Anticipating the future of agriculture: Towards resilient institutions and organizations

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Abstract

To cope with the wide range of complex and interlinked challenges facing agriculture in the European Union (EU) the EU Standing Committee on Agricultural Research (SCAR) regularly carries out foresight exercises. The SCAR strategic working group on Agricultural Knowledge and Innovation Systems (AKIS) carried out a foresight on how AKIS might develop towards 2050. The question is how policy makers can anticipate on future needs regarding the agricultural sector, food demand and supply. In particular, how can knowledge and innovation contribute to cope with challenges in agriculture. The paper addresses this by elaborating results from the AKIS Foresight exercise on how to establish resilient institutions and organizations for future agriculture and food.

1. Introduction

To prepare for the future of agricultural markets and food supply European governments need to gain insight in how knowledge and innovation processes could and should be organised, among other factors. It is a highly dynamic world with many types of emerging possibilities and risks. We are facing a rapidly changing (information) technology. The conditions for food markets are unpredictable and turbulent, creating many forms of scarcity and other challenges. Politics favours centralised solutions one day and decentralised ones the next day. The mix of market or governmental solutions is constantly battled. Also the organisation and governance of science and research is far from static. Policy ideas and instruments in this area are subject to constant discussions and revisions. This paper addresses the future organisation of knowledge and innovation for agriculture and food policy. Through its long term focus the Standing Committee on Agricultural Research (SCAR) uses foresight as a tool for public research planning and public policy building for the European Union (EU). Scenarios represent possible future circumstances that are not (easily) influenced by decision makers, like climate change, immigration, ICT, food technology and patterns and the future of the EU. More in particular, the SCAR foresight exercises:

- explore new challenges, take up cross-cutting issues, feed the strategic planning process of research policy making and give advice to political decision makers in the field of agriculture and food;
- highlight weak signals as well as future opportunities e.g. mid- to long-term priority setting for research to provide input for a more integrated research system for agriculture in Europe;
- result in a high number of joint activities between member states such as the implementation of working groups like collaborative working groups (CWGs), European Research Area Networks (ERA-nets) and Joint Programming Initiatives (JPIs) with a wide scope e.g. climate change, food security.

The results stem from an exploration of new challenges, cross-cutting issues, strong and weak signals that together are meant to feed the strategic planning process of research policy making and give advice to political decision makers. The main question is how to establish resilient institutions and organizations for future agriculture and food. The foresight addressed in this paper concentrated on the challenges of the European AKIS towards 2030, with potential trends in agriculture up to 2050 (for which research has to be carried out much earlier).

2. Methodology

The scenario study was based on the Horizon scan 2050 by STT (2014). Drivers for future changes related to the purpose of the foresight study were selected in 5 categories: 1) societal, 2) technological, 3) ecological, 4) economic and 5) political. In a workshop with AKIS experts (Bari, Italy, September 2014) additional drivers for the AKIS were added. This list of 59 drivers formed the basis for an internet consultation. More than 120 experts scored the drivers for change on relevance and impact. In a 2-day workshop organised for the SCAR strategic work group AKIS-3 (Antwerp, Belgium, March 2015) these drivers were used to build mini-scenarios. Eventually 3 final scenarios with 30 participants (researchers, policy makers and advisors) representing 10 EU countries were constructed: 1) high tech, 2) self organisation and 3) collapse. In addition, interactions of the Foresight Expert Group appointed by the Commission with the SCAR Strategic and Collaborative Working Groups (including the SWG AKIS) and

sectorial analytical documents have also provided invaluable input. The methodology for the scenario building was based on a basic version of Scenario Planning as used in business, originally developed at Shell (Van der Heijden, 2004) because of its recognition of uncertainties and identification of changes to stimulate adaptive policy management. To summarize the method used, 6 steps were conducted: 1) decide drivers for change and assumptions, 2) bring drivers together into a viable framework, 3) produce 7-9 initial mini-scenarios, 4) reduction to 2-3 scenarios, 5) drafting of the scenarios and 6) identifying the issues arising.

3. Results

The next sections discuss these scenarios in more detail and look to the effects on AKIS.

3.1. Scenario 1: High Tech

General and agricultural characteristics
Due to the removal of barriers for globalization through far-reaching international agreements, the trend to big data in ICT and patents on agricultural organisms in genetics, large private multinational companies with huge resources and influence are dominating the food chain and agricultural production. Multinational retail companies are dominant too. Private technology is now one of the most important drivers of innovation in society. Much attention and means go to chain management, the use of drones and robots run by multinationals. Non-governmental pressure groups use the reputation mechanism of multinational companies and brands to exercise a corrective influence for public issues.

Economy and ecology: the role of technology
New technological innovations (especially in ICT by companies that mass-produce sensors but also by companies like IBM and Google with big data expertise, and with GMO's) have solved the sustainability problems and form the basis for a booming bio-economy industry that provides food for the many and inputs for the chemical industry. After a number of crises, the European Union has evolved into a political unity named the United States of Europe (USE). As such, it is a serious counterweight with its competition policy to the huge multinationals. The federal character of the EU has limited the powers and the reach of the national states. However the institutions of the USE also have a limited influence. They are more following and correcting than steering the powerful business community. Social inequality is causing concern in this society which is on average rich, but with a wide distribution.

Extreme public budget cuts, trade liberalization and deregulation fuelled this process. Through global private summits private – public action programs are made for many sectors of society. Precision farming and genetics have delivered their promise and added significantly to the solutions of pollution, climate change and animal welfare. Pollution can for instance now easily be traced, measured, taxed or regulated through systems of best practices and certifications. As a result, there is less need for national policy and law enforcement, which is cost reducing for companies. Government officials are now mainly steering at a distance, which allows them to observe or participate, but usually only on invitation. They are seldom involved in steering committees and suchlike. Business sectors negotiate directly with the World Trade Organization (WTO) and the Convention of Biological Diversity (CBD). Consumer concerns and their claims for sustainability, as expressed by powerful non-governmental organizations (like Greenpeace) are leading for business, not governments. Companies are often concerned about paying higher taxes in the EU than in certain parts of, say, Africa or Asia.

The technological development has resulted in much higher production levels in a sustainable way. Due to solar energy, energy prices are very low and therefor also water shortage is not a problem. There is a booming bio-economy. The production covers both food and non-food products like plastics out of biomass and algae in food and chemicals. Transport is electric and self-driving. Privately run stock and commodity exchanges regulate prices, in cases where production is not contracted.

The process of internationalization has forced farmers and cooperatives of farmers to either grow big or be integrated with multinationals, turning to big scale and highly technological production. Large cooperatives have listed themselves on the stock market to attract capital for this internationalisation process. Information is centralized on a few websites with a dominant position (like Alibaba and Facebook), and sales take place on far away markets. There is much attention to optimized logistics and exchange of best practices. The notion of "strange food', as in artificial meat or insects, has been accepted. Algae and

insects are now commonly eaten. This high-tech driven society provides the masses with sufficient and cheap food. As there is quite some inequality in society, the Common Agricultural Policy (CAP) has adopted a food-stamp program.

