Chapter 9. Contending European Agendas for Agricultural Innovation

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Abstract

Amid expectations for a European 'transition to sustainable agriculture', there are competing transitional processes. Given the widely acknowledged harm from agro-industrial systems, unsustainable agriculture has divergent diagnoses and innovative solutions. In the EU policy context of a Knowledge-Based Bio-Economy (KBBE), there are also divergent accounts of its key terms: biological resources, economy, relevant knowledge and knowledge-producers. These accounts can be analysed as contending agendas for future agriculture.

The dominant agenda favours laboratory-based techno-scientific innovation as a means to use renewable resources more efficiently for competitive advantage in global value chains. Agriculture potentially becomes a factory for capital-intensive inputs to produce decomposable biomass for novel processes and industrial products. By contrast, a marginal agenda promotes farmers' knowledge of natural resources, especially via agro-ecological methods, alongside agro-food-energy re-localisation. Through short supply chains that valorise a comprehensive identity for agro-food products, producers can gain more of the value that they add.

These agendas contend for influence over EU research priorities. Through their divergent agendas, stakeholders also promote different power relations: between farmers, the agro-input supply industry, research institutions, knowledge and markets.

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1. INTRODUCTION

Since the 1990s 'sustainable development' has become a mainstream slogan. As agro-industrial systems are put onto the defensive, their sustainability problems are diagnosed in ways favouring different pathways of agricultural innovation and techno-scientific knowledge. Originally the term 'sustainable agriculture' meant alternatives to intensive cultivation methods and farmer dependence on the agro-food industry. Since the 1990s the term has been appropriated for a future high-yield agriculture driven by agribusiness, especially through the Life Sciences.

As these divergent accounts contend for influence over policy and resources, 'sustainable agriculture' has become an ambiguous and contentious concept. Amid optimistic expectations for a European 'transition to sustainable agriculture', there are competing transitional processes. Each has its own agenda for ordering the future. Although one pathway may dominate, others will persist (van der Ploeg, 2008).

Given that the term 'sustainable agriculture' encompasses divergent meanings, why does it matter? The academic literature has various answers to this question. Some scholars regard the terminological ambiguity as a flaw that must be mended, e.g. through scientific rigour for a standard definition. Or they propose to reject the concept of sustainable development as inoperable. Others see its ambiguity as an inherent feature – and as an advantage for bringing together multiple parties to deal with the complex, socially contested issues surrounding sustainability (van Mierlo et al., 2010: 114).

Although that advantage may be realised in some circumstances, the terminological ambiguity generally helps dominant political-economic interests to promote techno-fixes for sustainable agriculture, while marginalising other approaches. Meanwhile policy frameworks use the term 'sustainable agriculture' as if its meaning were consensual, thus obscuring societal choices. European policy frameworks for 'multifunctional agriculture' generally accept the dominant account of capital-intensive innovation for economic competitiveness, while also marginally accommodating less competitive agricultures and/or public goods such as ecosystem services. This narrative can obscure societal choices, as if policy were simply pursuing external market forces.

To highlight such choices, this paper will explore the following questions:

- What are the main accounts of innovation for sustainable agriculture?
- How does each account diagnose unsustainability, propose solutions and favour specific R&D priorities?
- How does each account give different meanings to the same key terms? e.g. innovation, knowledge, natural resources, etc.

To explore those questions, the paper focuses on a case study: EU-level stakeholders' agendas for agricultural innovation and their efforts to influence research priorities. Although comprising only 5% of all European public-sector research funds, EU Framework Programmes have great importance: they set agendas which both express and influence wider research priorities. Although they are a special case, EU research priorities are particularly significant as symbolic and material investments in a future vision for society.

The paper draws on information from a European research project (see Acknowledgements). Sources include: stakeholder proposals, policy documents, research programmes and interviews with key actors (though none are quoted here).

2. AGRICULTURAL INNOVATION: ANALYTICAL FRAMEWORKS

Different accounts of sustainable agriculture have been illuminated by several analytical concepts, e.g. innovation as socio-technical systems, and innovation as divergent paradigms. These will be discussed in turn.

2.1. Socio-technical systems

As an analytical concept, socio-technical systems are meant to explain transitions from one system to another. A socio-cultural regime denotes various cognitive and normative rules as expressed in policy, science, users, markets, etc. Any regime provides niches for radical innovation – which can eventually change the regime. The socio-technical landscape denotes aspects of the wider political-economic environment, beyond the direct influence of niche and regime actors; changes here occur slowly, perhaps over decades. Together these three components – niche, regime, landscape– comprise the multi-level perspective. In key diagrams of this perspective, directional arrows move from niche to regime to landscape, whereby the components comprise a 'nested hierarchy' (Geels, 2004: 913; Geels and Schot, 2007: 401).

In response to criticism, the framework has been elaborated to emphasise societal struggles for influence over innovation choices: "When new technologies emerge, … social groups have different problem definitions and interpretations, leading them to explore different solutions. This variety of meanings is eventually reduced through 'closure', an inter-group process of negotiations and coalition building….. In this socio-cognitive institutionalisation process, actors directly negotiate about rules (belief systems, interpretations, guiding principles, regulations, roles). This dynamic is played out at conferences, in journals, at workshops, struggles for research grants, etc. … actors try to make sense, change perceptions as they go along, engage in power struggles, lobby for favourable regulations, and compete in markets" (Geels and Schot, 2007: 405).

