been developed, creating value not only through commodities but also through ecosystem and social services including food cultures. Agriculture is intertwined with public goods which depend on farmers' collective knowledge. The concept of multi-functional agriculture is widely established in Europe (e.g. Piorr and Müller, 2009) but is ignored in the current bio-economy concept of the European Commission.

European agriculture has an economic opportunity by producing food of high quality, which is a central plank of the Common Agricultural Policy. In this context the European Commission refers broadly to food quality: beyond food safety and nutritional value, food

quality includes 'farming attributes' – e.g., production method, type of animal husbandry, use of processing techniques, place of farming and of production, etc. (European Commission, 2009b).

The Common Agricultural Policy recognises also the co-production of public goods in particular in the context of the rural development programme (Pillar II). This public goods perspective should be taken into account in an integrated, more broadly defined bio-economy. What do we mean by public goods related to the bio-economy? What definition of public goods is most relevant here? What do public goods imply for the bio-economy and its priorities?

3.1 Defining environmental and social public goods in agri-forest sectors

Industries that rely on biological processes and resources, such as those in the bio-economy, have intense interactions with the environment throughout the production cycle. Such processes therefore are fundamentally intertwined with public goods, which can be either enhanced or undermined. True public goods exhibit two defining characteristics; they are both:

- Non-excludable: if the good is available to one person, then others cannot be excluded from the benefits that it confers.
- Non-rival: if the good is consumed by one person, then it does not reduce the amount available to others (Mankiw, 2010).

When referring to the bio-economy (including the sectors of agriculture, forestry, fisheries, food, feed, chemicals and bio-energy) the most significant public goods are:

- Environmental public goods: agricultural and forested landscape; farmland and forest biodiversity; water quality and availability; soil functionality, climate stability (greenhouse gas emissions, carbon storage), air quality, resilience to flooding and fire;
- Social public goods: food security and food culture; rural vitality; animal welfare and health (adapted from Cooper et al., 2009).

Given the relationship between the sectors in the bio-economy and environmental public goods, activities within the bio-economy sectors that generate negative externalities can directly undermine the productivity of the bio-economy. For example if the ecological value diminishes over time, such as soil fertility or resilience to flooding, this will directly undermine the bio-economy and with that also the whole economy.

Public goods provide a direct social function. The European public places a high value on public goods, showing widespread concern for environmental issues especially with regard to biodiversity loss, mitigation of climate change, water and air pollution, and in particular the depletion of natural resources, including soil quality. There are also a number of secondary social and economic benefits that depend, partially or wholly, on the existence of the public goods provided by agriculture (Cooper et al., 2009). Therefore including public goods in the bio-economy concept may ensure real, continuous short- and long-term economic growth based on ecological, social, and economically sustainable systems.

3.2 Farming systems and public goods

All types of farming systems and methods can provide public goods if the land is managed appropriately. However there are significant differences in the type and amount of public goods that are provided by different types of farms and farming systems in Europe. Already a number of specific farming systems, and the practices employed within them, are particularly important for the provision of public goods.

These include more extensive livestock and mixed systems, the more traditional permanent crop systems and organic farming systems. There may also be a large potential for highly productive farming systems to adopt environmentally beneficial production methods and thereby to provide public goods (for more information refer to Cooper et al., 2009).

Building and maintaining a farming landscape with diverse assets, able to perform multiple functions (ecosystem services) and therefore enhance public goods, will help to open up more options for adaptation to environmental and socio-economic changes. This approach will require coordinated and long-term planning, so there is a need to combine research on agro-ecological, social and institutional aspects at different scales (Schmid et al., 2009).

Agro-ecological methods draw upon local natural resources, ecological processes and farmers' knowledge of them. Bio-diverse farming systems with lower dependence on external resources avoid the endemic stresses of monoculture systems and climate change, thus reducing the risk of epizootic and zoonotic diseases and food-related disorders. Agro-ecological, low-input and organic farming methods are important for maintaining and linking on-farm resources – e.g. soil fertility, plant genetic diversity and bio-control methods. Furthermore, by re-linking production and consumption patterns, this further reduces dependence upon external inputs, thus moving towards greater self-sufficiency (Niggli et al., 2008: 29; Schmid et al., 2009). For those reasons, many civil society organisations have argued that 'Agro-ecological forms of production must be defined as the standard form of production in the EU' (Food SovCap, 2010).

In the food sector there is a need to balance innovation (new knowledge) with tradition (old existing knowledge). Many European quality food labels are based on traditional products and are preferred by consumers because of this. In the past, technology in food and farming has created not only economic growth but environmental and public health risks. In the recent history of the food sector, there are several examples where technological development has caused major food scandals. The most prominent example is BSE, which prompted the European Union to move towards ensuring a high level of food safety, as expressed in a *White Paper on Food Safety* (European Commission, 1999). Therefore consumers have good reasons to seek re-assurance in traditional food products, rather than trust that all techno-industrial development in the food sector is always good for them.