The dominant business models are legitimized by certified and protected labels. Food service companies like McDonalds have contracts with highly specialised farms and factories spread over different regions all over the world. Their contract partners are usually cooperatives of farms or factory companies, but also governments are bound to long term contracts. Vegetables are grown in plant labs (vertical farms). Companies produce in many countries and profit from global marketing, branding and property rights. Food supply is very high and food is in general very safe. Contraction of agricultural area is inevitable (Rabbinge & Van Diepen, 2000). Much of the bulk production is now placed in countries like Ukraine, Russia and Africa, where farming is about large quantities and commodities, also for the poorer people in Europe. Precision farming and cheap transport, as well as local 3D-printing e.g. of spare parts for machinery, helped to solve the problems of the heterogeneous soils in Africa.

Politics: array of private arenas and institutions

Much of the decisive influence comes from an array of international and even global arenas and institutions. Large scale effects on the use of land, sea and air are often successfully kept outside politics and yet resolved, and for instance the North Sea is largely privatized and industrialized for the production of energy, aquaculture and algae. But at times land use and access to land and resources are still a source of dispute. Struggles emerge from disputed legal consequences of for instance the ownership of genetically modified crops or animals. Outbursts of conflicts and crises cause a blame game between business and governments but these are usually solved through social media platforms offering a range of interactive tools for dialogue. Prevailing struggle is often resolved through privately organized dispute settlement mechanisms like Round Tables (Opperman & Kaule, 1997), with reference to long term contracts or far reaching international agreements on for instance intellectual property rights. NGOs play an important role in this process.

The private food industry, input companies and retailers are active in law enforcement and carry out their own monitoring and control of farmers through private law (contracts with liability claims). The claims from some farmers that only the government can do this are rarely met with success, as governments are not very competent and also not overly united on these matters. Farms are large and very specialised: the typical broccoli-farmer operates holdings in three countries. They are seen as just another small and medium enterprise (SME) and their number is low with reduced political cloud. Due to collaboration between the USE, national governments and the (food) industry, many problems of the past are now resolved through integrated solutions, instead of the old fragmentation.

Technology: advanced and complex

High tech has now become one of the main drivers of the society and the foundation for success. The large multinationals own complex, large scale research entities that create totally new business models based on ICT and a range of advanced research on genomics, drones and synthetic biology for food security and safety. A privately run European Safety Control Agency is working on contract basis for the USE. Knowledge is about technological based developments. Not only environmental problems are largely solved by such high tech solutions, technologies and market innovations are also the essence of food production. 3D printing for food are commonplace and “the fridge tells you what to do”. Robots run the kitchen, and quite some health conditions are now leading to computer steered treatments and computer supervision: obesities and other lifestyle conditions might lead to a controlled access to the refrigerator, and biological sensors in the body and brains of these patients regulate behaviour. Personalized nutrition is standard. Data on food consumption and lifestyle are shared by consumers with their insurance company for risk-based (lower) premiums.

As the food demand is high, much technology is oriented towards the amount and the nutritive value of food. The type of food is changing, with high tech factory production of synthetic burgers which are now fashionable and common. Insects were for a while eaten by a few, but expanded to the mainstream due to smart marketing, heavily driven by large companies using celebrities in billion euro campaigns. People that are financially disadvantaged find it attractive for their low price or the link to food stamps. There is food waste but it is limited by international chain management.

Social life: much richer, more free time but also important inequalities

Much of the social fabric of society is caught between an advanced elite and the socially deprived. The elite pursues a lifestyle where many issues like health, fashion and shopping, are technologically steered by advanced business models. Many jobs are taken over by robots e.g. within online sale, media commercials and model work. Computer modelled designs prevail, controlled by business experts behind the scenes. There are only specialized roles for real people in the rare occasions when a robot is not sufficient. The leisure industry is an important employer, given the reduced working time of most people. Health matters are also often solved through online services and even surgery is being done through remote online devices and robots. A happy life is seen as the foundation for health, but many are also highly medicalized, supported by online health advice and counselling from internet platforms. Advances in neuro-science and ICT have helped and have led to complete understanding how food influences the body and brains, and how the brains influence food choice.

There are widespread concerns about the wealth inequality and an elite in their gated communities that is not very respondent to social problems. But the argument that we should and must solve the hunger problem by technology, not politics, is supported by many. Critics argue that a small elite of an extremely rich upper class usually sets the agenda, whereas the 25% living in deprived and disorganized poverty are in general unable to catch up, despite repeated promises of a better life. The poor are politically weak as well, and unable to organize themselves and stand up for their views.

There are now less farmers and people are living largely in urban settings. There has been a rural exodus, with many agricultural functions centralised in attractive cities. The city administration is usually important for the social dynamics of urban life. Rural areas are depopulated and administered through private contracts. There are many nature reserves where local (often poor) people are denied access, both physical access of living and working in nature areas as well as the right to make use of natural resources. Large parts of the Amazons are owned by a global consortium of food, mining and pharmaceutical industry in search of genetic and mineral resources. But these parties are in that way also able to protect much nature. Much of the day-to-day social life is determined by high quality advice on how to create a happy life, supported by advanced neuro-science. It is a social life with little politics and much techno-driven individualized fun and reduced risk management.

3.2 Scenario 2: Self organisation

General and agricultural characteristics

Concealed in a multitude of institutions and actors lies a Europe that is facing common challenges but approaching them with much a space for self organisation. Some speak of a 'Europe of the Regions'. This provides fuel for a mosaic of cultures to thrive on their own. But for some it is a struggle against economic hardship. While some regions face poverty due to a lack of resources and skills, others are prospering in growth and new investments. However the financial crisis in the early start of the century is still fresh in mind. Some regions are now independent as their countries broke up. Several of them are de facto city states, where the main metropolis runs the region. Some have abolished the euro or it has become a non-issue as society has managed to overcome the economic barriers (Rogojanu & Badea, 2014) of using ICT based bitcoins. For most regions the major debate is related to social inequality and nutrition. Due to global warming, desertification has become an issue and it has even led to a shift in food production from South-Europe to other parts of the world.

Economy and ecology: the importance of the regional scale

The ability to solve the problems around social inequality and nutrition through a common, central, approach is currently limited as the solutions are often chosen and restricted at regional level. In this scenario the regional approach has been strengthened, as ICT provided plenty of opportunities for new ways of organising the society. Internet has proven to be very disruptive, with Airbnb and Uber as early examples, and very much used to shape new collaborative business models in the sharing economy. Crowdfunding and the block-chain technology have weakened the position of the old banks. This disruptive character of the technology has strongly undermined the position of large companies in retail and the food business.

Agriculture in this scenario is characterised through high food supplies and differentiated food streams: organic, conventional, mainstream, cheap, luxury and many hybrid forms. Branding and brands have also raised in importance, partly as a result of increasing consumer demand for experience and a (regional) authentic character. The consumer wants to know if food is technologically processed or based on traditional 'granny' recipes like homemade food. As a result, the demand for different types of food and

production methods is high. Not only in terms of quantity but also in terms of quality. Regional food is popular. Labelling and certification have partly given way to full transparency as the buyer can trace the history of an individual product with ICT. Consumer demands differ per region.