In that process, a landscape may respond to a regime change and/or facilitate such change. "Socio-technical landscapes do not determine, but provide deep-structural 'gradients of force' that make some actions easier than others…. Landscape changes only exert pressure if they are perceived and acted upon by regime actors…. Societal pressure groups and social movements may voice protest and demand solutions. They can mobilise public opinion and lobby for tougher regulations. Outside professional scientists or engineers may have specialist knowledge that allows them to criticise technical details of regimes and propose alternative courses of action. Outsider firms, entrepreneurs or activists may develop alternative practices or technologies" (ibid: 403, 406).

How do different actors contend for influence over innovation agendas? Such an analysis may unduly stretch the regime concept within the analytical framework of socio-technical systems. So let us turn to the 'paradigm' concept, which has already been elaborated to analyse conflicts around agro-food systems. In general a paradigm is an explanatory model or problem diagnosis, which favours specific types of solutions.

2.2. Contending paradigms of sustainable agriculture

Since the 1970s agro-industrial systems have been put onto the defensive for causing various types of damage such as soil degradation, vulnerability to pests, greater dependence on agrochemicals, pollution, genetic erosion and uniformity, etc. Diverse remedies have been promoted in the name of sustainable agriculture. Originally this term referred to producers developing alternatives to crop monocultures, e.g. via less intensive and agro-ecological methods, as a basis for independence from the agricultural supply industry. Soon the term 'sustainable agriculture' was recast to mean a future high-yield productivist agriculture based on capital-intensive inputs. The Life Sciences propose remedies through 'sustainable intensification', thanks to genetically precise changes, which can protect crops from external threats.

Regardless of success in its own terms, this pathway conflicts with other European accounts of 'sustainable agriculture', which has been increasingly defined by distinct cultural values, linking the quality of food products, rural space and livelihoods with consumer support. Although chemical-intensive methods still prevail, the countryside has increasingly been regarded as an environmental issue, variously understood – e.g. as an aesthetic landscape, a wildlife habitat, local heritage, a stewardship role for farmers and their economic independence.

Towards those aims, farmers often develop modest innovations, e.g. substituting their knowledge for external inputs, thereby linking environmental with economic sustainability; but these innovations are often dismissed as inadequately novel or as elusive for government bureaucracies (SCAR FEG, 2007: 8; van der Ploeg, 2008). More fundamentally, research agendas have become more distant from producers' knowledge, while favouring specialist laboratory knowledge for agricultural inputs and processing methods. According to an expert report, commissioned by the EU's Standing Committee on Agricultural Research (SCAR): "European agricultural research is currently not delivering the type of knowledge which is needed by end-users in rural communities as they embark on the transition to the rural knowledge-based bio-society. The problems are not exclusive to agricultural research but they are felt more acutely in this sector where the role of traditional, indigenous knowledge is already being undermined as a result of the growing disconnection with ongoing research activity" (SCAR FEG, 2007: 11).

What explains that gap between farmers' practices and agricultural research? According to the dominant agenda, farmers have failed to keep up with techno-scientific advances. Yet SCAR's 2nd foresight report diagnosed a long-standing problem: member states have been dismantling the institutional basis for disinterested science, public good training and extension services, thus undermining farmers' knowledge. As a remedy, the report advocated agro-ecological approaches, *in situ* genetic diversity, farmers' knowledge, etc., especially as means to enhance food security – by contrast to remedies based on lab science, e.g. ag-biotech. Actors promote different paradigms of problem-diagnoses and solutions (SCAR FEG, 2008). Divergent agendas use similar terms in their own distinctive ways. As climate change potentially destabilises agricultural systems, vulnerability becomes a threat to be addressed through various adaptive means. Resilience has emerged as a consensual concept for addressing such vulnerability: "Despite this consensus, different paradigms claim to have the solution to the challenges of the next and following decades. One yet-to-be-realised paradigm is focused on mobilising science and technology to increase resilience to shocks, reduction of dependence on external resources (and on fossil fuels in particular), open-source exchange of information and biological materials, and a strong involvement of farmers and other societal actors in co-researching the ways forward. Another, commercially dominant paradigm, relies on industry-led technological innovations, on markets, and on proprietary knowledge", (SCAR FEG, 2008: 56).

In the dominant account, resilience means 'the capacity of a system to experience shocks while retaining essentially the same functions and structures'. This definition understands vulnerability as occasional shocks, which warrant remedial or adaptive measures. By contrast, other accounts diagnose a systemic stress from agro-industrial monoculture systems (Jackson et al., 2010: 80). Such interpretive differences indicate contending paradigms of sustainable agriculture, as a potential basis to identify synergies and/or conflicts between them (SCAR FEG, 2008: 67).

Agricultural development pathways have been theorised as contending paradigms in several ways. Agricultural research agendas have favoured a biotechnological paradigm over an agro-ecological one, whose incremental farmer-led improvements are not officially seen as innovations. A combination of factors has generally locked in biotech, while locking out agro-ecology, especially in public-sector research priorities. 'The issue is thus how to break out of this lock-in situation, as incremental progress is just not enough…' (Vanloqueren and Baret, 2009: 980). An analogous typology is Life Sciences versus Ecologically Integrated methods (Lang and Heasman, 2004). With a different focus on product quality, another binary typology is decomposability versus comprehensive product identity (Allaire and Wolf, 2004).

