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AGRICULTURE & INNOVATION

EIP-AGRI Seminar
'Data revolution: emerging new data-driven business models in the agri-food sector'
SEMINAR REPORT
22-23 JUNE 2016

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1. Introduction

The development of Information and Communication Technologies (ICT) and sensor-based technologies, procedures and software has enormously increased the amount of data collected and data available in agricultural sectors and throughout the whole supply chain (from farm to fork). The appearance and adoption of biosensors, nanotechnology, low-cost electronics, the Internet of Things or remote sensing devices, among others, will further boost the data domain. This development offers significant potential for new data-driven business models.

Several initiatives are already in place, many are quickly developing, and even more initiatives are just ideas. This state of infancy suggests that it makes sense to connect initiatives by bringing the community together and by giving people who are launching or conceiving new data-driven businesses the opportunity to discuss, test and enrich their ideas while meeting other members of the community. This was the idea that triggered the organisation of a seminar within the framework of the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI) by the European Commission's Directorate-General for Agriculture and Rural Development in cooperation with the Institute for Agrostrategies and Innovations in Sofia, Bulgaria, on 22-23 June 2016.

The seminar also reflected on how agricultural and rural development policy can support the data revolution for an enhanced productivity and sustainability in the wide agri-food chain, covering different sectors, farm types and production systems. The concrete objectives of the seminar were:

- To identify and discuss existing and potential data-driven business models in the agricultural sector, including the whole supply chain
- To identify enabling conditions for these business models, and strategies to support their development
- To bring people together to further develop data-driven business models

Experiences and ideas of participants were at the core of the seminar by using participative methods.
Many participants presented their business models to other colleagues and innovators.
This document is the report of the seminar. It is partly based on keynotes given at the seminar by Krijn Poppe (LEI Wageningen UR) on data-driven business models and by Iman Boot (DG AGRI) on available support measures. Many of the insights in the report come from the interactive workshops in the seminar.

More information on the seminar, including the agenda and presentations, can be found on the EIP-AGRI event webpage.

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2. Summary

ICT and sensor-based technologies increase the amount of data collected in agriculture and throughout the whole supply chain. This development offers significant potential for new data-driven business models. In June 2016, the European Commission's Directorate-General for Agriculture and Rural Development organised a seminar in Sofia, Bulgaria, in the framework of the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI). The goal was to reflect on how agricultural and rural development policy can support the data revolution for an enhanced productivity and sustainability in the wide agri-food chain. Just over 100 persons from all over Europe participated in the seminar, which was organised in a very interactive, bottom-up way. The seminar was designed according to its three main objectives: To identify and discuss existing and potential data-driven business models; to identify enabling conditions; to bring people together to further develop data-driven business models.

ICT can be very disruptive to current business models, as for instance Uber shows in the taxi world. A very dramatic example is Wikipedia, where an arrangement on a voluntary basis wiped out the commercial market for encyclopedias. It also raises the question how money can be earned with data. Five types of business models are typical (Van't Spijker, 2014):

1. basic data sales
2. product innovation
3. commodity swap: data for data
4. value chain integration
5. value net creation

Examples of all five types were discussed at the seminar, with an emphasis on data (or software) sales, value chain integration and value net creation. Small or medium-sized enterprises (SMEs) dealing with ICT were the main types of participants at the seminar. For these participants, product innovation was more associated with manufacturing agricultural equipment, and commodity swaps rather with data exchange between farmers and food processors.
Discussions focused on limiting and encouraging factors for data-driven business models. The following groups of limiting factors were identified:

- A lack of awareness of the possibilities and benefits of data-driven applications for agriculture. For ICT developers this implies a necessity to focus on farmers' needs.
- The lack of standardisation and interoperability.
- Incentives for letting farmers share data are needed to add value to data.
- Discussions on the governance of data and the potential effects of ICT on the food chain.
- Financing the investments in data-driven solutions.

By far the most encouraging factor for data-driven business models in agriculture and the food chains is of course the insight of innovators that problems (whether they are operational problems at farm level or societal challenges at large) can be solved by a clever application of ICT. The problems of today are the business of tomorrow. Governments offer support to innovators in many ways, from (financial) support for starters to research projects that provide results that can be used in commercial applications. In relation to data-driven business models in agriculture, the European Commission – DG AGRI in this respect focuses on the innovation-driven research approach and on the interactive innovation model through the European Innovation Partnership "Agricultural Productivity and Sustainability" (EIP-AGRI). Operational Groups, Thematic Networks and Multi-actor research projects are key activities, with financial support from the Rural Development Programme

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and Horizon 2020. The EIP-AGRI Service Point organises relevant seminars and focus groups, and enables networking.

The EIP-AGRI seminar has helped to create awareness that ICT and sensor-based technologies, procedures and software are being implemented in agriculture and the food chain. However, it is also clear that we are still in a state of infancy concerning data-driven business models. Seminar participants welcomed the opportunity to connect initiatives by bringing the community together. In line with practices in the ICT community, participants decided to create an online platform to stay connected and exchange information on Slack: https://agridata-eu.slack.com/

In addition to what innovators can do themselves, the European Commission could take actions that overcome the limiting factors identified at the EIP-AGRI seminar. Five actions were suggested that have a high potential to promote data-driven business models:

- Develop an EU ICT Architecture Strategy for AGRI-FOOD to provide guidance on the desired information architecture, for a food sector based on family farms and SMEs in food processing
- Active provision of digital data by government organisations with open data, and integration of government data capturing with systems in the food chain
- Solve the discussions on data ownership and data governance
- Make a more in-depth analysis of data-driven business models to learn what works and what doesn't
- Create a research agenda for real-time agronomic models, to transform data into information that can be used for making farm decisions.