Farmers are not only food producers but are also energy producers (like biogas from manure) and managers of landscape and nature, often through collective contracts. Much of the trade takes place on the international market via internet market places where consumers and producers are often directly linked.

Care for nature is a regional responsibility. The protection of natural areas is mostly managed by regional government bodies, but in close collaboration with citizens, environmental groups and farmers groups in the region. This took off when economic incentive schemes were properly put to work. The ecosystem services approach (Sukhdev, Wittmer and Miller, 2014) now forms the umbrella label for the agro-economy and ecology in ecological farming and agro-forestry. There are quite some societal debates on the scale of farms. In practice there is a whole range of farms, from very large industrialized high tech factory farms to very small family farms. The variety is huge, with many cooperatives and many SMEs. In some cooperatives larger farms 'take care' of smaller sized enterprises. Regions and cities make up their own rules for spatial planning and accepted farm sizes. The CAP has been fully regionalised: regions can make a choice from the CAP menu and mainly have to prove that their measures are not trade distorting. Choices depend on conditions like demographic and historic background, economic competitiveness in and between regions and the presence of human capital. In some there is a rural renaissance with population growth as ICT permits some to work in areas of interesting scenery and a nice climate.

Politics: community based self-steering mechanisms

The political framework of the EU is characterised by different geopolitical settings. The EU sometimes takes the lead in certain cross-regional political matters, but implementation usually lies in the hands of regions. The powers of the EU are often (viewed to be) dispersed or at least decentralized. A part of the decentralization is caused by and is a tribute to Europe as a mosaic of local cultures. It led to a maze of regional governments and collaborative settings. Many regions make use of referenda by internet comparable to the Swiss system. The notion of Europe of the Regions fits a picture of a Europe where the role of regions has increased, providing space for self organisation and regional sovereignty. Public institutions have budgets for a range of (public) tasks. In general EU and national institutions and subsidies are gradually giving way to regional governance. The role of the EU is mainly concentrated on foreign policy, defence (a European army), internal market and basic public and private law.

Risk management in agriculture is shared between different regions, based on agreements between cooperatives and through chain management. Food waste is an overall problem as food supply is higher than food demand. Food safety on the other hand, is well organized, mainly driven by consumer organizations but also managed through full transparency in the food chain with ICT. Public agencies (mostly regional) ensure publicly controlled law enforcement. However critical incidents like animal diseases form a recurring societal problem. Responsibility for the environment is in the hands of regional governments and agencies but there are many public-private covenants. Chain management, cooperatives, certification and public private covenants form different instruments to handle risk.

Technology: focus on the social context

Technology is important for society, but the main driver is knowledge. In fact, technology is rather well regulated within public-private platforms of citizens, NGOs, businesses and regional governments. Often cities dominate and there is quite some resistance to new technologies in genetics, nanotechnology and ICT, especially if it does not have a social component. There are plenty of opportunities for self-steering and many look upon this as a democratic control of ICT/technology. Active participation in Wikipedia-like media is one of the tools for participation. In terms of agriculture and food technology, high tech lives side by side with traditional crafts. There is a variable usage of drones and other kinds of unmanned vehicles, depending on the specific context. But there is also resistance. Some ICT developments are met with scepticism, like the control of big data by governments or multinationals. Especially liability matters and privacy issues are at stake. It tends to be seen as a risk to peoples freedom. Using drones to monitor food production seems unproblematic but using it to monitor your competitors is another matter. The emerging 3-D printing of food however arrived at a more quite pace, at least in a legal sense. Its specialist usage in health situations and in the case of food shortage is undisputed, but its expensive technology is continuously up for debate. Technology has delivered totally new business models, often based on ICT and sharing of (over-)capacity. There is great diversity and space for entrepreneurs and opportunity seekers. A range of new regional food

websites and digital platforms are following this development. There is an intensive coverage on the social media. But the unequal spread of opportunities is a concern, as some technology is quite expensive. Introduction of new foods like algae or insects has been unprofitable due to the expensive tests that are required for novel foods and which do not guarantee that consumers take the product for safe. Market introductions are very sensitive for negative social media campaigns. When it comes to artificial meat, there is resistance to the application of it, in some regions and within certain groups. If there is some acceptance, it is usually related to sustainability issues or low prices. In social media, it is often hard to distinguish between expert statements, lobby input and amateur opinions, now that everybody is involved in participatory processes and co-creation.

The new business models that come from the technological development are diverse due to the creativity that has been tapped. It is about plastics out of biomass, algae in feed, fuels and chemicals. There is a modest growth in demand for biomass. It is the non-competitiveness of biobased solutions and the fast breakthroughs of prominent alternative solutions, particularly solar energy, that keep the use of biomass down. Due to the sharing economy, the demand for energy has seen a modest development. Products based on insects thrive particularly among alternative or avant-garde lifestyle groups, of which there are many in this pluriform society.

Social life: strong community orientation

Social life is now very much oriented towards community life and being part of one or more communities. It is a value guided choice in many ways, but at the same time it is part of a daily practice that reflects an economic reality. The value orientation is based upon the notion that many problems can be solved within and by the community in question. This is partly the case with environmental problems (where regulation and public incentives often come from). Often cooperative and regional solutions are preferred to national or European law.

For many, happiness in life is built upon trust in the community and its ability to solve problems. In terms of demography, a rural renaissance has often taken people out of the city. Many start-ups in rural areas reflects this trend, and gradually, the share of people living in rural areas is increasing. There are in general less specialized farmers as mixed farming (often organic) is preferred. In many regions multi-functionality is important. In cities urban farming and short supply chains have become mainstream and are integrated in food delivery services. It has become common to combine work outside agriculture with food production and at same time being a student. The regional variations on this matter are nevertheless huge.

Lifestyle is often oriented towards the community. In health and lifestyle at large, self-diagnosis based on smart phone apps information is common, as is remote but regionally organized treatment of illness and disease. Consumers track their food intake, life style and medicine use nearly automatically by smart phone and post their data anonymous on an internet platform, where doctors and big-data analysing firms provide advises. As for the type of food, there is a strong emphasize on regional products. But regions differ in terms of dominant diets.

3.3 Scenario 3: Collapse

General and agricultural characteristics

Rising temperatures due to climate change cause drought in several regions in Africa and the Middle East, leading to massive floods of refugees to Europe. But also the Northern Mediterranean is affected by heat waves and lower agricultural yields. Meanwhile an EU unfriendly government in West Africa has military control of the phosphate mines and sells its resources exclusively to China and India. These geopolitical developments lead to a lack of energy and phosphate resources and rising prices of raw materials. European soil exhausts due to intensive agriculture and overpopulation - leading to rising poverty. Several European countries are in conflict either internally or leaving the European Union (the Grexit and Brexit have become reality).

The combination of several of these events mounts to a tipping point for a European Union collapse. It marks the end of the Euro which is divided into the Mark (aka 'Neuro' for Northern Europe) and the Franlire (aka 'Seuro' for Southern Europe). The institutions are in despair and Europe is in desperate need of reconstruction. The situation is often compared to Europe directly after the second world war. Food and (clean) fresh water are the basic needs and have first priority, but also infrastructure for transport often needs repair. A directive agricultural policy is back on the agenda, mainly run by national governments and a light coordination in Brussels. Politicians are breaking their heads over building a new governance model.