Contending accounts of sustainable agriculture can be analysed by combining those typologies. The dominant agenda combines Life Sciences and decomposability, while other agendas combine agro-ecology and comprehensive product identity (see Table 1 and also Levidow et al., 2012). Through these paradigms, stakeholder networks pursue their different agendas for the future. The next section examines the dominant account, while the subsequent one examines marginal accounts. The analysis focuses on arable agriculture and its links with energy production, especially in the EU policy context of the Knowledge-Based Bio-Economy (KBBE), although this concept also encompasses animal husbandry, forestry and aquaculture.

Table 1: Contending Paradigms of Agricultural Innovation

	Dominant	**Marginal**
Paradigms		
Techno-scientific engineering paradigm (paraphrasing Vanloqueren & Baret, 2009)	Genetic engineering and life sciences: modifying plants for greater productivity or for new objectives, e.g. nutritional content, via capital-intensive knowledge production.	Agro-ecological engineering: designing agricultural systems that minimise need for external inputs, instead relying on ecological interactions.
Quality in socio-technical paradigm (paraphrasing Allaire & Wolf, 2004)	Decomposability of qualities, via converging technologies, for recomposition into profitable combinations for extra market value.	Integral/comprehensive product identity via holistic methods and quality characteristics recognisable by consumers, as a basis for their support.
Knowledge in socio-technical paradigm (paraphrasing Allaire & Wolf, 2004)	Computable data for novel inputs and/or outputs, which can gain market advantage, by correlating compositional qualities with product characteristics.	Knowledge for validating comprehensive product identities of various kinds, e.g. organic certification, agro-ecological production methods, territorial characteristics, specialty products, farmers' markets, etc.

3. Life Sciences and global value chains as the dominant KBBE

The Knowledge-Based Bio-Economy (KBBE) concept addresses the problem of unsustainable agriculture: conventional dependence on agrochemicals, as well as degradation and constraints of resources, alongside competing demands for land use. In the initial vision of the KBBE: "The EU's ambition to build the world's most competitive knowledge-based economy implies the existence of an efficient and effective knowledge-based bio-economy: a sustainable economy based on renewable resources. This will help wean Europe off its dependence on diminishing oil supplies and will enable it to better compete with fossil-fuel rich areas of the world by levelling the energy playing field. It will also lead to the creation of new and innovative goods and services that will enhance Europe's competitiveness and meet the needs of its citizens", (DG Research, 2005a: 3).

3.1. Decomposable biomass for future value chains

In the Life Sciences account of the KBBE, narratives conflate the terms 'sustainable' and 'renewable': renewable resources will be used more efficiently and thus substitute for chemical ones. Moreover, beneficial characteristics are attributed to such substitutes: 'Eco-efficient products are less polluting and less resource-intensive in production, and allow a more effective management of biological resources' (DG Research, 2006). Sustainability is equated with greater efficiency, which can expand resource availability and enhance global economic competitiveness and thus European prosperity.

In the dominant account, these tasks are assigned to converging technologies. According to the DG Research Commissioner: "The life sciences and biotechnology are significant drivers of growth and competitiveness here. These sciences will help us to live in a healthier and more sustainable fashion by finding more environmentally friendly production methods and pushing forward the frontiers of science… This requires a holistic approach that transcends the narrow confines of scientific disciplines – blending, for example, the bio- and nano-sciences – and cuts across policy areas: from research and innovation, to trade and health and consumer affairs", (DG Research, 2005a: 1, 3)

In this Life Sciences perspective, eco-efficiency is sought through molecular-level changes in inputs, outputs and processing methods. In this decomposability paradigm, research seeks qualities that can be identified, standardised, quantified, extracted, decomposed, recomposed and commoditised in new forms (Allaire and Wolf, 2004). From this baseline, more specific knowledge can be privatised. Agriculture becomes a biomass factory; residues become waste biomass for industrial processes.

At the launch conference of the KBBE, a speaker drew analogies between current and future industrialisation: 'In addition to the countryside's role as a "food factory", it could be used to grow renewable bio-resources as sustainable raw materials for our energy needs and for industry' (DG Research, 2005a: 5). This frames the sustainability problem as an inefficiency to be overcome through a techno-knowledge fix (Birch et al., 2010). In this way, the KBBE narrative promises to link economic, environmental and social sustainability.

These research agendas have been co-developed with industry. In preparing FP7, the Commission invited industry to establish European Technology Platforms (ETPs), especially to define research agendas that would attract industry investment. This arrangement has meant to meet the Lisbon agenda target of 3% GDP being spent on research. ETPs were meant to involve 'all relevant stakeholders' in developing a 'common vision' emphasising societal needs and benefits. This state-industry partnership has been much closer than a lobbying relationship.

For the agri-food-forestry-biotech-energy sectors, ETPs were initiated mainly by industry organisations, with support from scientist organisations. Several relevant ETPs were officially recognised by the European Commission and then granted start-up funds. In particular:

Plants for Life, led by the EPOBIO network, representing ag-biotech companies and research institutes
Forestry-Based Sector, 'Innovative and Sustainable Use of Forests', led by forest industries
Food for Life, led by the CIAA, representing the European food industry
Biofuels (and its predecessor, Biofrac), representing various industries and research institutes
Sustainable Chemistry, hosted by EuropaBio, representing biotech companies
Sustainable Farm Animal Reproduction & Breeding

(This paper focuses on how the 'biomass' concept links plants, fuels and chemicals; so the analysis here omits novel foods and animal breeding.)