3. Participants

108 persons participated in the seminar, as a result of two invitation rounds. The first one followed a public call for participants. That call resulted in more than 300 applications from many countries, including several outside of Europe. From this round, the participants that are the most relevant and interesting for Europe were selected, based on their cases and motivation. The second invitation round was based on a selected pull of organisations which were kindly requested to propose participants. These included among others some standard organisations, industry organisations like CEMA, IFOAM, CopaCogeca, CEJA, EUFRAS, etc. By far the majority of the participants came from the first group and more than 40 participants actively wanted to present a case in which they were involved.

The group of participants was relevant to the topic, well balanced geographically (see table) and in terms of profile. There was a significant participation of the private sector through many ICT-SMEs and not much participation from big players (big machinery companies, food industry, other ICT-providers, etc.).

The seminar was designed according to its three main objectives (Identify and discuss existing and potential data-driven business models; identify enabling conditions; bring people together to further develop data-driven business models). It put the participants and their contributions at the core of the event with only two classical presentations. The rest of the time was devoted to different types of group work and interactive discussions. According to the evaluation by the participants, the third objective was clearly achieved.

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Participants very much stressed the opportunities to meet potential partners and extend their network. The first objective was also quite well covered. The second one, the identification of enabling conditions for data-driven business models, was only identified as being reached by around one third of respondent participants. Nevertheless, 65% of respondents improved their knowledge on the EIP-AGRI and on Operational Groups (OGs).

Country	Participants
Austria	2
Belgium	7
Bosnia and Herzegovina	1
Bulgaria	13
Croatia	1
Cyprus	1
Estonia	2
Finland	3
France	5
Germany	5
Greece	8
Hungary	3
Ireland	4
Italy	10
Lithuania	3
Montenegro	1
Netherlands	9
Poland	2
Portugal	3
Romania	1
Serbia	1
Slovakia	1
Slovenia	2
Spain	12
Sweden	4
United Kingdom	4

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4. Data innovations in agriculture and the supply chain

Information and Communication Technologies (ICT) change the world we are living in. Cloud computing, Internet of Things, location-based monitoring, social media, block chain technology and big data are technologies that have a high potential for unprecedented innovations and that have led to disruptive business models in several industries. These technologies are quickly invading agriculture and the supply chain, from input industries (like the machinery industry) via farming and food processing, to logistics, retail and even the consumer when it comes to food and health apps.

The state of the macro-economy is characterised by a major economic crisis. Innovation is needed to create a smart, sustainable and inclusive society. This situation suggests that we need institutional innovations that change the way we organise our economy. These could come from a focus on using ICT as driving technology to solve societal challenges like food and nutrition security, climate changes, environmental issues and healthy diets for a healthy life (Perez, 2002; Poppe et al, 2013). These innovations include new business models and they will probably bring further changes in the organisation of the supply chain. Large organisations in the supply chain have already digitalised most of their data, but data exchange and interoperability between organisations is still poor. There is room for productivity gains (fewer administrative burdens) and there is an under-exploitation of ICT in monitoring and managing production and consumption processes, to make them more sustainable. The increased interoperability that is needed can be created by software ecosystems for ABCDEFs: Agri-Business Collaboration & Data Exchange Facilities (Poppe et al, 2015a).

Depending on how such software ecosystems are developed, two scenarios have been sketched (EU SCAR, 2015). One is that of a **Captive Prescriptive Model**: the farmer becomes part of one integrated supply chain as a franchiser / contractor with limited freedom, and is supported by one platform for e.g. the potato breeder, machinery company, chemical company, and the french fries processor. In this case the integration with service providers and the government is likely to be weak. A second scenario is that of an **Open Collaboration Model**: markets for services, apps and data are developed in common, open platforms with fewer lock–in effects. The business model of such a platform is probably more difficult, because it requires a higher common investment, to be paid up front. But probably it would also mean more empowerment for farmers and cooperatives. Against this background, it makes sense to look to new data-driven business models in more detail.

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5. Data-driven business cases

A business model describes the rationale of how an organisation creates, delivers and captures value in economic, social, cultural or other contexts. The process of business model construction is part of a company's business strategy. A business model has several dimensions. The value proposition is the main element. It describes what service is delivered to a specific group of clients. The value architecture describes the organisational infrastructure and the technological architecture which allows the movement of products, services, and information. The value finance provides details on information related to how income is generated, with elements such as the total cost of ownership, pricing methods, and revenue structure. The value network articulates how the company collaborates with other organisations. A very popular tool to create and visualise a business model is Osterwalder's Canvas Model. Several interesting examples can be found in the literature and on the worldwide web. The attractiveness of the tool is that it visualises the different aspects of a business model, as described above, on a large surface (at least an A4 landscape piece of paper) so that groups of people can jointly sketch and discuss business model elements with post-it notes or board markers. It is a hands-on tool that fosters understanding, discussion, creativity, and analysis, and that supports all types of business models (see Osterwalder et al, 2010).