A broader, systems-based approach to agri-food innovation in the bio-economy can help to turn research into economic growth whilst at the same time providing public goods. A more diverse, robust bio-economy is less vulnerable to external shocks such as erratic climatic behaviour or resource scarcities – e.g. fertile land, freshwater, phosphorous and biodiversity. Such an approach will create more resource protection, resource-use efficiency, business diversification and agricultural resilience. These offer added value and a more equitable distribution of wealth (Padel et al. 2010).

Farmers are being encouraged to increase productivity, which can have different meanings. From a public goods perspective, it can mean fewer external inputs needed for the same output and/or higher-quality outputs, e.g. through eco-functional intensification (Niggli et al. 2007). Practices protecting natural resources depend upon farmers gaining a greater share of value added in the agro-food chain. Also the Commission's Communication on Agricultural Productivity and Sustainability suggests the need for greater productivity:

> The increase in output must go hand in hand with improved economic viability for primary producers who have suffered a declining share of value-added in the food chain over the past decade. Without greater farm profitability, ecological sustainability will become even more challenging (European Commission, 2012e: 3).

According to that document, moreover, «Innovative solutions should be adapted to the whole supply chain as well as the growing bio-based economy. Solutions should be sought for bio-refinery and recycling and the smart use of biomass…» (European Commission, 2012e: 8). Such solutions include on-farm agro-ecological recycling of organic matter to produce energy and other inputs for agriculture (Niggli et al, 2008: 34; Schmid et al., 2009: 59).

Short food-supply chains provide means to remunerate agro-ecological methods via greater market demand, alongside closer relations between producers and consumers. These relations depend on consumer knowledge and trust of agricultural production methods and/or 'quality' labels (Karner, 2011; Knickel et al., 2008; Levidow, 2008). Such supply chains thereby provide financial and social incentives for methods that conserve or even enhance natural resources.

Moreover, a participatory approach to knowledge and innovation with regards to the delivery of public goods from agricultural practices can add value to the bio-economy and help create economic instruments that promote an appropriate balance between private and public goods. At the farm, watershed, district and national scales, new methods may be needed to assess and improve the performance of farming systems in relation to the multiple functions of agriculture, as outlined in the IAASTD synthesis report (McIntyre et al., 2009).

As an economic community and a society, Europe is in a unique position to achieve a bio-economy that provides both market and public goods. Both can be achieved through innovation, especially the wider development and application of agro-ecological knowledge. Of particular importance becomes social innovation (explained below).

The Common Agricultural Policy (CAP) has opportunities to promote public goods through support measures, both directly and indirectly. For example, climate change can be mitigated by reducing energy inputs and enhancing soil organic carbon, which also improves soil fertility. The post-2013 CAP aims to promote «improvements in energy efficiency, biomass and renewable energy production, carbon sequestration and protection of carbon in soils based on innovation» (European Commission, 2010e: 5). Likewise, «Mitigation action should relate to both limiting emissions in agriculture and forestry from key activities such as livestock production, fertilizer use and to preserving the carbon sinks and enhancing carbon sequestration with regard to land use, land use change and the forestry sector» (European Commission, 2011a: 11; also European Commission, 2012e: 8).

Farmers need support measures «in adopting and maintaining farming systems and practices that are particularly favourable to environmental and climate objectives, because

market prices do not reflect the provision of such public goods» (European Commission, 2011: 5). Such public goods can be provided by agro-ecological methods, which therefore warrant greater support measures. On-farm energy production, via organic recycling of bio-wastes, provides an extra means to reduce external energy inputs.

3.3 Social innovation and knowledge base

Social innovations are widely referred to in the context of health and education and feature prominently in Innovation Union documents (e.g. European Commission, 2012c: 7, 2012d: 18-19). Social innovations aim for the empowerment of groups facing common problems and address dysfunctional markets by deploying non-monetary resources and rules of partnership and collaboration (BEPA, 2009, 2010). Such activity has clear relevance to the bio-economy, especially for public goods.

As outlined in a report by the SCAR Working Group on Agricultural Knowledge and Innovation Systems (AKIS), a distinction is necessary between science-driven research and innovation-driven research (EU SCAR, 2012: 101). In the latter perspective, innovation is seen as a bottom-up, interactive social process, rather than top-down from science to implementation. Even very technical innovations are socially embedded in a process involving clients and advisors. Often partners are needed to implement an innovation.

> As innovation is a risky business and benefits from the exchange of ideas, learning and innovation networks have proven to be an adequate vehicle for empowering groups of farmers to investigate new options to make their business more viable or sustainable (EU SCAR, 2012: 9).