In practice, membership in ETPs has defined who is (or is not) a relevant stakeholder, according to their prospective contribution to future value chains. Oriented to capital-intensive research and innovation, ETPs have little common ground with civil society organisations (CSOs), which have remained marginal. Citizens are relegated to the role of consumers, at best.

Early on, ETPs gained support from COPA, the European federation representing the relatively more industrialised farmers. As a high priority, COPA seeks ways to reduce input costs, while increasing productivity. But it played a only minor role in agenda-setting for R&D. Eventually COPA wondered whether the KBBE would offer farmers any benefit – other than selling biomass in competition with cheap imports.

3.2. Horizontal integration via recomposing qualities

In the dominant agenda, agri-production is recast as raw materials or biomass. Here the KBBE is 'the sustainable production and conversion of biomass into various food, health, fibre and industrial products and energy', according to a consortium of ETPs: " Through the improvement of plants, the Bioeconomy can produce healthier, high-quality, sufficient, diverse, affordable raw material for the sustainable production of food and feed', as an alternative to the fossil-based economy (Becoteps, 2011). Likewise a key challenge is 'sustainable feedstock production'; the post-2013 CAP must help 'to maintain a competitive supply of raw materials' (Clever Consult, 2010: 11). Efficiency benefits are attributed to novel inputs: "In the coming decades, we anticipate the creation of more efficient plants (able to use water and fertiliser more efficiently and to be self-resistant to pests), leading to more efficient farms and new economic opportunities ", (Plants for the Future ETP, 2007: 5, 9).

As an industrial innovation, the agenda also promotes horizontal integration across sectors: food, feed, energy and other industrial products. Agriculture is seen as 'oil wells of the 21st century' (Biomat Net, 2006), i.e. like a mineral reserve for extracting renewable resources as biomass, which can be cracked into its various components for further processing. According to proponents, technological innovation provides new opportunities for rural employment but must horizontally integrate agriculture and energy as value chains: "However, the production of green energy will also face the exceptional challenge of global industrial restructuring in which the very different value chains of agricultural production and the bio-refining industries must be merged with the value chains of the energy providers", (Plants for the Future ETP, 2007b: 33).

Playing a promissory role, the 'value chains' concept mobilises economic and political investment around prospects for future wealth. Biotech is promoted as a prime tool and beneficiary, and especially as a means to gain patents. These are cited as a key benchmark for Europe's knowledge base and for its place in global competition. Patents are presumed to be a means to gain and protect income from new scientific knowledge, especially for biological resources, which are otherwise freely reproducible by farmers for re-use and exchange. For example, 'Knowledge and intellectual property will be critical to fulfilling the goals outlined in the other four challenges' (Plants for the Future ETP, 2007a: 9).

For diversifying the use of agricultural biomass, bio-refineries are already converting oilseeds or grain into fuels and feed. Some crops are being genetically modified specifically for commercially more valuable feed and/or for easier breakdown of cell walls. As a greater ambition, an 'integrated diversified bio-refinery' would also produce other industrial products. An analogy is drawn between plant material and crude oil: 'New developments are ongoing for transforming the biomass into a liquid "biocrude", which can be further refined, used for energy production or sent to a gasifier' (Biofrac, 2006: 21). Such a metaphor naturalises the decomposability paradigm as the basis for horizontally integrating agriculture with energy production. Alongside these research agendas, the same organisations lobby for policy changes, which include: easier access to patents on biological material, more ambitious targets for biofuels, and public procurement criteria favouring 'green' products.

4. AGROECOLOGY & RELOCALISATION FOR A DIFFERENT KBBE

Although rarely using the term 'innovation', other agendas promote innovative agro-production methods, which help to bring producers closer to consumers. As an overall alternative for future European agriculture, shorter food supply chains have been promoted as a means for producers to gain more from the value that they add, thus reinforcing agronomic practices which rely less upon external inputs. These chains build societal identification with food 'quality', variously defined and often rooted in a specific territorial origin and/or production method.

4.1. Quality as social identification

Institutional innovations are necessary so that producers, consumers and their networks identify with such forms of product quality. Agro-food identities depend upon various measures for promoting and validating quality, though not necessarily via formal certification. Going beyond territorial brands, food re-localisation builds identification and solidarity with local producers, e.g. in order to support environmentally less harmful methods and the local economy. Given the diverse bases for social identification, this has been theorised as a paradigm of comprehensive product identity (Allaire and Wolf, 2004).

In Brittany, for example, local food networks have developed innovative ways to supply consumers with food, often organic and/or higher-quality, while bringing them closer to producers. By selling their products through short chains, many farmers have found incentives to reduce their energy inputs – initially as a cost-saving measure and later as an environmental commitment. Already available, such methods could be implemented rapidly and at low cost; the main obstacles seem to be farmers' and institutional mindsets (Aubrée et al., 2010; Maréchal and Spanu, 2010).

Such an agenda has been promoted by numerous NGOs and the European *Coordination Via Campesina*. They have tended to elaborate on the 'food sovereignty' concept from the global South, rather than attempting to salvage the 'sustainable agriculture' concept from its dominant meanings: "The ways in which we grow, distribute, prepare and eat food should celebrate Europe's cultural diversity, providing sustenance equitably and sustainably…. [e.g. via] the production and consumption of local, seasonal, high quality products reconnecting citizens with their food and food producers", (EPFS, 2009).