ICT has an effect on business models. It can be very disruptive to current business models, as for instance Uber shows in the taxi world. A very dramatic example is Wikipedia where an arrangement on a voluntary basis (in the 'commons') wiped out the commercial market for encyclopedias. It also raises the question how money can be earned with data. In his book "The New Oil - using innovative business models to turn data into profit", Van't Spijker (2014) has suggested five types of business models:

1. basic data sales
2. product innovation
3. commodity swap: data for data
4. value chain integration
5. value net creation

Below we discuss these types in more detail, based on the literature (Poppe et al, 2016, some of the text below is taken from that report; and Ge and Bogaardt, 2015) and illustrated with some inspiring examples presented at the EIP-AGRI seminar reported on here.

Basic data sales

Most examples on data-driven business models, also those presented at the EIP-AGRI seminar, can be classified as a form of basic data sales: software is created to help farmers or others to collect data (by manual registration or a relatively simple sensor), data is in some cases linked to other, open data and then information for the decision maker is generated. Essentially, the buyer pays for the software or data, either by subscription or by paying up front for the software package or data set. Two examples from the EIP-AGRI seminar deal with the cost of production data in Italian dairy farming, and tracing and tracking in honey production in Montenegro (see box 1).This category includes examples where the software is sponsored by the government or a research / advisory organisation, and where it is given away for free. Food processors sometimes offer a similar support, but often these are examples of commodity swaps (see below), as the farm data is also useful for the food processor.

In the case of basic data sales in agriculture, we often think of the farmer as being the client of the data-driven business. It would be interesting to test the idea of farmers sharing or selling their data to others, for instance via a cooperative. An example from the USA is the Farmers Business Network (FBN). Its mission is to

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Milk and honey

MILK MONEY is the first online internet-based system to benchmark milk production costs in Italy. The tool was developed by CRPA with the financial support of the Emilia Romagna Region. Any technical adviser or dairy farmer who pays an annual fee can easily get access to the system, calculate his milk production costs, revenues and profitability. They can then compare the result with a range of farms selected according to specific criteria. The possibility to benchmark the farmer's own results with groups of farms located in the same area gives the farmer the opportunity to understand which cost or revenue items are out of range and need to be investigated to understand the reasoning behind them. This knowledge has in most of the cases been an important input to adapt the farm strategy and improve profitability.

The honey traceability programme in Montenegro implements value-added services through food safety and quality assurance. According to the users, low quality honey from unknown sources is a significant concern for the growing industry. This creates food safety issues, undercuts fair market prices and damages the industry's reputation for quality and safety. The goal is to create an online database of all natural honey producers in Montenegro with data about the beekeeper, bee hive, queen bee, GPS position of bee hives, weather conditions at the bee hive location, and honey variety produced. Collected data will allow the creation of a central website with all data for all beekeepers in Montenegro. The website would also offer QR codes for each beekeeper, which should be printed to be put on honey jars. The QR code, scanned with a smartphone, will allow users (customers, consumers, but also beekeepers, importers and exporters) to access the respective website with all data. This will bring transparency and will clearly demonstrate the value of the honey that is provided – starting at the hive. Feedback from customers and consumers will be encouraged, and it will be open and displayed, ensuring healthy business competition. Beekeepers will pay a monthly subscription fee for website data updates.

Box 1

make data useful for farmers to select the optimal seeding grade for their variety and their field, in order to reach a maximum potential. In 2015 FBN aggregated data from 7 million acres of farm land across 17 states in the USA. FBN is able to assess the performance of 500 seeds and 16 different crops. No data is shared with other parties. Access is by payment: 500 USD per year. FBN is not linked to any agri-business company, but it received investment by Google Ventures. They are a community of farmers and independent persons (Ge and Bogaardt, 2015).

Another example is Farmobile, which sells a simple data collection tool that centralises growers' agronomic data from multiple systems in one electronic farm record. Farmobile standardises the data and makes it easily searchable for customers who want to purchase data. Farmobile's data management system starts with a $1,250 annual subscription fee. If farmers opt to share their data through Farmobile, they will get 50 percent of the revenue derived from selling the data. At Farmobile the electronic farm record (EFR) is owned by the farmer. Farmers have the power to authorise or deny access. Data is stored as long as the subscription remains active. The farmer's data is housed on cloud servers of Farmobile. In its marketing, Farmobile claims that "farmers believe their trust has been violated": their data go to multinationals, which announce a large future income from big data, while the farmers have to pay for everything. By the end of 2015 Farmobile had raised $5.5 million in equity financing from Anterra Capital (a growth capital fund, jointly funded by proprietary investment of FIL and Rabo Private Equity).

We classify such services as data sales, as it is software that helps farmers to manage their operations and/or to sell their data. But they could easily develop into a commodity swap or platform solution (see below) when food processors or others add the data they have that is relevant for farmers.

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Product innovation

In the category product innovation, existing products (often machinery) become much more data-intensive. It could even be that the hardware or product turns into a service. An example of the latter is a breeding company that sells sperm for cows and adds services on bull selection and inventory management (of frozen sperm in the farm), or that sells pedometers to track if cows are in heat (to trigger this service delivery). Especially the development of Internet of Things stimulates original equipment manufacturers like tractor and machinery companies, but also developers of milking robots or stable and glasshouse equipment to be very active in adopting this type of business model.