Social innovation refers to more than social aspects of the innovation process or the aim that innovations should also be sustainable in the sense understood by corporate social responsibility (Freibauer et al., 2011: 90). Social innovation also highlights the fact that social problems need innovative approaches. Such problems include rural development in Europe's lagging regions with declining populations, decreasing (governmental) service levels and (sometimes) uncompetitive agriculture. Agro-food systems have developed many forms of social innovation (EU SCAR, 2012: 50-60). In poor neighbourhoods of big cities with high rates of unemployment and obesity, social innovation with urban farming and food projects can contribute to a better quality of life (EU SCAR, 2012: 101; Karner, 2011).

A sustainable development of the bio-economy requires, first of all, not only a broader definition of the term «bio-economy» but also a wide understanding of the necessary knowledge base. In its above report the SCAR AKIS working group recommends building on models of joint knowledge-production, spanning the boundary between knowledge generators and users (EU SCAR, 2012: 32, 42). This implies that expertise is sought in multiple forms from academics, practitioners, businesses, land managers and the public, all of whom can make valuable contributions to the knowledge base. Scientific and non-scientific knowledge can be mutually enriching.

The joint production of knowledge model underlines the need to move from ideas about one-way «knowledge transfer» to processes that will facilitate «knowledge exchange». Indeed, «This evolution towards a knowledge exchange approach should enable greater

participation in comparison with a knowledge transfer approach» (EU SCAR, 2012: 75). Such a joint participatory model for knowledge-production should overcome the boundaries between knowledge generators and users, while respecting and benefitting from a transparent division of tasks. It recognises the importance of local knowledge and leads to the enhancement of local capabilities, while also accommodating diversity and complexity (Padel et al. 2010: 58; Padel et al., 2011). Here farmers and SMEs have an important role.

3.4 New structures and partnerships for providing public goods

As a multi-functional activity, agriculture has a fundamental role in the economy, especially in the bio-economy by producing food as well as delivering public goods and services. European national governments seem unlikely to restore their previous role as leading investors in agricultural research. Therefore we need new structures and partnerships for the direction and delivery of public agricultural research that reconsider the public goods aspects of the knowledge and technology outputs required. By 'public goods' in research outputs we mean those that are largely in the public domain and whose consumption is non-rival and so available to different uses and users.

According to Technology Platform Organics, this means:

> The creation of a green low-waste production chain, that is also able to secure food supply in the context of climate change and growing population can span from improved management systems that minimize inputs at the land/sea level and throughout the supply chain. Farmers' collective knowledge of natural resources, ecological processes and product quality, can be used as a basis to minimise dependence on external inputs and gain societal support. Shorter agro-food chains based on consumers' trust and greater proximity to producers can also be seen as a basis of a low-waste production chain, whilst addressing consumer demands for high quality food, taking into account animal welfare (TP Organics, 2011).

The bio-economy directly links innovation to economic growth. It is therefore important that the knowledge base of the bio-economy is non-restrictive. In order to increase productivity whilst maximising the efficiency of resource use and minimising the impact on the environment, innovation is needed not only in scientific research and technological development, but also in all areas of the bio-economy. This has to involve many stakeholders – in particular farmers, foresters, fishermen, advisory services – and all industries involved in the supply chain, as well as consumers and society at large. According to a linear model of innovation, however, a new technological development is patented with the expectation that its products will be purchased by farmers (EU SCAR, 2012: 15-17); this model marginalises the potential for innovation and thus for greater economic development of entire industries and sectors, thus restricting the bio-economy. To enhance public goods, Europe needs policy support measures for a broader bio-economy: 'Societal interests (or public goods related demands) tend to be – by definition – not adequately addressed through market demand and demand-driven approaches' (EU SCAR, 2012: 41).

Farmers, processors and other actors throughout the food chain are experimenting regularly and are generating innovations, as they have done since agriculture began (Hoffman et al., 2007). Farmers bring experience from their lifelong work on one complex farm experiment, which includes a largely tacit body of knowledge. This requires the uti-

lisation of group approaches, and encouragement of producer ownership of the problems and solutions. These experiments in social innovation take many forms – e.g. community-supported agriculture, short food-supply chains, and territorial labels – bringing consumers closer to producers, especially through better knowledge of agro-ecological production methods. Public knowledge systems are needed to help promote those innovations and thus the public goods that they generate (Levidow et al., 2012).

Extension (or advisory) services can play an important role, as increasingly recognised in Europe. However, these advisory services have declined in most EU member states over the past decades; at the same time, agricultural research has become more distant from farmers' knowledge. This process should be reversed. The post-2013 CAP plans to promote farm advisory services, mainly so that farmers can fulfil their statutory obligations relevant to sustainable development (European Commission, 2011). These services could also help to integrate agro-ecological methods with closer relations between producers, retailers and consumers.