Socio-economic situations are fragile and concentrated in various and different regions. This scenario can be best described with the following motto: “freedom is just another word for nothing left to lose” (Janis Joplin).

Economy and ecology: various communities, main economic sector is agriculture

The collapse scenario is characterised by various communities in different regions. Each community has its own agenda for reconstructing their small, local economy. People work closely together with their direct family relatives and neighbours. Unemployment is high and many persons returned from cities to their old family country house to grow their own food (subsistence farming). Money is not seldom informally replaced by new forms of barter and division of resources between communities. Europe depends on investments by Asia (like China, India) or Africa (e.g. Nigeria) to get its economic system back on track. Resources are scarce and people depend on what nature has to offer. People tend to return to nature for their basic necessities (food, water, shelter and medicines), but nature is also an enemy due to severe weather conditions, nature catastrophes, diseases and environmental problems. Knowledge is power (Francis Bacon, cited in: Hobbes, 1658) and limited to few. Local knowledge sources are scarce but an emerging information transfer takes place through storytelling and mouth-to-mouth.

The dominant economic sector is farming. Farmers both preserve food and focus on the production of edible new types of food (like insects, plant bulbs, etc.). Agriculture can be characterized as urban permaculture, where agriculture is conducted in close interaction and respect for nature. Some cities resemble the period of the city Detroit filing for bankruptcy (Sugrue, 2014). People now develop their own ecological farming systems, in combination with technological advances offered by city administrations, individuals or small groups and companies. Urban agriculture is hot. Farm business types are small and the focus is on ‘local for local’. There are hardly any large and intensive farms. Often farms are involved in both horticulture (vegetable gardens) and cattle (various animals) to have manure. Cooperatives are formed as a way to survive and combine resources in the most efficient way. The need for human capital and resources is traditional and basic (crafts). Food supply is scarce, natural, mostly organic and there are few new technologies developed for food production. Older technologies are still in use, with the exception of some that demand too much expensive energy or have been replaced by cheap labour from immigrants. The demand for food is modest and based on necessities. Sources of risks like poisoning or other critical incidents are tracked and traced within the farming system. Trust in the producer is built directly between farmer and consumer, based on close relationships. The threat of poverty due to bankruptcy or loss of reputation through diseases in the community makes sure that the production processes are carefully handled. Risk management is very important. The dominant focus on farming creates strategic space (Hubeek et al, 2006) for new innovative ideas within the community and between communities through knowledge circulation. Innovation is oriented on reinventions in new formulas, adapted to the new environment.

Political: fragmentation

National and European governance is restricted to a few politicians and policy makers. The institutions have become fragmented. Focus is on facilitating the local communities. Governance is oriented on control and setting rules to prevent communities from breakdowns. Political leaders depend on their own wisdom or they are experienced managers using their local network often guided by knowledgeable advisors (professors). China’s economy is leading and therefor a very powerful nation. European public budgets are restricted which does not lead to robust institutions. Agriculture policy is renationalised as a sector linked to local food distribution systems. Farmers set their own rules for their small production and distribution business but are restricted by some rules and legal frameworks in order to prevent chaos. The main political topic is bio-scarcity and division of resources and avoiding further widening of the gap between supply and demand. Food security comes first, food safety next.

Technology: reparations of old techniques

There is a downfall of technological development. Because resources are scarce (except labour), technology is expensive. Focus is more on repairing old technologies instead of fabricating and inventing new ones. Those who have access to technology and internet profit most and are able to further educate and develop themselves. The communities depend on those who chose to stay and rebuild the economy. Others go to China, the land of opportunities, to live ‘the Chinese dream’. Remittances are for some regions an important source of money.

Social life: communities and reconstruction

Partly due to the streams of refugees, the population in Europe grows. Social relations are focused on families and neighbours (they are your best friends). Communication mainly takes place face-to-face or through social platforms on local internets. The global internet has broken down into different versions. People's happiness is based on living in (relative) peace and freedom. Their lifestyle is oriented on surviving of their families and self-provision of basic necessities. Medicines are scarce and therefor herbs have become popular for medical aid. This leads to the search for finding and inventing new types of medicines and food, like insects that are considered to be a nutritious diet for proteins. Agriculture supports social work like the operationalisation of care farms for thieves, not for punishment but to work on the land to avoid further downfall ('agriculture as a hobby to work').

3.4 Impact three scenarios on AKIS

3.4.1. Impact of the High Tech scenario on AKIS

Economic and political

AKIS are in this HighTech scenario very centralized and also largely privatized. Due to public budget cuts, national governments are unable to be involved in many issues, and the big companies have taken control of the knowledge exchange in the agri-related business. The organisation of the food chain now mimics that of the car-industry (Van der Schans et al, 2015) at the beginning of the millennium: large global automotive companies like Volkswagen and Toyota that organise a large part of the chain, from design (in co-innovation with suppliers) to sales by dealers and knowledge development with some universities. As farmers are often contract farmers of a large company, and their political influence is much smaller than in the past. Politicians see less need to maintain state extension services and governmental applied research institutes. Levy organisations like commodity boards have disappeared and do not finance applied research anymore. The main interest of the government is to have first class university education for the needs of the multinational food companies and large farms. Agricultural universities have been merged into general universities, where students take majors on system biology and ICT with a minor in agriculture. This is sometimes also labelled as applied biology. Such universities have become 3rd generation universities (Wissem, 2009): besides teaching and research, innovation is their third objective. They support start-up companies that develop basic research findings into new products ('spin-outs') on their campus in a science park, in collaboration with alumni that act as business angels and with incubators and venture capitalists. Multinationals support this as a kind of open innovation. Once start-ups are successful and need more capital and access to global markets they buy them.

There is a strong orientation towards competition, internationalization and the subjects in education tend to be very specialized. There is however some resistance against the domination of multinationals. This is a type of resistance, with a few so-called independent and 'non-corporate AKIS', established and run by many different types of people and organizations, including engaged individuals, NGOs, small universities, with some participation of governmental agencies. Such a resistance is organized from outside the establishment. Dominant multinationals usually frame this resistance as 'radical' and 'idealistic', accepting its presence, as long as it does not disturb the agenda of the private industry.

Through AKIS, companies try to reach and engage consumers in dialogue and discussions on the often used Open Minded Society, which is mainly online platforms for discussions on consumer issues as health, nutrition and lifestyle. Among the topics are discussions of regulation and labelling. A rising interest in insects as daily food in the EU has caught the attention of AKIS as well. Gourmet insects produced on large scale is one of the business models that has become a billion-euro business. Trust, and the role of transparency of the system with big data, is an important matter that is monitored closely by large companies. The role of certifications and global institutions for regulating the rules of play are important. Partly due to these issues, collaboration has become pivotal to AKIS. But a reduction of knowledge exchange outside the large companies is a concern. In general, AKIS also goes for non-food issues, as food in many respects is 'already taken care of' and is fully integrated in the bio-economy. The links between food and for instance lifestyle have become more pressing for the agenda. The language of AKIS is now English.