Examples are machine companies like the American corporation John Deere, which collects data from the agricultural machinery of the farmer. This includes the location of the machinery, engine hours, operational data (e.g. amount of fuel used) and diagnostic data of the machinery. All the data is collected in the web portal MyJohnDeere.com. Another example is the Dutch company Lely Industries, which manufactures milking robots and collects data on the performance of the individual cows.

Commodity swap

In a commodity swap, data is exchanged between (for instance) farmers and food manufacturers to increase the service component of the transaction. Examples show that software can be made available by processors of agricultural products to support the management of the farmer and at the same time improve the production or marketing process of the food company. The UniTip software of the Dutch sugar cooperative

Farmers meet consumers on Facebook

Short supply chains that bypass several levels in the food chain and directly link consumers to farmers have many attractive characteristics for both sides. It can mean lower prices, better traceability, a better understanding of how the product is made, more sustainability, and it contributes to local communities, to name a few of the advantages. Farm shops and farm markets are classical ways to organise short supply chains. Like AirBnb and Uber, several initiatives have turned to ICT to organise short supply chains. Several examples were discussed at the EIP-AGRI seminar.

An extremely successful and very interesting example comes from Finland. REKO is a direct selling system from producers to consumers. It is based on the use of social media as a market channel. It is embedded in Facebook, where volunteer administrators run closed Facebook groups with producers and consumers. Such groups are extremely easy to establish (from an ICT point of view): a group is formed, farmers post their offers on a weekly basis, and consumers use the comment option in Facebook to order (and inspire others in the group to place an order too). The orders are delivered at a central point and at a certain time slot for pick-up and payment (e.g. Saturday morning between 10.00 and 11.00 hours at the parking lot of the local school). Existing retailers are often happy to allow the hand-over of products at their own parking lot, hoping that this will lead to visits of consumers to their shop for other products.

The characteristics of this solution are that it is totally free for all (both for producers and consumers), and it requires very little administration and no middlemen. By using an established social media tool there are no costs for developing and maintaining ICT. Three years ago REKO started with two projects in the western part of Finland. It went well and now there are more than 130 projects (REKO-circles) running, with a total number of more than 180 000 members involved. The estimated turnover for 2016 is 30 million euros. Initiator Thomas Snellman received several awards for his initiative.
This example shows that it is not technology as such but the aspect of social innovation that creates new opportunities with a data-driven business model. Data-driven, as ultimately it is the exchange of data in Facebook that generates the business in REKO.

Box 2

Cosun is an example: farmers can register their field data in the software of the cooperative. They then receive management tips and benchmarking data. At the same time the cooperative uses this data to organise its logistics, production planning and its marketing (as it can provide its clients with sustainability data). In this example the pressure of the food and drink industry for sustainable production methods at farm level has brought the cooperative to the decision to make the software mandatory for its members by 2018.

Value chain integration

In a value chain integration business model the activities in an existing chain are organised by ICT in an alternative way, as the availability of data makes decision making at another point in the chain more efficient. An example is prescriptive farming, where some of the decision making moves from the farm (based on local knowledge or 'green fingers') to software at another level in the value chain.

Multinational agricultural biotechnology corporations like Monsanto and Dupont have adopted the strategy of acquiring start-ups, to adopt this business model and strengthen their existing position. For example in 2013 Monsanto acquired the weather and agronomic data modelling start-up Climate Corporation, which provides planting advice to farmers based on data science. Monsanto's primary software product FieldScripts also helps farmers to maximise productivity, minimise risks and realise higher yields. This move into prescriptive farming originally also included an investment in a machine manufacturer, but this business has now been sold to John Deere. Monsanto charges $10 per acre for FieldScripts (Ge and Bogaardt, 2015).

A European example in services is the Dutch-Flemish breeding cooperative CRV, which supports dairy farmers in insemination decisions for cows. Where traditionally the farmer looked in the meadow if a cow was in heat and ready for insemination, pedometers have taken over this detection. CRV developed an app that not only signals this status but also suggests sperm from three preferred bulls. As most farmers always choose option A of the list of three, they can now subscribe to a service where CRV automatically delivers the sperm, if not in stock with the farmer already.

Value net creation

Business models that create value out of data by creating new value nets are in essence platforms that link different groups of clients and support their interaction. Often there is an element of co-creation: the data of one group triggers activities by the other group and vice versa. Sometimes such platforms have strong network effects: for users it is attractive to join a platform that other customers have already subscribed to, as in the case of LinkedIn or Facebook. Some of these platforms create new markets, like AirBnb has done by linking house owners and travellers.

Within such platforms a market of specialised apps can be created, like in Facebook. In agriculture several platforms have been set up that create an ecosystem of apps. European examples are 365Farmnet and the Dutch Akkerweb by the international cooperative Agrifirm. Another example is the EU project FISpace (Future Internet Business Collaboration Network) which is now available for commercial exploitation by offering a business-to-business collaboration platform that could link platforms like MyDeere.com, 365Farmnet, Akkerweb, Agriplace and others via a Linux-like Open Source model. Several EU FI-PPP accelerator projects like SmartAgrifood, FINISH and Fractals are using the platform.
At the EIP-AGRI seminar, several interesting initiatives that were presented fall into this category of data-driven business models. Some of these linked farmers and consumers, as in the very successful Finnish example described in Box 2. Others had a business-to-business focus. One of these is the Dutch example of AgriTrust (Box 3), which is of special interest because it helps farmers to execute the ownership of their data and reduce administrative costs.