Only when there is cooperation among producers and all other actors along the supply chain will the European bio-economy fulfil its potential. Involving all levels of supply chains in the knowledge-base could lead to a better-managed system addressing the problems set out in the EU Bioeconomy Action Plan. Farmers and SMEs have been a major source of innovation and knowledge in the food and farming sector in the past. Their potential to drive innovation for the future needs to be recognised and supported.

3.5 Bio-economy and rural development

Rural development can be promoted through a bio-economy. This linkage is mentioned by the European Commission's Communication on the «Bio-economy for Europe», as well as the related Staff Working Document:

> The bio-economy can significantly contribute to the future development of rural and coastal areas because it will promote both supply and demand actions with regional dimension, such as the creation of supply chains for residues and waste as feedstock for bio-based industries, setting up of a network of small-scale local biorefineries or developing aquaculture infrastructures (European Commission, 2012d: 18).

This aim could be supported by future Cohesion Policy as well as by the reformed CAP. Both in Pillar I and Pillar II of a revised CAP there will be more possibilities to support the sustainable production of biomass for purposes other than food and feed. Examples are coupling farmers' area payments for specific desired products for energy or material use with specific sustainability requirements (Menrad et al. 2011: 93).

To what degree new biomass processing and bioenergy plants will create new employment and income will depend on policies, which could favour either more large-scale centralized businesses or else more decentralised systems with stronger involvement of farmers. Along the latter lines, a bio-economy more oriented to public goods could create additional opportunities for rural development, such as by:

- Enhancing the landscape value and quality of life in rural areas as basis for other agricultural activity such as agro-tourism and eco-tourism, including its economic value for rural development.

- Supporting green-care entrepreneurship: Green care refers to the utilisation of farms – farm animals, plants, gardens, forest, and landscape – as a base for promoting mental and physical health and quality of life for a variety of client groups.
- Linking agriculture with energy production by recycling bio-waste at farm level, thus reducing input costs and GHG emissions.
- Building short food-supply chains that remunerate farmers for agro-ecological methods.
- Enhancing resilience of bio-diverse agro-food systems through in-built protection from threats of epizootic disease.
- Creating attractive employment for professionals in the field of agriculture, horticulture, food processing and nursing services.

4. Conclusions

Currently an industrial perspective dominates the EU policy framework for a European bio-economy. A broad concept is being promoted at the public-relations level, but a narrower one apparently drives the EU's R&D priorities. The latter perspective is promoted by stakeholders who foresee further industrialising agriculture as an opportunity for a 'gold rush', opening up a boundless cornucopia of 'renewable resources'. The Commission's proposal on the bio-economy emphasises greater resource-efficiency, largely within an industrial perspective on global economic competitiveness, benefiting mainly capital-intensive industries at higher levels of the value chain.

However a responsible bio-economy must initially address the sustainable use of scarce natural resources – such as soil, water and biodiversity – many of which are public goods. Farmers should be seen not only as commodity producers but also as providers of quality food, as managers of the agricultural eco-system and landscape and as contributors to rural development. A public goods-oriented concept of the bio-economy emphasises agro-ecological methods, the organic and low (external) input food and farming sector, ecosystem services and social innovation.

Therefore the bio-economy concept should have a much broader scope than the dominant one expressed in the European Commission innovation policy. We need integrated, comprehensive and sustainable approaches towards innovation by carefully developing future systems of natural resource use, both within and beyond agriculture. This also needs multi-stakeholder partnerships involving a broad range of civil society groups, including farmers, scientists, SMEs and consumers in addition to representations of various sectors of bio-based industries.

The potential of farmers and SMEs to contribute to innovation in the food and farming sector must be fully recognised. They can contribute to a joint production of knowledge. The knowledge base of the bio-economy needs a move away from the classical top-down 'knowledge transfer' towards processes that facilitate 'knowledge exchange'. This approach recognises the importance of local and tacit knowledge, which encompasses different types of expertise, enhances local capabilities, and accommodates diversity and complexity. An important feature is social innovation in multi-stakeholder collective practices and knowledge-production.

In sum, special efforts are necessary to ensure that the EU initiative for a «Knowledge Based Bio-Economy» will become a contribution to sustainable development, espe-

cially to ensure the delivery of societal benefits and public goods. As an academic article has argued, «proposed solutions to environmental sustainability challenges are often orientated towards the partisan agendas of dominant stakeholders and myopic technological fixes, while marginalising other civil society actors and critical insights from social science» (Diedrich et al., 2011: 937). Socio-economic research is needed to inform strategies, pathways and stakeholder cooperation towards sustainability goals.

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