Cooperation among producers, as well as greater social proximity to consumers, has been promoted by practitioners' networks, whose motivations go beyond market advantage (Hinrichs, 2003; Renting et al., 2003). Such initiatives depend crucially upon support from local authorities, e.g. by facilitating cooperation, providing various skills for agro-food marketing, enhancing the public reputation of local and/or territorially branded food, and favouring local suppliers for public procurement. Often initiated by organic farmers, such networks can include and benefit different kinds of producers (Karner, 2010).

4.2. Agro-ecology as a different KBBE

Agro-food relocalisation has complemented agro-ecological methods, which emerged from the convergence of ecology and agronomy. Ecological science is applied to the study, design and management of agro-ecosystems. To develop agro-ecology as a new discipline, knowledge from separate disciplines has been collected and combined to solve problems at a higher scale – beyond a plot or farm. Although experimental, this larger scale has less control over conditions, and knowledge can less readily be generalised across contexts. Towards holistic solutions, agro-ecology needs interdisciplinary methods, including sociology and economics (Daalgaard et al., 2003). Indeed, agro-ecological knowledge production depends on closer social connections among farmers and various disciplines, especially on means to overcome barriers between them.

Agro-ecological methods do not correspond exactly to organic farming, for at least two reasons. On the one hand, these methods are used far beyond organic-certified farming, e.g. in economically less favoured areas, and so could be used much more widely than at present. On the other hand, some organic farmers have moved towards more industrial methods. These opposite tendencies have been conceptualised as the organification of conventional agriculture, alongside the conventionalisation of organic farming (Sautereau and Bellon, 2011).

By contrast to the dominant account of eco-efficiency, an agro-ecological account appropriates, enhances and/or integrates ecological processes. Organic farming attempts to keep cycles as short and as closed as possible, as a means to use biodiverse resources more efficiently. Such methods maximise the use of farmers' knowledge and locally available renewable resources, thus minimising dependence on external inputs, while also maximising outputs of diverse kinds. Residues can become media for recycling nutrients via ecological processes, so replenishing soil fertility.

This agenda has been conceptualized as Ecologically Integrated methods to enhance biodiversity, as means to improve productivity, nutritional quality and resource conservation (Lang and Heasman, 2004). These methods can complement shorter food chains: 'Agro-ecologists privilege alternative food systems operating at a regional scale or based on closer farmer-consumer relationships, or product networks that mobilize localized resources and have strong identities' (Vanloqueren and Baret, 2009: 981).

To promote those methods, the organics industry has helped to build a Technology Platform Organics, aiming to influence research priorities. Dissatisfied with agendas of officially recognised ETPs, the organisers put forward agro-ecological alternatives while also attempting to recast the KBBE concept. They proposed a Technology Platform for Sustainable Organic and High Welfare Food and Farming Systems. Such systems 'are an important and fast-growing part of the European knowledge-based bio-economy'. The proposal included 'industry objectives of improving (i) ecological and social sustainability, (ii) food quality and safety, (iii) production efficiency and profitability and (iv) introduction of innovation' (IFOAM-Europe, 2006). Like the Technology Platform proposals from capital-intensive industries, this one was submitted to FP6 as a Coordination and Support Action, but it did not gain a sufficiently high score.

Even without funds from the European Commission, organics promoters continued the work. They built broad stakeholder support including relevant commercial actors across the agro-food value chain as well as environmental NGOs. Eventually they published a *Vision for an Organic Food and Farming Research Agenda to 2025* (Niggli et al., 2008), with the aim to set up a Technology Platform Organics. This has been followed by a *Strategic Research Agenda* in the name of TP Organics (Schmid et al., 2009). There the term 'innovation' is linked with public goods, farmers' knowledge, learning and competitive advantage. Key terms from the hegemonic agenda are recast to favour agro-ecology. For example: "… the innovations generated by the organic sector have played an important role in pushing agriculture and food production generally towards sustainability, quality and low risk technologies… Organic agriculture and food production are innovative learning fields for sustainability and are therefore of special interest to European societies…. In order to maintain a leading position in this innovative political and economic field, research activities are crucial", (Niggli et al, 2008: 9).

According to their problem-diagnosis, organic farming faces a problem of low productivity, which has potential solutions in agro-ecological engineering, here called 'eco-functional intensification': "The weakness of organic agriculture so far remains its insufficient productivity and the stability of yields. This could be solved by means of appropriate 'eco-functional intensification', i.e. more efficient use of natural resources, improved nutrient recycling techniques and agro-ecological methods for enhancing diversity and the health of soils, crops and livestock", (Niggli et al, 2008: 34; cf. Schmid et al., 2009: 59).

Horizontal integration between agriculture and energy production provides means to close up organic cycles, as well as to substitute for external inputs: "Diversified land use can open up new possibilities for combining food production with biomass production and on-farm production of renewable energy from livestock manure, small biotopes, perennial crops and semi-natural non-cultivated areas. Semi-natural grasslands may be conserved and integrated in stockless farm operations by harvesting biomass for agro/bio-energy and recapturing nutrients from residual effluent for use as supplementary organic fertiliser on cultivated land", (Schmid et al., 2009: 26).