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Farmers as data owners

Paperwork is important in farming, especially if (tax) accounts are obliged and compliance with certification schemes (like Global Gap) has to be demonstrated. Much of that data is available on computers of food processors or input suppliers, in the form of invoices, delivery notes etc.

In the Netherlands, a huge datahub (EDI-Circle: http://www.edi-circle.nl/) is used for exchanging invoices and several other messages from feed suppliers, dairy companies and the government, to accounting firms and farm management software. In dairy farming it is also the basis for a farm mineral accounting system (ANCA - annual nutrient cycle assessment). Farmers control the flow of data in EDI-Circle with authorisations. They authorise companies to provide their documents to other business partners (e.g. they authorise the feed company to send their invoices in EDI-format to their accountant, their farm management software and their veterinary). Currently this authorisation is done on paper, but a special website (AgriTrust) is under development now that a standard EDI message for authorisations is becoming available. This authorisation system builds trust in (digital) data exchange because it allows farmers to execute the ownership of their data.

EDI-Circle is also used by Agriplace (https://www.agriplace.com/en/), a start-up by a Dutch NGO with a sustainability compliance objective. Agriplace offers farmers a platform to share their certification data with the auditing organisations (like SGS or Control Union which audit GlobalGap and other standards), the certification bodies (like the Dutch SKAL which certifies organic production) and the food processors (or, in the case of farmers in developing countries, with Dutch importers).

In Farm Digital, a Dutch multi-actor public-private partnership project, 1.000 farmers from the Netherlands, South Africa and Costa Rica have helped to create this platform as testers and first users.

Box 3

All in all, the different types of data-driven business models lead to a very dynamic landscape in which the traditional actors of farms, agricultural technology companies (machinery manufacturers) and agri-business companies (chemicals, seeds, food processors) now also see new players like the classical ICT companies (large and small) and the venture capitalists that support start-ups in ICT and agricultural technology (as in urban farming).

Among farmers, the development of new data-driven business models in agriculture has also raised issues about data governance and the companies that exploit such models. These include questions of data ownership (legally a difficult concept), data access rights (including the question of farmers if government agencies have access), but also intellectual property rights on machinery ("Do I still own my tractor if so much of it is a software licence?"). In some cases there are worries about lock-in effects (can farmers take the historical data with them if they move to another supplier?). Some of the business models have also raised the discussion whether big corporations do gain market power on future markets by having access to all farmers' data, or to the role of the farmer in the future (does he become a franchiser with the risks but not the returns?). There are signs that this picture is becoming more clear: companies tend to handle data of farmers as personal information, and systems are being developed (like box 3) where farmers can influence where the data ends up. Nevertheless, there is also more work to do, especially in a European context where privacy issues differ between member states. The privacy aspect of data is only one aspect. It helps farmers to prevent data from travelling to the public, the government and to competitors that farmers do not want to give data access to. The other aspect is being able to use the data as a farmer yourself, and combine it with data from other applications. This can be at this very moment on your management dashboard, or in the future in case you switch to another equipment supplier.

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6. Limiting factors

The EIP-AGRI seminar used several interactive methods to discuss the state of data-driven business models in agriculture and the food chain. Discussions focused on limiting factors, but also encouraging factors were discussed (chapter 7).

First of all, there is a lack of awareness of the possibilities and benefits of data-driven applications for agriculture. If farmers and other operators do not know about the new possibilities, they will not use them. Linked to this lack of awareness is the need for any new data-driven application to show tangible results for the end user. There needs to be a clear return on investment, and the potential buyer of an application should have clear information about its costs and benefits to be able to decide to buy the application or not.

For ICT developers this implies a necessity to focus on farmers' needs: many current applications do not provide real solutions in practice, perhaps because the developers do not understand the reality of farmers' problems very well. Cooperation with clients in developing data-driven business products is essential: speaking with, and understanding farmers and other people in the farming and agri-food sector is essential to develop user-friendly products that address real questions. Especially small farms, where the use of formal management systems to keep oversight is less needed and where farmers are on average much older, are far from convinced that they benefit from applying ICT in their business.

Data as such does not always have value, up-to-date agricultural models are needed to turn data into information. If a farmer knows - thanks to precision farming - that at a certain square meter wheat is not growing very well, he or she can still be unsure what the cause is (weather can be very local, damage by wild animals even more) and if more fertiliser (to promote growth) or less (as it is a waste of money on this poor soil) has to be given.

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Another issue related to the awareness and cost / benefit considerations is the speed of development in itself. This makes farmers and other end users hesitant to buy applications as it is not clear when the best moment is to buy a system instead of waiting for another one that may be even better.

A second limiting factor is the lack of standardisation and interoperability. This also affects the data that is produced and (not always) delivered by public organisations (i.e. several data in the realm of IACS or other weather, agronomic or socioeconomic data). This also hampers the development of new applications. Integrated solutions are asked for by the sector, with flexibility to move between different systems / platforms. This is currently not guaranteed.

A third group of limiting factors deals with incentives for sharing data by farmers. Why should farmers share their data? There should be a clear and 'real' benefit for them to do so. Farmers' trust in how collected data will be used (also by NGOs and government agencies) is important. To generate value out of data, data often has to be aggregated, and data from different sources has to be combined. Data sharing is difficult to achieve, especially when businesses involved think that they can earn money with their own data, and when clear methods to value the contribution of each other's data to the common product or service are not available. A similar reluctance to share data can be observed with public agencies that experience institutional, legal and technical limitations.