Technology, knowledge and innovation

International competition is the main driver for innovation. Competition involves competing for the attention of consumers. As AKIS serves the interests of multi-national companies, AKIS also focuses on producing or stimulating the development of skills. Such a process has become known as "up-skilling"; i.e. the development of specialized knowledge and expertise, including skills in international networks and consulting. 'International networked research' is one of the essential topics. There is a tendency to focus on technology and the technical context. Farming is more for technologists rather than for instance for land managers. AKIS tools for innovation are often technology driven with a global scope. Developing benchmarks for economic efficiency is of great interest. But innovation is also about labelling and consumer science; thematic cross-overs as health, ICT, lifestyle, design with agricultural production are of great importance. Much attention is also paid to the functioning of global food chains and flows, in relation to the rest of the bio-economy. Themes of interest are food security, ICT and robotics for production and control, the ability of day-to-day advice and reporting. Innovation also occurs as a result of AKIS integrating into other global knowledge areas. Agricultural production and services are coupled to infrastructure development, urban-rural relations and transportation systems. Often this concerns technical and technological research but it is also often related to system analysis and the effects on consumers and the consumers sense of well-being. The danger of exclusion of groups and claims of closeness is a source of inequality and can be a threat to innovation when there is not enough diversity in the system.

Knowledge organisations and other AKIS actors

The dominance of a few large companies ensures that innovation is about the needs of these companies. Multinationals teams up with the most important and largest global oriented universities and these partnerships run much of the R&D on the food system. There is an 'Ivy League' of 7 global universities with a strong biobased and agricultural faculty who collaborate but also compete for the best students and train them for top science and management functions for the multinationals in the bio-economy and food chain. 'Connecting the globe' is an often used motto for their need to innovate at an international level, because the focus of AKIS is on the global food chains and flows.

There are hardly any independent public funded AKIS parties, other than education. Governments only play a minor role. R&D is organised at European level in the form of Public-Private Partnerships to improve its competitive position and to deal with some of the public issues that NGOs put on the table. The United States of Europe sets up such PPPs with e.g the remaining 5 largest dairy multinationals. Joint Programming Initiatives are used for collaboration with other continents, ERAnets have disappeared due to small budgets in member states and centralised decision making with multinational companies. However, PPPs and JPIs do not compensate for the diminishing public R&D. The result is less focus on public oriented issues. These are mainly addressed by regulation (that leads to innovation within companies) and much less by research. The concept of interactive innovation, in which a lot of use is made of 'innovation in the wild' based on local knowledge, has disappeared. However the method of co-creation of products with wealthy consumers that have time to spend has gained much more ground: retailers and food manufacturers run highly popular 5 day courses on 'discovering new recipes and innovating products' with big chefs in theme parks, where also new technologies like 3D food printers are tested.

Not only public applied research institutes (that were merged into universities) but also public extension have disappeared in this scenario. Advise to farmers is now given by the input industry and food industry, as part of their contracts. They offer a few days a year training to their farmers on their own "university", but in reality the John Deere University and the Danone University are high level training centres that sometimes run together with a real university. Some multinationals use specialised consultancies like Ernst & Young to provide advice to large farms and have taken over the role of the traditional advisory services that were not able to meet the demand for advice and training on topics like strategy, contract design and human relation management in large sSME-type of farms.

3.4.2 Impact of the Self Organisation scenario on AKIS

Economic and political

AKIS are strongly regionally organised (decentralised) and diverse. They have a more specific character meaning there is no particular focus on specific cross regional topics. AKIS are often locally governed and agendas are set by communities. AKIS have different governance and financial systems. In some regions farmers pay for advice, while others have publicly financed extension services. Some regions have their AKIS dominantly publicly managed and financed, others are more privatised. There are many public-private

partnerships to stimulate knowledge and innovation. Knowledge services dominantly focus on the 'grass root' regions and projects are either conducted on national or regional scales or conducted cross-regionally through multi-linguistic actors combining multi-regional knowledge, experience and insights. Farmers and agri-business are integrated in the AKIS which leads to trust among consumers that the food they eat is safe. Food safety is everyone's concern and problems and incidents are traced through profound chain research (in this system arguments count, not positions of parties of actors).

Technology, knowledge and innovation

The main driver for innovation is competition. There is both competition between regions and collaboration between regions to be competitive on an international scale. Because of the diversity in food and agricultural skills, innovation is often small scale. Especially due to a large amount of SMEs, public-private partnerships for innovation are more likely to focus on optimising methods and reduction of time for production. Emphasis on the regional level is more on R&D and innovation then on basic science. Long term focused knowledge development is mostly derived from scientific fundamental research conducted by some universities and research institutes. Often industry is not involved in this type of curiosity-driven research hence there are several debates on knowledge valorisation and the gap between science and practical impact. Radical breakthrough innovations are quite scarce. Industry, knowledge institutes and governments are involved in the AKIS debate on the efficiency and effects of knowledge and innovation and on how to optimize the knowledge chain and its services (research, education, advice and extension work) for both economic and societal impact.

There are multiple skills and professions in the agricultural sector. Farmers are both land managers technologists, care takers and facility managers (e.g. nature, care and hotel farming). In this scenario the type of skills and demand for human resources also differ per region. AKIS become diversified and increase in number in order to be able to properly address all these different and new professions. AKIS are oriented on adaptations in regional settings yet connect regions because of the stimulation of peer-to-peer learning networks. Several innovation and demonstration centres (IDCs, Geerling-Eiff, 2014) arise focusing on either sectors or specific topics (like ecologically friendly farming and short supply chain marketing). Their aim is to closely connect knowledge development to the immediate demonstration of the results. Knowledge workers work closely with frontrunner farmers who share their best practices with other farmers and chain partners. In exchange they receive subsidy for further innovation. These IDCs are built on regional partnerships from the start but quickly extend their network on an international scale. They are financed through regional funds but they disseminate their results on a global level and receive interested spectators from all over the world. The interactive innovation model with transdisciplinary research and co-creation between farmers and consumers are important phenomena in this system. These IDCs are exemplary to the complex subsidy instruments for knowledge and innovation that Europe of the Regions knows. Regional funds are not seldom a combination of both local public investments, national subsidy programs and EU instruments that focus on the development of different regions within its continent, next to investments of the private sector. All different instruments have various regional or national juridical back grounds and different criteria leading to complex financial audits and bureaucracy. Because of relative high overhead costs and risks of fines if not properly administered, especially industrial partners are not very keen on entering calls for proposals. This means that subsidy instruments for knowledge and innovation are mostly left to scientific and research infrastructures.

Knowledge organisations and other AKIS actors

In general farmers are becoming more and better educated. Farmers have various and ever more diversified roles, depending on the local context and personal aspirations. Some are mainly farm entrepreneurs focussing on production and quality. Others focus at nature and landscape maintenance. The trend is the farmer with different skills rather than the specialised farmer. Both specialised in high tech as in traditional agriculture.