TP Organics has developed its research proposals in consultation with farmers, food processors and distributors, partly through Europe-wide consultation meetings. The concept 'eco-functional intensification' refers to the search for ways to increase productivity without conventionalising organic farming. This concept has aroused keen interest in the organics section of COPA, as a basis to support 'a European knowledge sharing and transfer platform for organic and low-external input farming'. The consultations strengthened specific proposals, as a stronger basis to influence research priorities.

5. SHAPING EU-LEVEL RESEARCH PRIORITIES

Stakeholder proposals for agricultural research have sought to influence state agendas, especially the Framework Programme 7 on Food, Agriculture, Fisheries and Biotechnology (FAFB), which runs between 2007-13. From the start, it has aimed at 'building a Knowledge-Based Bio-Economy'. Here the KBBE is understood as 'the sustainable, eco-efficient transformation of renewable biological resources into health, food, energy and other industrial products' (DG Research, 2006). The FAFB programme has tensions between different agendas and their accounts of a KBBE.

When FP7 began, approximately half the calls were drawn from proposals by officially recognised ETPs, led by capital-intensive industry. The food, crops and forestry ETPs were among those whose proposals had the greatest coverage in FP7 priorities (DG Research, 2007: vii). As a route to this successful influence, the Commission referred to ETPs as if they were neutral experts in both technological and commercial prospects.

From the start, the programme emphasised Life Sciences and converging technologies, especially as a means to identify biological characteristics, which could enhance value chains in future markets. The FAFB programme has had an average annual budget of €200m, allocating approximately one-quarter to Activity 2.3, 'Life sciences, biotechnology and biochemistry for sustainable non-food products and processes'. As that title indicates, earlier priorities were largely shifted to non-food uses, including energy and other industrial products.

The adjective 'green' means the substitution of plants as raw materials. For example, the call for research on 'Green Oils' aims to develop 'Market driven, hardy, viable and profitable oil seed crops with enhanced traits derived from conventional and biotechnological breeding techniques which exploit the post genomic knowledge base' (DG Research, 2006: 45). Here green or natural can mean any product of biological processes.

Funders expect economic and environmental benefits from techniques, which standardise novel data. These agendas are naturalised through anthropomorphic metaphors of nature, e.g.: metabolic engineering will enhance knowledge for 'green factories' to provide efficient engineering of high-yield and quality products; research will expand the biochemical diversity of natural product libraries; biocatalytic processes will provide high efficiency and low environmental impacts; modern biotechnology will provide systemics for cataloguing and therefore preserving microbial diversity, etc. (DG Research, 2008). These R&D priorities coincide closely with the Strategic Research Agendas and narratives of ETPs (e.g. SusChems, 2005; Plants for the Future, 2007).

In response to the calls, specific research proposals are evaluated for their prospective Impact, which counts as 1/3 the evaluation score. Commercial prospects are a strong criterion, especially for research towards novel plants; the expected Impact often includes the term 'market-driven', potentially meaning patents. Research agendas emphasise 'pre-competitive' research – understood as generic knowledge which itself does not provide commercial products but which can lead to them. As this concept recognises, commercial techniques and products depend upon freely available knowledge for common standards (Allaire and Woolf, 2004). At the same time, 'pre-competitive' research anticipates competitive innovation within the decomposability paradigm, eventually generating patentable knowledge.

Along with the FAFB programme, the FP7 Energy programme launched a joint initiative for research on 'Sustainable Bio-refineries' in 2008. This likewise responded to ETPs' proposals for horizontally integrating agriculture with other industrial products by redesigning and recomposing biomass. Several calls were put out for proposals related to novel crops and processing methods for converting biomass more efficiently into liquid fuels. By mid-2009 the Commission had approved biofuel projects totalling €60m.

Despite the dominant agenda, the FAFB programme has included some other research priorities. Some promote knowledge for protecting public goods in an agricultural context. While organic methods always have had a presence in EU Framework Programmes, FP7 has given greater prominence to agro-ecological themes, whose calls had reached a total budget of 20m Euros by 2010 and increased thereafter. Agro-ecology is seen as a means to solve problems of resource shortages and pollution, as well as to provide public goods such as eco-system services. Although the term 'agro-ecology' does not appear in FP7 documents, the FAFB programme included several agro-ecological themes: enhancing soil management, recycling organic waste, replacing chemical pesticides, developing integrated pest management, enhancing on-farm production of renewable energy, etc. (DG Research, 2008, 2010).

Such priorities have played a stronger role since the start of FP7, partly by incorporating proposals from TP Organics. Its novel concept, 'eco-functional intensification', has attracted interest from DG Research. This opportunity has had several sources in wider deliberative processes.

The FAFB programme has hosted foresight exercises, aiming to open up research agendas to wider knowledges (see Section 1.2 above). Its second report advocated new kinds of Agricultural Knowledge Systems (AKS) beyond the formal research system. It emphasised innovations resonating with proposals from TP Organics: "Farmers cannot be supported by AKS to follow new innovation paths supportive of public good goals if there is not a clear support from public agencies. The AKSs that have been developed outside the mainstream, to support organic, fair trade, and agro-ecological systems, are identified… as meriting greatly increased public and private investment. These documents also argue for bringing the lessons of existing sustainable, productive, profitable agro-ecological [systems] into the AKSs mainstream. AKSs for instance would focus on ways to reduce the length of food chains, encourage local and regional markets, give more scope for development and marketing of seeds of indigenous crop varieties and foodstuffs, and restore the diversity of within-field genetic material, as well as of farming systems and landscape mosaics ", (SCAR FEG, 2008: 42).