More general is a fourth group of limiting factors which deals with discussions on the governance of data and the potential effects of ICT on the food chain. Some worry that the increasing use of ICT will change the division of the value added in the chain and that it will influence the distribution of market power within the sector. It raises the question what type of agriculture we want for the future (family farms or another structure). Some participants at the EIP-AGRI seminar stated that the general framework of where we want to go is not clear. It would be easier to invest with lower risks if there was a clear strategy on ICT in agriculture and the food chain, with some common infrastructure (e.g. data standards) as a result. If this strategy would support a structure of family farms, and if agriculture becomes very much based on ICT, the question arises whether cyber security is sufficiently guaranteed in a system with so many small players.

Appropriate legal frameworks for data ownership are important. Data ownership is in itself a difficult legal concept, as it only exists in privacy laws for natural persons and intellectual property rights including business secrets. This issue is certainly not specific for agriculture, although family farms are an interesting entity between natural persons and (larger) businesses.

A fifth group of limiting factors discussed at the EIP-AGRI seminar relates to financing the investments in data-driven solutions as costs tend to precede benefits. Pricing structures to spread the payment for data services over those who benefit, including farmers, consumers, and society in general could be difficult, especially if environmental or climate benefits are an important societal benefit. Some wonder what the added value is for the end consumer (the citizens) and the farmer (and the operators in between). Another question is who will in those cases pay to implement such technologies. The discussion addressed the issue of food prices: if consumers are not willing 'to pay the real food price', how could new costs be charged or how could new revenues be obtained from the use of these new opportunities? A solution to this problem could be to support the development of such ICT tools, to lower costs and support innovation.

Public-private cooperation / investment to stimulate data-driven business development could be one way to go. Finding the right balance between the requirement to share new findings and results paid by public money, and a market approach would then be important. Discussions at the EIP-AGRI seminar showed diverging opinions on the need for public investment to stimulate data-driven business, and on the support schemes that would be most effective.

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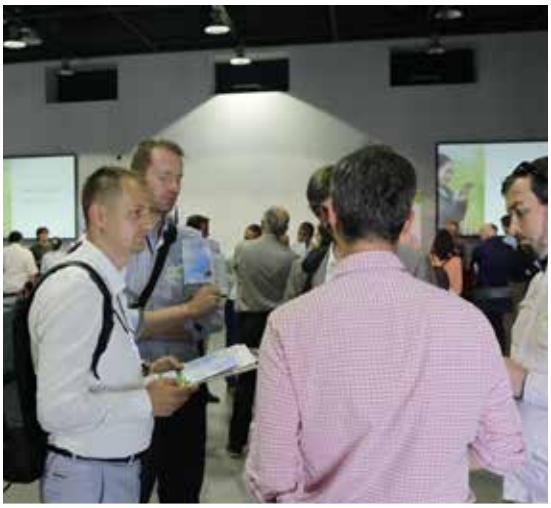

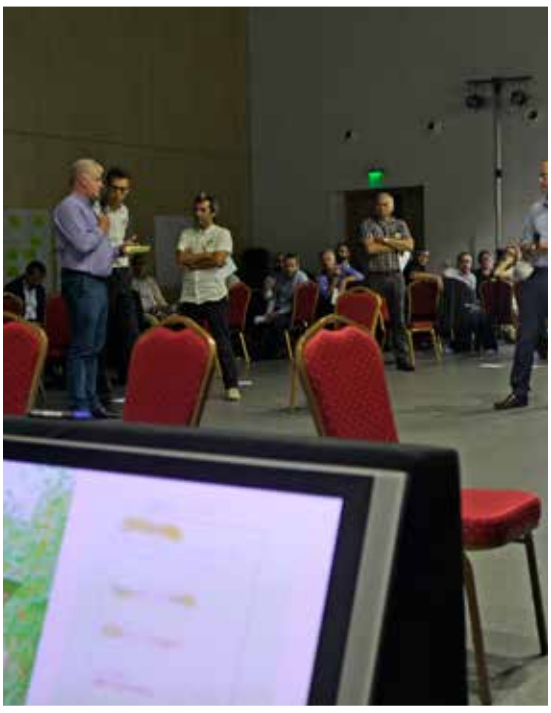

7. Encouraging factors and available support

By far the most encouraging factor for data-driven business models in agriculture and the food chains is of course the insight of innovators that problems (whether they are operational problems at farm level or societal challenges at large) can be solved by a clever application of ICT. The problems of today are the business of tomorrow. Several business models presented by participants at the EIP-AGRI seminar proved this point. As several aspects of the food chain are effected by ICT (see for instance the retail and the growth of webshops) and some consumer segments are unsatisfied with the current food system (for instance making them look for more sustainable or regional food), there are plenty of chances for new value propositions based on a data-driven business model. However, it is also clear that innovation is a risky business and that in this confusing environment many projects do not deliver what their initiators had hoped for.

