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Design of a System for Information Transfer to Reduce Administrative Burdens in the Agrifood Sector

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ABSTRACT

Agricultural policies are widening the scope to contribute to environmental objectives, such as the Green Deal, Paris Climate Agreement and sustainable development goals. This leads to new monitoring and data needs. To fulfil these data needs, it is crucial to explore the opportunities and limitations of new technologies. This paper analyses the information flows within the agricultural sector and its potential to contribute to future information needs.

Farmers act within a network of commercial and governmental organisations. The information exchange with these organisations could increasingly occur through digital means, but in reality, there is still a lot of data transfer on paper or in PDF format. This implies information loss. Digital information flows provide a wealth of information for policy evaluation and monitoring and have the potential to reduce transaction costs. Combining data from different sources (open data like earth observation data, data from on-farm sensor networks, accountancy data like invoices and data from food chain platforms) concerning a single farm is an even bigger challenge than the transfer from paper to digital. Based on these observations a list of requirements for a future solution for information transfer is defined.

Based on these requirements, this paper presents the design of a System for Information Transfer to Reduce Administrative burdens (SITRA) to combine data from different sources and give farmers control who can access these data. SITRA will address farmers' needs to reduce the growing administrative burden placed on them by governments and the food chain sustainability and food safety schemes, especially if data would be stored in a digital farm locker and a farmer could voluntary give his consent through an authorisation mechanism to share specific data with his business partners, paying agency, statistical organisation and Farm Accountancy Data Network (FADN, an EU monitoring system for the Common Agricultural Policy). A platform that provides such data lockers could also provide benchmark facilities and a tool for common (open source) maintenance of coding systems.

The paper proposes some follow-up activities to test this design. As a pilot, organic farmers that participate in the Dutch Farm Accountancy Data Network (FADN) will be recruited to co-develop and test the design principles of the system. Given trust issues around data management, the design of the governance and business model of the system are key issues in the follow-up. This group is chosen as organic certification and FADN are the most data-intensive monitoring and evaluation tools in the CAP. The Farm to Fork communication proposes to enlarge the organic sector to 25% of the agricultural area. A new organic control regulation, based on a risk assessment approach is about to be implemented. The Farm to Fork communication also proposes to link the FADN much more with the Farm Advisory System and to extend it to a Farm Sustainability Data Network.

Keywords*: Information transfer system; administration; farm data accounting network; sustainability data network.*

1 Introduction

Farmers are persons with green fingers and –as a humourist once quipped– a sense of humus. In the last 150 years biology and chemistry have been added to or have replaced tacit local knowledge and *Fingerspitzengefühl (gut instinct)*. ICT and its datafication is the latest development that will make farming more based on formal logic and algorithms. Computers arrived on the farm in the 1980s with the introduction of the personal computer (PC). The internet in the 1990s enabled data and information transfer and this century started with the appearance of satellites (enabling GPS), RFID chips (for tracking individual animals) and robots, with the milking robot as the best-known example. The Internet of Things (IoT) has reached agriculture, leading to a deluge in data, with applications in farm management systems, blockchains and digital twins, to name a few.

The increase in data availability has an effect on the relations in the supply chain [EPRS, 2016; Poppe et al, 2016; Boehlje, 1999]. Food processors want to be informed on some aspects of farming to reduce risks in food safety (like in GlobalGAP), incentivise farmers, plan their operations or to market more sustainable products [Poppe & Koutstaal, 2020]. Actors in the food chain develop big data strategies [Goedde et al., 2020]. This raises the question if governments, who run agricultural and environmental policies, could benefit from data-intensive policy instruments [Ehlers et al., 2021]. Historically the use of farm data in designing and executing policies has been limited as reliable data were hard to collect and led to an administrative burden. Therefore, more general policies without much localisation are preferred to influence farmers' behaviour and observations from outside the farm like satellite data are preferred in monitoring the compliance of the farmer and to evaluate the effectiveness of the Common Agricultural Policy (CAP).