Similar accounts of *in situ* agricultural diversity have gained prominence in discussions among national agencies that fund agricultural research. Having adopted 'Green Growth' as a conference theme, participants gave the concept a different meaning than the dominant productivist one: "We have to optimise sustainable growth dedicated to human welfare and the environment, e.g. nutritional value/hectare rather than volume/hectare; acknowledge diversity of situations and thus diversity of solutions; assess agricultural impacts within the global context and with regard to all interfaces…. We have to promote co-operation rather than competition with regard to research disciplines and research stakeholders… We have to increase our capacity to preserve public goods, share infrastructures and develop open access databases", (Euragri, 2010).

In these ways, a rival account contends for influence in EU-level research agendas and other policy arenas.

6. CONCLUSIONS: CONTENDING AGENDAS OF AGRICULTURAL INNOVATION

Amid expectations for a European 'transition to sustainable agriculture', there are competing transitional processes. Given the widely acknowledged harm from agro-industrial systems, 'unsustainable agriculture' has divergent diagnoses and innovative solutions. This rivalry can be analysed as contending innovation agendas; the analysis here combines theoretical paradigms of agricultural innovation, as summarised in the Table 2.

These agendas are promoted by distinct stakeholder networks, especially via European Technology Platforms. In an EU policy context of a Knowledge-Based Bio-Economy (KBBE), there are divergent accounts of its key terms: biological resources, economy, relevant knowledge and knowledge-producers. Likewise, divergent accounts are found of innovation, intensification, resource efficiency, resilience, bio-energy, horizontal integration, etc. (Levidow, 2011).

The dominant agenda favours laboratory-based techno-scientific innovation as a source of 'efficient' inputs, which can use renewable resources more efficiently for competitive advantage in global value chains. Agriculture becomes a factory for recomposable biomass, as inputs for capital-intensive processes and various industrial products. This reduces farmers to input purchasers and biomass suppliers, while marginalising their own knowledge. Innovation becomes a search for the optimal lab-based technology (cf. Godin, 2006; Felt et al., 2007). At the EU level this agenda is led by a state-industry partnership, especially European Technology Platforms, representing multinational companies and large research institutes.

Table 2: Contending Agendas of Agricultural Innovation

Paradigm Issue	Life Sciences	Agro-ecology
Problem-diagnosis: agro-economic threats	Inefficiency (of farm inputs, processing methods and outputs) disadvantaging European agro-industry, which falls behind in global market competition for techno-scientific advance.	Agro-industrial monoculture systems – making farmers dependent on external inputs, undermining their knowledge, distancing consumers from agri-production knowledge, etc.
Solution in sustainable agriculture	More efficient plant-cell factories as biomass sources for diverse industrial products. As 'oil wells' of the future, agricultural biomass can be a substitute for fossil fuels, thus expanding available resources. Sustaining economic growth, resource usage and commodity flows.	Agro-ecological methods for maintaining and linking on-farm resources (plant genetic diversity and bio-control agents), thus minimising usage of external resources. Sustaining the resource base, communities and solidarity.
Society as community; social sustainability	Individual beneficiaries of global markets through rural employment and novel 'green' products available for rational consumer choice.	Closer producer-consumer links through trust in a comprehensive product identity based on images of quality, food culture and territory/place.
Natural resources	Mechanical-informatics properties as a natural cornucopia, which must be identified, unlocked, mined and commercialised in value chains.	Ecological processes (e.g. nutrient recycling, soil as a living system, whole-farm systems, etc.), which can be used by farmers for agricultural production.
Resource constraints	More efficiently use renewable resources, so that productivity increases overcome constraints and thus continue economic growth, i.e. commodity circulation in the global economy.	Re-link production and consumption patterns in ways reducing dependence upon external inputs, while enhancing diverse outputs, towards greater self-sufficiency.
Resilience against vulnerability	Capital-intensive defences against external shocks (e.g. climate change), so that the system can maintain, restore or even increase productivity.	Bio-diverse farming systems with lower dependence on external resources, thus avoiding endemic stresses of monoculture systems & climate change.
Knowledge	Computable data for more efficient, flexible agro-inputs, production methods and/or outputs, which can gain advantage in value chains. Laboratory research to create databases of standard information. Privatisable knowledge, verified by pre-competitive research and public reference standards.	Farmers' collective, experiential knowledge of natural resources, ecological processes and product quality, as a basis to minimise dependence on external inputs. Scientific research to explain why some agro-ecological practices are effective. Open-source exchange of information and biological materials (organicEprints)
Quality	Compositional qualities that can be standardised, identified, quantified, extracted, decomposed and recomposed for extra market value.	Comprehensive product qualities – e.g. aesthetic, production methods, farmers' skills, rural space – recognisable by consumers as a basis for their support.
Eco-efficiency as intensification: using renewable resources more efficiently	Sustainable intensification via smart inputs from lab knowledge: enhancing external inputs, engineering their compositional qualities and increasing land productivity.	Eco-functional intensification via farmers' knowledge of agro-ecological methods: improving nutrient recycling techniques, enhancing biodiversity and enhancing the health of soils, crops and livestock.