Governments offer support for innovators in many ways, from (financial) support for starters to research projects that provide results that can be used in commercial applications. In relation to data-driven business models in agriculture, the following information of the European Commission – DG AGRI is relevant (text taken and adapted from EU SCAR, 2015):

At European level, the innovation-driven research approach and the interactive innovation model are promoted through the European Innovation Partnership "Agricultural Productivity and Sustainability" (EIP-AGRI). The focus is on bottom-up approaches and cooperation between farmers, advisers, researchers, businesses and other actors in Operational Groups (OGs) to realise innovations. It is expected that this knowledge "exchange" will generate new insights and ideas and will mould existing tacit knowledge into focused solutions. Such an approach should stimulate innovation from all sides and should help to target the research agenda.

The EIP-AGRI is challenge-driven, focusing on societal benefits and rapid modernisation. Like other EIPs, it streamlines, simplifies and better coordinates existing instruments and initiatives and complements them with new actions or a more coherent policy framework where necessary.

Operational groups are the key acting entities in the EIP. They gather farmers, advisers, researchers, businesses, and

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other actors (e.g. civil society including NGOs and governmental bodies). The forming of OGs takes place at the initiative of innovation actors. No specific conditions are laid down by the EC as regards the size, the composition and the specific undertakings of an OG. OGs have to draw up a plan, describing their specific project and the expected results of the project. Furthermore, the OGs have to disseminate the results of their project, in particular through the EIP network. The exact content of a project plan depends on the actors involved and the problem, issue or opportunity that needs to be tackled. Innovation brokerage can help to find innovative ideas, and help partners to connect and set up an OG formed around concrete projects.
For funding concrete innovative actions, the EIP-AGRI is implemented through actions that are mainly supported by two EU policies: the Rural Development Policy and Horizon 2020. Funding, implementation and prioritisation of actions all take place through the delivery mechanisms embedded in the respective policies.

Several measures under the Rural Development Regulation 2014-2020 can be used to stimulate innovation and the activities of OGs. The cooperation measure (Article 35) plays a key role in the implementation of the EIP-AGRI. Support can be given both for the establishment and operation of OGs of the EIP-AGRI, and for the implementation of their projects. This support can also be combined with support under other measures such as training (Art.14), advice (Art.15), investments (Art. 17), etc. The Rural Development Programme can fund bottom-up innovation projects with a 100% support rate.

Within the societal challenge "Food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bio-economy" of Horizon 2020, two new instruments were developed that support the EIP-AGRI: multi-actor projects and thematic networks. The key feature of **multi-actor projects** is to address the needs, problems and opportunities of end users and to generate the necessary interaction between researchers and end users such as farmers / producers, advisers and enterprises by attributing a clear role to the different actors in the work "all along the project". This combination of practical and scientific knowledge should generate innovative solutions that are more likely to be applied thanks to cross-fertilisation of ideas between actors, and the co-creation and generation of co-ownership for eventual results.

Thematic networks mobilise all concerned actors on specific thematic areas. The aim is to develop end user material to facilitate the discussion on knowledge, and the dissemination and sharing of knowledge in an easy and accessible way. This can serve as input for education and for a research database for end users, making results available long-term. Next to the newly developed EIP-AGRI instruments, a range of existing instruments will continue under Horizon 2020 (collaborative projects, ERA-NETs, JPIs and COST actions).

The concept of OGs may also be applied within various funding sources. The EIP-AGRI is not exclusively linked to the Rural Development Policy and to Horizon 2020. There are also potential synergies with other policies like the EU Regional Development Fund, national or regional funding schemes, private funding, etc.

The EIP-AGRI is supported by the EIP-AGRI Service Point, which connects people and initiatives. Besides operating a website (www.eip-agri.eu) including more information on the EIP-AGRI and a database of innovative actions and projects, the Service Point produces several publications and organises interactive seminars (like this one on data-driven business models) and EIP-AGRI Focus Groups.

EIP-AGRI Focus Groups are temporary groups of selected experts focusing on a specific subject, sharing knowledge and experience. Each group explores practical innovative solutions to problems or opportunities in the field, and draws on experience derived from related useful projects.
The reports of EIP-AGRI Focus Groups on precision farming, benchmarking and short supply chains are especially useful for readers with an interest in data-driven business models.

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8. High potential actions to trigger data-driven business models

The EIP-AGRI seminar on data-driven business models has helped to create awareness that ICT and sensor-based technologies, procedures and software are being implemented in agriculture and the food chain. They enormously increase the amount of data that is collected and available in agricultural sectors and throughout the whole supply chain (from farm to fork). The appearance and adoption of biosensors, nanotechnology, low-cost electronics, the Internet of Things or remote sensing devices, among others, will further boost the data domain. The EIP-AGRI seminar confirmed that this scenario offers significant potential for new data-driven business models. However, it also is clear that we are still in a state of infancy.