There are many regional universities that are specialised in specific skills and types of professions needed for the region. For instance precision agriculture in Denmark (Fountas et al, 2005), multi-functional agriculture in Baden Wurttemberg (Knierim & Siebert, 2004) and organics in Austria (Willer & Kilcher, 2011). Different universities closely interact with each other. AKIS organise interregional exchange programmes so that students can follow different minor courses for which they receive formal certificates in addition to their degree/diploma. Universities are both academic schools and perform scientific research which makes them second generation types. This trend jumps over to higher education which incorporates the function of applied research, intertwined with experimental farms and advisory services. The idea behind this is that

central hubs of life-long learning and applied research are close to the clients, in different districts of a region. Peer-to-peer learning processes (like operational groups) are quite popular in several regions. The challenge for AKIS is to organise multi-knowledge networks that integrate initial and post-initial education and training.

3.4.3 Impact of the Collapse scenario on AKIS

Economic and political

KIS work with a 'must reach all' interaction, as agriculture now is essential for everyone. The focus is on small group learning processes. Farmers are the pivot in the food chain and enjoy a high social status. AKIS are very important but fragmented and locally organised. As nearly everyone works in agriculture or connected sectors (like herbs for medicines) the AKIS have a large target group. This group is divided in three types of jobs: land managers, technologists and knowledge workers. The focus in the AKIS lies on the primary production process, resources such as soil and water and food safety issues due to e.g. animal diseases. AKIS are characterised as problem oriented. A lot of (previous) knowledge on agriculture went lost due to less access to internet and digital sources. There is need for 'knowledge caretaking' also known as restructuring AKIS to avoid (further) knowledge losses. Good absorption capacity is viewed to be important for survival. The first priority is on regaining basic skills with help of information from elders (the grandparents). One learns though trial and error. There is strong community thinking. The agricultural sector and actors exist of local networks that differ within the EU because of nationalisation on the one hand and the work in small communities on the other hand. AKIS are struggling to address the variety in society within the different communities. It is a challenge to make use of the potential of new ways of farming. An important working method is stimulating community thinking and access to variable ways and branches of agriculture. English is no longer the dominant language; knowledge is communicated in different community languages and dialects.

Technology, knowledge and innovation

Innovation is characterised by urban and ecological farming. Europe depends on China which controls genetics, ICT and big data. Innovation agendas are set by individual communities. Projects are often supported through charity and philanthropic organisations. Donors can be very decisive in allocation of AKIS resources. Projects are conducted through small groups and individuals in communities working on new entries and ideas for farming. Agriculture has cross-overs with other industries to further develop urban farming, farming and city development. Integration with health science and research becomes more important like new plants and food as medicines. Knowledge development happens on a small scale and mostly concerns private R&D. Research and innovation topics are e.g. technological development for farming, food security, optimization and food safety in relation to food composition (nutrition) and usage. AKIS facilitate combining research results and the dissemination of results to a wider public, connecting people through applied solutions. Public-private research is facilitated through foreign (e.g. Chinese) research programmes ("Orient-ation 2060"). It concentrates on negotiating global deals with e.g. China and the USA on acquiring basic knowledge. Education and (vocational) training focus on hands-on information, agricultural basic skills and craft work. The best students are recruited for the student exchange programme quota for China.

Knowledge organisations and other AKIS actors

Universities suffer from reduced public funding as they struggle to stay alive and to avoid loss of relevance. Focus in science is on societal challenges regarding food security and climate change, especially adaptation scenarios. There are hardly any financial means left for scientific research thus universities distinguish themselves in the quality of teaching, turning back to first generation university types (Wissema, 2009). There is more demand for applied research. Fundamental scientific research and know-how is obtained from China and India and through "knowledge archaeologists" that search for and dig up saved and left over knowledge sources. Experimental farms cater for the needs of local farmers while advisors and agricultural coaches return to traditional extension workers to instruct farmers how to apply knowledge and innovate. There is a push to think about applied solutions led by many interests and individual competition. This leads to connecting actors in agriculture in networks. Innovative farmers are the head group of the peloton and distribute their skills and experience in local operational groups to facilitate colleagues. Donors (non-governmental organisations) and educated locals like school teachers help to organise communities. The driver is to form a school (of 'fish') that together leads to a stronger local

agricultural business, than individual farmers themselves. The demand for initial and post-initial education can be divided into three levels: 1) vocational for skills and craft work, 2) higher education for advice and extension work and 3) the academic level for scientific development, teaching and (applied) research.

4. Conclusions and recommendations

The reader of scenarios might be tempted to choose one of the scenarios as most attractive. In case of three scenarios like above, there could be a tendency to agree on a scenario that on some important aspects is in the centre, with the other being more extreme. However that is not the purpose of a scenario-analysis. Scenarios represent external circumstances that are not under the influence of the decision maker, in this case the SCAR community. One could argue that the European Union could influence some of the developments that are important in the three scenarios, but reality in dossiers like climate change, immigration, the future of the euro or the position of the UK or Greece in the EU, are not fully under control of the Commission, the Council or the European Parliament.

Scenarios are not created to choose from, but to prepare for the situation that they might come true. Of course the scenarios will most likely not become history in exactly the way they have been described here. But important elements of them (also in other combinations) might be faster a reality than some of us wish or dare to think. Scenarios should be evaluated on the question if they contribute to a strategic conversation: what are we to do at this moment to make AKIS more robust for these futures, how can we make it future-proof? To support this discussion, table 1 summarizes the way AKIS is organised and governed in the three scenario's.

Table 1: Organisation of AKIS in the three scenarios

Characterisations	**High tech**	**Self-organization**	**Collapse**
Economic			
Geographical economic scale	Stronger internationalization and more specialized orientation.	Stronger regionalism and more general orientation. Community oriented.	Stronger individualism and holistic orientation. Clan oriented.
Financial	Large scale private R&D. Private industry does not compensate reduced public R&D. IPR (intellectual property rights) provides funding.	Mix public-private. Farmers pay for advice and new actors in AKIS. Linked to regional governance. Stress by rapid change "everybody is challenged".	Small scale private R&D, some local awareness building. Rising urban farming. Individual but rising community thinking. Often tribal (family/area).
Role of consumer (feedback)	Consumer: indifferent in product choice; "it is all far away anyway" but issue management via NGOs.	Consumer: co-creation and incident oriented "problem-by-problem".	Consumer: food first, no big quality issues. Essentials first (like animal disease research).
Language used	English.	Multi-linguistic actors and projects as connectors.	Your own.
Political			
Governance	AKIS centralized and privatized. No independent public funding.	AKIS decentralized and diverse (public-private collaboration).	AKIS fragmented and local (farm/food driven). Very specific and localized AKIS.
Government role and policy	Minor role of government, private multinational business models dominate. Guerrilla type of resistance ('non-corporate AKIS').	Government active on community level, mixed public-private orientation & regional public finance. Grass-root research and innovation.	More local groups and individuals: fragmentation & "many internets". Rising status and importance of the agricultural sector in policy making.
Agenda-setting	Agenda set by business.	Agenda set by	Agenda set by individuals