The CAP is monitored continuously and changes are based on evidence-based decision making, implying the need for evaluations based on harmonised data and indicators. The European Commission has set up the Common Monitoring and Evaluation Framework (the former CMEF, which is now being transferred into PMEF) to assess the performance of the CAP. The PMEF is a set of rules, procedures and indicators to evaluate the CAP (income support, market measures and rural development). To implement the CAP for the next seven years the individual Member States have to come forward with a National Strategic Plan. This must include Eco-schemes in Pillar 1: voluntary schemes for farmers to take up obligations for climate, biodiversity or environmental actions, in exchange for a payment per hectare. This should lead to better targeting of policies. Member states should also explicitly pay attention to aspects of digitalisation and the Agricultural Knowledge and Innovation System (AKIS). A Farm Sustainability Tool for Nutrients (FaST) will be obligatory.

In its Green Deal (EU, 2019a) with its Farm to Fork strategy (EU, 2019b) the European Commission intends to increase the share of organic farming to 25% of the agricultural area. The EU has already introduced a new regulation for the organic sector, starting in 2022. Control authorities are introducing risk-based audits, implying a need for more data like mass-balances of products.

The trend in the CAP towards more targeted measures and the inclusion of a greater range of public issues results in a prominent role for the use and renewal of indicators associated with the monitoring of existing policies and for the preparation of future CAP plans. This will most likely lead to the adaptation of the PMEF and its indicators[1]. In the current situation, data for the calculation of these indicators stem from two main sources:

- Administrative systems such as the application by farmers for CAP payments (IACS, LPIS);
- Data from national statistical agencies, Eurostat (Farm Structure Survey) and DG Agri's Farm Accountancy Data Network (FADN).

In the Netherlands, the focus of this paper, the government emphasises the need to base agriculture on circular principles to become more sustainable. A committee installed by the Ministry of Agriculture to study the business models for farmers in circular agriculture recommended to provide farmers with a dashboard with relevant indicators [May, 2019]. A coalition from food chain actors and NGOs has proposed to provide farmers with Key Performance Indicators that could provide the basis to reward them for eco-system services [Deltaplan Biodiversiteitsherstel, 2018]. The Council for the Environment and Infrastructure advised the government to link the CAP Eco-schemes to such private schemes [Rli, 2019; Poppe and Koutstaal, 2020].

[1] For an overview of CMEF indicators see: https://agridata.ec.europa.eu/extensions/DataPortal/cmef_indicators.html

Another committee, installed by the government to come forward with solutions for the stalemate in the reduction of ammonia emissions, has proposed to measure farm emissions with material balances and a sensor network [Remkes, 2020].

All these proposals have in common that they announce policies that ask for new types of data for their monitoring and evaluation; types of data that are difficult to observe from outside the farm, like the use of antibiotics or pesticides. Indicators on soil management in relation to climate change are another example.

Given the new policy needs, new indicators have been identified, developed and tested, among others in the FLINT project [Poppe and Vrolijk, 2018]. More data will be required to adequately measure sustainability. Ideally, the future monitoring system should result in a smart combination of innovations in current statistics, combined with data from satellites and sensors, and a better overall harnessing of data flows within the agricultural sector (e.g., farm management, invoicing, tracking and tracing, certification and labelling).

This leads to the main research question of this paper: What are the changes in the information availability and data exchange in the agricultural sector and how can these data be organised to also support the use of these data for the monitoring and evaluation of new policies?

Section 2 reviews the current information flows at farm level and in the farming sector with a focus on the Netherlands. It identifies the incentives and limitations of digitalisation and the main contributors to the administrative burden. This section is based on a literature review and a number of interviews with key stakeholders[i] in the last three years.

Based on this assessment of the current situation we formulate a number of design principles for a prototype for data management to facilitate the use of data for monitoring and evaluation. Based on these design principles we give an outline for a functional design and proto-type called SITRA (to be detailed in Section 5) and design the governance and business model of SITRA (detailed in Section 6). Given the importance of trust in sharing data with supply chain partners and/or the government, the design of the governance is at least as important as the technical design. The paper ends with a section that discusses our approach and outlines the next steps in which we intend to test the design in a co-creation project with a group of organic farmers.

2 Review of information sources and flows at the farm and farming sector

Farmers act within a network of commercial and governmental organisations. Exchange activities in this network like trade or subsidy payments are documented by order forms, invoices, dispatch notes and bank statements and are an input for the business administration of the organisations involved and are used for (financial) accounting. This data exchange between farmers and these organisations increasingly occurs through digital means. These digital information flows provide a wealth of information for policy evaluation and monitoring and have the potential to reduce transaction costs (e-declarations etc.). However, the current farm information system is far from perfect to fulfil that potential. Situations differ considerably between member states, between farming sectors and within regions between farmers. For the Netherlands (and several other countries) a fair description would be as follows.