Seminar participants welcomed the opportunity to connect initiatives by bringing the community together. This gives people the opportunity to discuss, test and enrich their ideas while meeting other members of the community. In line with practices in the ICT community, participants decided to create an online platform to stay connected and exchange information on Slack: https://agridata-eu.slack.com/

In addition to what innovators can do themselves, there is the question if others, and especially the European Commission, could take actions that overcome the limiting factors that were identified at the EIP-AGRI seminar. Based on the limiting factors (see chapter 6) and further reflections during the seminar, five actions are suggested that have a high potential to promote data-driven business models:

1. Develop an **EU ICT Architecture Strategy for AGRI-FOOD** to provide guidance on the desired information
   architecture, for a food sector based on family farms and SMEs in food processing. For them, data-intensive processes to guarantee quality (tracing and tracking, food integrity) are essential. Such a strategy would provide a more secure investment environment for innovators with data-driven business models. It would solve ongoing discussions on data ownership and data governance as identified during the seminar (second and fourth limiting factors in chapter 6). Most likely, the information architecture would stress (and speed up) interoperability via standardisation at a European level, to make competition and collaboration between data platforms and apps possible and effective. This could also reduce network and lock-in effects. It would sketch how farmers and others (e.g. with authorisations and e-recognition procedures) could execute the "ownership" of their data, to create more trust in big data solutions. It would also sketch how farmers could be simply connected to different cloud data platforms of agri-businesses and governments, from their own integrated dashboard (in farm management software). Such an EU ICT Architecture Strategy for agri-food could probably be delivered by a high level panel (supported by a 'sherpa'-group) with representatives from farmers' organisations, ICT companies (big and small), standard organisations, advisory services, science, and the food, input and machinery industry as well as NGOs (consumer and sustainability interests, NGOs on privacy and data protection).

2. **Open data and active provision of digital data** by government organisations is important for the development of data-driven business models. In many areas new services have been set up by innovative ICT companies and others, with the use of open data of governments. In agriculture, weather data, satellite data and soil maps are some of the examples. However, in many countries more can be done, as mentioned already in chapter 6. Examples of good practices include paying agencies that make land use data at individual field level (from the applications for CAP subsidies as stored in the IACS system) collected over the last years available to the public. FADN data on regional average farm results could be made available in a format that is easy to use in benchmark software. The same holds for inspection results from food safety authorities or customs data (to make markets more transparent). Government agencies should also

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make it possible for farmers (or their advisers) to submit data in digital form from their farm management software. Also, if they use the website of the government agency to enter data, farmers could forward their digital data to their business partners, such as advisers and agri-businesses. If farmers have informed the paying agency where their sugar beet fields are, it should be easy to inform their sugar company and their service contractor who is taking care of the harvest by forwarding the data entered in the government system. Developing best practices in this area of open data and active provision of digital data could be stimulated by a thematic network or a multi-actor H2020 project. This does not need to wait for the EU Strategy advocated under point 1. Actions, such as a seminar, encouraging Managing Authorities to support Operational Groups in the data domain could also be beneficial.

3. Given the discussions on **data ownership and data governance**, it makes sense to start an action on this point, with or without the EU strategy advocated under point 1. This action should not only study the legal aspects, but also look for best practices and realise solutions. Denmark has strong leadership from the cooperatives and farmers' organisations in this field, which may be one of the potential solutions. In the Netherlands a solution with authorisations and digital identification seems to work (see Box 3), but companies are asking for international solutions. Best practices could be explored and stimulated by a thematic network or a multi-actor H2020 project.

4. The development of data-driven business models could benefit from more in-depth analysis of what works and what does not work. There are still clear gaps between business developers and final clients at needs, knowledge and technical levels as mentioned in the first type of limiting factors identified in chapter 6. Short presentations, as presented at the EIP-AGRI seminar, help to identify interesting cases but do not provide enough detailed information to understand why a particular solution is working and whether it can be scaled up or copied to other regions or sectors. This asks for a more **in-depth analysis of data-driven business models** with formal methods like Osterwalder's Canvas model or Harvard case studies. In the current H2020 call for proposals there is a call to submit (by February 2017) a proposal for a multi-actor project on business models (not necessarily data-driven) in agriculture. If this call leads to insufficient attention for data-driven business models, a follow-up call specifically oriented at data-driven business models might be interesting.

5. Data is not information. The deluge of data coming out of all sensors and other Internet of Things sources will not automatically lead to better decision making by men or machines. Often agronomic models are needed that interpret the real-time data. Many scientific models are from an era without such abundant real-time information and are based on measurements in specific research sites. This implies that science also has to learn to cope with big data and the needs from practice for improved models based on real-time data. Programming the most urgent needs for updated agronomic models in a **research agenda for real-time agronomic models** is a useful action. This can for instance be done by an EIP-AGRI Focus Group or a working group in SCAR (the EU's Standing Committee on Agricultural Research), to support data-driven business models. This agenda should also identify how to incentivise scientists to make sure they do not only make their publication available as an open source, but also their research data, their source code and - in a multi-actor approach - set up big data advisory services that apps can tap into. Researchers, who work in a heavily competitive market, often have incentives for not making their data and source code available, and funders might consider changing this. At the same time, this knowledge has to be properly delivered to and interpreted by the ICT experts. A close collaboration between content experts and ICT experts is needed, and actions promoting Operational Groups in the agriculture data domain will facilitate such collaboration.

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The European Innovation Partnership 'Agricultural Productivity and Sustainability' (EIP-AGRI) is one of five EIPs launched by the European Commission in a bid to promote rapid modernisation by stepping up innovation efforts.

The **EIP-AGRI** aims to catalyse the innovation process in the **agricultural and forestry sectors** by bringing **research and practice closer together** – in research and innovation projects as well as through the EIP-AGRI network.

EIPs aim to streamline, simplify and better coordinate existing instruments and initiatives and complement them with actions where necessary. Two specific funding sources are particularly important for the EIP-AGRI:

- the EU Research and Innovation framework, Horizon 2020
- the EU Rural Development Policy

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