		communities.	and donors.
Organisation of food safety	Trust: monitored by large companies. Certifications and global institutions important.	Trust in civil society is high via transparency: "arguments count, not positions".	Trust: about rebuilding institutions. Government fragments are important and influential.
Technology, knowledge and innovation			
Driver for innovation	International competition.	Regions in both competition and collaboration.	Individuals and small groups searching for new entries and ideas to farming.
Risks in innovation	Risk: Danger of exclusion (closeness) & controlled access. "Access for the few".	Risk: much "muddling through" and sense of "nothing is gonna change". Reduced capacity AKIS.	Risk: outside control of ICT (China). "Local survival of the strongest".
AKIS-skills / type of competences	"Up-skilling" through the need for specialized knowledge & skills in international networks and consulting.	"Multi-skills", efficiency, territorial and value competition. Community representation, "peer consultation".	"Basic-skills", problem oriented towards the basics as food, soil and water.
Basic educational orientation / profession of farmer	Technologists, not land managers.	Land managers, not technologists.	Technology and land management.
Domain of AKIS	AKIS go for non-food (bio-boom).	AKIS go diverse – increasing in numbers.	AKIS go for more community thinking: access to variety. Food only: bio-scarcity.
Internationalisation	Connecting the globe: centralized research; dominance by a few large companies.	Connecting regions, decentralized research.	Connecting people through applied solutions.
Focus of AKIS	Global food chains and flows. Strongly product oriented.	Adaptations in the regional setting (cooperatives). Strongly farm system oriented.	Food composition (nutrition) and usage.
Tools in AKIS	Global tools & benchmarks, economic efficiency and labelling; thematic cross-overs. IPR is important.	Demos & regional network tools, institutional efficiency (best practices).	"Must reach all" interaction; small group learning processes; trial and error.
European Research programs	Large PPP between EC and multinationals dominate (like in Future Internet PPP and Biobased PPP). JPI and KIC survive, ERA-nets disappear (no national funding).	Very differentiated landscape of AKIS all over Europe. They need to be linked but it is difficult to find good instruments. The role of the EU becomes less important, most influential in basic science and in research infrastructures.	Not relevant, as EU is hardly relevant. Concentration on negotiating global deals on acquiring basic knowledge. Recruitment of the best students for the student exchange program quota for China.
Cross-overs with other industries	Important (see ICT and Biobased PPP). More beta science than social science. Strong specialisation in disciplines. Technology	Multidisciplinary. Need for (traditional) agricultural research in combination with other disciplines. Technology / beta science is important, in	Urban farming, attention for farming and city development. Health science / research becomes important (new plants / food as medicines).

	becomes more important than (traditional) agricultural research.	combination with social science.	
Knowledge organisations and actors			
University	Direct contact on research and education programs with companies. Silicon Valley model. Innovation is part of the business model (patents etc.). 3rd generation university (teaching, research and innovation). Students from all over the world through MOOCs and TEDx's. Only a few, big Life Science universities in Europe. Campus with research stations.	Many regional universities that collaborate and specialise 2nd generation universities (both teaching and research).	Struggle to keep alive and stay relevant due to reduced public funding. Focus on the societal challenges of food security and climate change. Less money for research, focus on teaching. Back to first generation university (teaching).
Applied research	Moves into (applied) *universities*. Companies find it more attractive to deal with universities. Public support declines.	Moves into applied (higher) *education*. Life-long learning hubs. More intertwined with experimental farms and advisory service.	Relatively important over fundamental research. Gets part of its basic know how from fundamental research in China and India.
Farm research stations	Public funding ends. Collective funding via levy / commodity boards ends; some are saved by big farms.	Networked in a research infrastructure and on campus with education. Farmer field schools and on farm research.	Cater for the needs of local farmers.
Advisory service	Advice is a service provided by multi-national food companies and input industry, and their computer-generated advice. Public extension disappears. There are some certified independent consultants and coaches (facilitators).	Mix of public extension service and commercial advisory organisations. Linked with applied research and higher education.	Para-professionals act as the traditional extension-worker that gives instruction on low-risk practices. Could be part-time farmers or local problem-solvers like teachers. Extreme big role of donors.
Operational groups / interactive innovation	Less relevant as innovation is more top down driven.	The challenge is to organise multi-knowledge networks that integrate education and training.	Innovative farmers contribute to local innovation.

To make the AKIS more robust for the three scenarios[1], the SCAR strategic working group AKIS identified the following actions that could contribute to more resilience of the AKIS at European, national and regional levels:

[1] The scenarios might also be used to program research or promote innovations on certain topics that are very relevant for one or more scenarios like permaculture (Holmgren,2002) in the Collapse scenario or the functioning or cooperatives and the role of trust in the Self Organisation scenario. As research programming is not the objective of this report, this is not pursued here with the exception of a few issues like ICT, social science and cross-overs that also heavily influence how AKIS is organised.

Research on ICT and especially its governance. The role of ICT and how information systems are used and governed is an important aspect in the three scenarios. The differences between the scenario's High-Tech and Self organisation is mainly based on the way ICT is used and data is owned and shared in the society. There is a need to investigate the governance of data-exchange and where needed to create neutral platforms on which farmers, SME, consumers and others share data.

Cross-overs between agriculture and themes like ICT but also other sectors in the bio-economy (like chemistry, energy, logistics and waste management) are a direct consequence of the importance of ICT as well as the bio-economy. Design studies (for an era where totally new products are possible with genetics, ICT, nanotechnology, and richer consumers have new desires) is an interesting sector too. Such work on cross-overs will influence the AKIS itself in the sense that AKIS need collaborative and absorption competences to run cross-over research and innovation programs. Collaborative competences refer to capacities in the AKIS to find partners in other sectors and to successfully cooperate with them. Absorption competences refer to being able to apply research and innovation results from other sectors in agriculture. Such competences should not only be available in the universities, institutes and research stations that carry out R&D or are active in innovation but certainly also at the level of programming and financing. This is not new. In the 7th framework program and H2020 DG RTD and DG Connect have experiences in running generic ICT-programmes that include projects for application in specific sectors like agriculture and food. Some member states have specific programs that target cross-over innovation.

Big Data is a development that not only will influence agriculture but also science, research & development and innovation processes in the AKIS. This goes much deeper than open access and linked open data sets in science. Especially methods and incentive mechanisms for farmers and consumers to share their data real time with researchers deserve attention. Where the past is characterized by doing research on data from one experimental farm or only a sample of farms (like in the FADN) that results into one advise for everybody, the future is characterized by doing research on data of all farms, real time, that results in individually customised advises for individual farms. That also further blurs borders in AKIS between research and advice. In designing such methods and incentive mechanisms for sharing data it should be realised that the governance mechanism of data platforms and the attitude of farmers and consumers on sharing data with research is very different in a High Tech scenario than in a Self Organisation scenario. Early positive successes in this area could also influence the developments that lead to the different scenarios.

Social sciences including economics, are an important discipline, not to be neglected in programming research. ICT as well as the challenges of the transition towards one of the different scenarios (or a mix of them) underpins this need too. This should partly have a reflexive character, that helps actors in the transition by monitoring and evaluation (in the sense of a learning process). This implies that not only challenge-based, agricultural research and innovation should have work packages for social sciences (and be multi-disciplinary), but that there should also be some basic programs on social sciences where agriculture and food is a case to study new ways of governance, public administration, political economy etc.