Knowledge-Based Bio-Economy (KBBE)	Sustainable production and conversion of biomass [or renewable raw materials] into various food, health, fibre, energy and other industrial products.	Agro-ecological processes, in mixed and integrated farming, for optimizing use of energy and nutrients, so that producers gain from the value that they add.
Agricultural Knowledge Systems (AKS)	Cooperation among actors in value chains, esp. for linking biological characteristics with novel inputs and products.	Cooperation between lab science, agronomy and farmers, especially for enhancing their knowledge of natural resources for sustainable production methods.
Product validation	Technological convergence for databases to standardise properties of molecular components and their new combinations.	Certification systems for product identity or integrity that will be recognised by consumers.
Economy & markets	Global value chains realising market value in commodities (agro-inputs and outputs) and proprietary knowledge, as a basis for capital-intensive knowledge to gain from added value.	Shorter agro-food chains, based on consumers' trust and greater proximity to producers, as a basis for valorising their knowledge of natural resources, cultivation methods and food culture.
Government policy on research	Private-sector access to innovation-friendly policies, e.g. public funds for research, natural resources and proprietary rights over knowledge.	Farmer access to integrated agro-ecological research and to advisory (extension) systems.
food chain	Avoid unfair anti-competitive practices, which block more efficient supply chains.	Support for food re-localisation via infrastructure and urban-rural linkages.
bio-energy	Subsidy and targets for bio-fuels to create a European market and thus stimulate innovation, which can be exported.	Measures for farm-level development of bio-energy, which can substitute for (or supplement) external sources.
externalities	Green public procurement rewarding processes which minimise externalities.	Incentives for all actors along the value chain to internalize as many externalities as possible
Public knowledge and support	Need a European society in which all stakeholders understand and trust the concept of the bio-economy. Concerns about genetic information need to be addressed and overcome for the Bio-economy to achieve its potential.	Need a public, which is knowledgeable about agro-production improvements via agro-ecological methods and re-localising European economies.

Note on Table: Diverse accounts of sustainable agriculture can be analysed as contending paradigms. The Table draws on several typologies – Lang and Heasman (2004: 28-34), Allaire and Wolf (2004), Marsden et al. (2002), SCAR FEG (2008), SCAR FEG (2011) and Vanloqueren & Baret (2009).

By contrast, other agendas promote farmers' knowledge of natural resources, especially via agro-ecological methods. On this basis, they can reduce energy inputs, increase productivity and add value through quality. In this account of eco-efficiency, production methods appropriate, enhance and/or integrate ecological processes. Such methods also can enhance public goods (Schmid et al., 2008). Such benefits depend on joint knowledge-production, spanning the boundary between knowledge generators and users (EU SCAR, 2012: 32, 42). Through short supply chains that valorise a comprehensive identity for agro-food products, producers can gain more of the value that they add. These short chains, also known as relocalisation, depend on combined knowledges from diverse sources. At EU level this agenda has been led by Technology Platform Organics with support from organic farmers' organisations, small businesses across the agro-food supply chain and environmental NGOs.

With those contending agendas, rival stakeholder networks seek to influence R&D priorities, especially the EU's Framework Programme 7 on Food, Agriculture, Fisheries and Biotechnology (FAFB). This programme aims to build a Knowledge-Based Bio-Economy (KBBE), a concept originating in European Commission policy for the Life Sciences. Accordingly, the FAFB programme has favoured lab and engineering knowledge for more 'efficient' products as a means to create a more sustainable agriculture. At the same time, the FAFB programme has increasingly promoted agro-ecological research, thus overcoming its general lock-out from research agendas. This resulted from coordinated efforts by stakeholder and expert networks attempting to influence R&D agendas.

From the standpoint of multifunctional agriculture, such contending agendas can play complementary roles in different rural spaces. Some agro-food practices may combine aspects of different paradigms. As a concept, Agricultural Knowledge Systems may provide a common space for interchanges between divergent agendas and their research priorities.

However, these innovation agendas promote conflicting visions of the future. Rival coalitions attempt to influence R&D priorities, innovation trajectories and wider policy frameworks along those divergent lines. In addition to simply competing for research funds, they promote different power relations between farmers, the agro-input supply industry, research institutions, knowledges and markets. They promote different accounts of social, environmental and economic sustainability – also known as people, planet and profit, respectively. Moreover, the Life Sciences agenda dominates agricultural research priorities, partly by appropriating key terms from other agendas. Capital-intensive innovations tend to gain commercial domination in agro-food markets, thus likewise marginalising other agendas (e.g. agro-ecology, short supply chains, etc.).

These contending agendas are generally treated as complementary in research programmes. By contrast, stakeholder conflicts arise overtly in several policy areas: agricultural subsidy (reform of the Common Agricultural Policy), ag-biotech regulation, patent rules, public procurement, land-use planning, etc. Stakeholder networks attempt to use or shift the wider political-economic landscape along lines favouring their account of sustainable agriculture and its emerging regimes (cf. Geels and Schot, 2007).

These societal choices can be obscured by policy frameworks, which favour 'efficient' techno-fixes from capital-intensive innovation. Social science faces an analytical task: to identify how stakeholder groups contend for influence, especially how they define and justify the societal challenges (or problems) that warrant agricultural research. On this basis, critical analysis can inform wider efforts to gain public accountability for societal choices, as well as for the research agendas that favour or marginalise those choices.

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