Interactive, transdisciplinary innovation as well as transdisciplinary research & development processes should be strengthened in the AKIS. Using 'innovation in the wild' that reflects local needs and circumstances and the competences of an educated, creative population in a diverse European society is essential in the scenario's Self Organisation and Collapse. But also in the scenario HighTech it is useful that people can adapt centrally developed innovations. The developments in ICT with easier data exchange and communication channels between farmers and research makes interactive innovation easier and more likely. New rewarding and assessment systems in research and innovation are needed to foster this type of innovation, and would contribute to some of the other actions in this list too.

Public – Private Partnerships in research and innovation for agriculture should be tried out. In scenarios like HighTech and Self organisation these will be more used than in today's world. In agricultural policy (e.g. on sustainability) and in innovation processes around specific agricultural products, farmers do not want different incentives from food companies and government, that are hard to integrate in one management decision. They want synergies so that for instance part of the cost of sustainability measures (like ecological focus areas) can be paid for by a certified niche product of their chain partner, and the rest by a

CAP premium. In a similar way they benefit if innovation on such topics is coordinated. Via levy boards (commodity boards) many countries have a long tradition of public-private partnerships and the same is true for DG RTD in the ICT-areas. Some sectors are taking initiatives to coordinate research and innovation (like the Animal Task Force). This could be a fertile soil to experiment with public-private partnerships at a European level. In designing such programs it is important not only to connect with e.g. the seven largest sugar beet or dairy companies (which fits in the High Tech scenario) but also make space for SME to collaborate in such programs. This not only would fit in the Self organisation scenario, but in many industries part of the innovation is done by SMEs (be it start-ups, spin-outs from universities or small support companies from e.g. ICT or Design) that are in a later successful stage bought by multinationals to realise global growth. This means that also multinationals have an incentive to include SME in such innovation programs, with respect for their limited possibilities to contribute to financing them. In addition also NGOs (non-governmental organisations like the World Wildlife Fund or Greenpeace) should be invited to take part in such partnerships as they often act as change-agent in public issues like sustainability.

Involvement of regional authorities and cities in research and innovation in agriculture and the food system should also be tried out. These authorities should not only be participants (beneficiaries) in the program but also contribute to its funding, not unlike in joint programming initiatives. Experience in this type of collaboration is relevant for futures that are described in the Self organisation and Collapse scenarios. Topics like healthy food for children, food and aging, malnutrition, short supply chains in relation to the current retail infrastructure and mobility issues, peri-urban farming (multifunctional services around the city), urban farming, vertical farming etc. are just some of the topics that might interest cities that, like London, Amsterdam, Barcelona and Gothenburg, have a food related policy agenda.

Excellent Research Infrastructures are relevant in all three future scenario's. In several scientific areas Europe has created common Research Infrastructures, under the guidance of the European Strategic Forum for Research Infrastructures (ESFRI). Originally these were centrally located hard infrastructures that were too expensive for a member state (like the collider of CERN in Geneva), but RI's are now also soft (e.g. databases and standards or protocols), distributed and virtual and include for instance blood banks and DNA data for health research. Until now the concept has not been taken up in agriculture and food (with the exception of a recent proposal to start a DISH-RI on food choice and food intake by consumers, linked to body status and health). The scenario-analysis on AKIS suggest however that the idea might make sense. In the High Tech scenario it is probably the multinational industry that links and coordinates innovation programs in farm research stations and applied research in the different regions to develop and test new seeds, analyse big data, investigate cropping rotations or no-tillage etc. In the Self Organisation scenario the regional specialisation and relatively low regional budgets make European research infrastructures as a coordination mechanism interesting. It could be easier to exploit together a research infrastructure as a platform in which regional AKIS-partners could collaborate and compete, than to organise joint programming where regions have to contribute financially and then a central committee decides what happens. It is the difference between subscribing to a service and paying a levy. In a Collapse scenario the fast climate change implies that it could be beneficial to have some mechanisms were know-how on innovation in farming moves from one region to another, as cultivars and pests migrate.

International collaboration with international partners (other continents) is attractive in several scenarios, however for very different reasons. In the High Tech scenario companies in the input industries and food processing and retail dominate on a global scale. That makes it useful to collaborate with other global powers on standards (IPR, food safety, data exchange), basic science and regulating the industry. Top universities that work with these companies in innovation as well as being a place for recruiting the managers of the companies will also adopt a global perspective. It makes sense to support some European universities to develop themselves in a global leadership position. This also makes Europe a more attractive place for headquarters and research labs of those multinational companies. In the Collapse scenario the motives for international collaboration are quite different. Collaboration with Africa and the Middle-East moves from altruistic motives to targeted actions to combat effects of climate change and reduce migration. With China and India, who in that scenario invest heavily in basic research and are investors in European agriculture and the food industry, the motive is collaboration in and access to basic research. Whatever the future looks like, these potential developments make it attractive to invest in more joint programming of research at the global level. The USA, Africa, China and India resemble attractive partners, although that should not rule out others.

A real *European Research Area* is a prerequisite for many of the actions suggested above. With the European Innovation Partnership (EIP) for agricultural productivity and sustainability in Horizon 2020 and the CAP, this research area is becoming a bit more advanced. The EIP includes processes in which farmers become aware of (applied) research done elsewhere in the EU. Multi-national farmers' cooperatives (nearly 50 cooperatives have members in more than one member state, and others are also active cross borders) and input industries working in many countries also contribute to integration. The Erasmus program helps too, now also farm advisors are active in exchange programs. Farmers that are more mobile, and e.g. use the internet or visit international agricultural fairs like DLG fairs in Hannover or the SIMA in Paris, also become more aware of what research and innovations are carried our elsewhere in Europe.

Nevertheless the ERA is still a patchwork that leaves much to be desired. A small (but on the European level not unneglectable) part of it functions as a market with tenders for research in which players have very different 'business models' with which they compete and collaborate. Some research institutes for example function as a not-for-profit company that have a full cost pricing model, while others are hardly motivated by money or receive considerable 'state aid'. A large part of the ERA also functions nationally or regionally as part of the administration (often in an agency at arm's length of the central government) under political governance without much incentives, other than curiosity, to collaborate and specialise. Or it is a local market in which a small number of universities compete. Especially this national or regional part is in many regions confronted with large budget cuts. This not only reduces the amount of research but also hampers the hiring of new young staff, often one of the mechanisms how applied research takes up new ideas from basic science. Or, like in extension, public functions lose from private organisations. It also reinforces the need for common research infrastructures as a platform in which a European market could function.

A starting point for this action would be to have a much more informed discussion in Europe on the need for a real European Research Area and how it should look like and function. In this respect it does not help that the current system is not well understood. Fortunately in the last years the AKIS has been much better studied, not only by this strategic working group but also in European projects like Solinsa, FarmPath, Pro-AKIS and Impresa. The role of education in the ERA is still unclear, and probably undervalued seen the trend towards life-long learning. One of the next steps might be to try to understand the European Research Area, and its potential futures, better by modelling the area. Research projects that try to understand the functioning and resilience of food chains could probably include or be inspirational for new projects on trying to understand in more detail the functioning of the ERA. New techniques like agent based modelling and interactive serious games might help. This would also help to carry out an impact assessment of the action points we propose as an insight from our foresight resulting in the three scenarios High Tech, Self Organisation and Collapse.

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