Historically farm management information systems have two origins: farm accounting and farm field books. A century ago, in the Netherlands farm accounting was made obligatory for income tax reasons [Poppe, 1997]. That led to the establishments of cooperative farm accounting offices that also provided benchmarking. These data were used in the 1950s and 1960s in farm study groups to get a grip on the mechanisation of farming. In the 1960s the EU provided interest subsidies to farmers on the condition that they kept analytical accounts. Since the 1980s accounting has included volume data and that created the opportunity to calculate material balances and environmental indicators like the use of pesticides, antibiotics and nitrogen-surpluses [Poppe, 1992]. From 1998 to 2006 the Netherlands operated its MINAS system, a policy instrument to manage nitrate and phosphate emissions that made mineral accounts with nutrient balances obligatory [Breembroek et al., 1996]. By linking these to the fiscal accounts the auditability of the accounts improved as it made it less likely to 'forget' an invoice on e.g. feed (that is a deductible cost in income calculations but increases the nutrient input). The signature of an accountant under the calculations helped too. The system was abolished when the EU Court of Justice found the system non-compliant with the Nitrate Directive which applies stricter norms for the application of fertilisers than norms for the net-loss of fertilisers as applied in the Netherlands.

As accounts are available rather late, based on invoices and often produced by specialised accounting offices, farmers used field books to make notes on treatments of animals (individual or at group level), crops and fields. These were digitalised as farm management information systems. Adoption was slow, as such records demand a lot of manual input. But they were more useful for operational management than the farm accounts. They have become more popular in the last decades, as several information systems in the supply chain for tracing and tracking, food safety (GlobalGap etc.) and sustainability schemes (Animal welfare, organic, On the way to PlanetProof, etc.) are partly based on these records. Advanced management systems are also well integrated with obliged animal registrations and applications of CAP subsidies with their requirements for field maps (LPIS/IACS).

Integration of accounting and farm management systems has until now been problematic. There are differences in timing (use of pesticides is sometimes recorded before the invoice of the supplier arrives) and in supporting institutions (accounting offices versus software suppliers) offering these services. Accounting also has to handle payments like total-sales bonuses or profit-sharing transfers by cooperatives that farm management information systems neglect for simplicity.

Not only policies but also farm accounting and farm management systems are adapted to new circumstances. Our interviews suggest four areas where problems occur or changes are happening: digitalisation of data flows, access of open (government) data, Internet of Things based on sensor data and platforms.

Digitalisation of data flows

The current data flows in Dutch agriculture are complicated (figure 1). Farmers hardly sent invoices or dispatch notes. Accounting has been made easy in the past by the food processors by creating the invoices. For a dairy factory that also measures the quantity and quality of the milk, it is easier to send 5,000 invoices to the supplying farmers than to handle 5,000 incoming invoices. Many invoices are still delivered by post on paper, but digitalisation is slowly on its way. In the 1990s the accounting offices installed a system for Electronic Data Interchange (EDI) with a central hub (EDI-Circle, now part of the cooperative datahub JoinData) and in the livestock sector some of the invoices relevant for the MINAS system were digitalised. Accounting offices received payment data from the banks on magnetic tape already in the 1980s (far before the current PSD2 obligation for banks to make payment data digitally available). Linking these two flows made an early form of automatic coding possible – an early version of a practice now labelled as 'robotic accounting'. However, this best practice was not copied by other actors that send invoices. In recent years PDFs have been introduced in addition to or replacing paper invoices (e.g. by companies like UnifiedPost that handles the invoicing for large clients that have to print thousands of invoices). That is not always an improvement. Some are machine readable (e.g. with OCR technology), others are not. And some of them are not sent to or stored by the farmer but must be accessed on websites of the companies that create them. This can turn accounting into a search activity for the relevant documents on a wide range of password-protected company web-sites.

Data from invoices and other documents have to be entered in software and coded (into types of costs and sales) and some of the data has to be allocated to crops, fields or animals. As long as data are not fully digitalised that is a labour-intensive task and prone to errors. Some farmers do it themselves (using software linked to that of their accountant like Visma or Exact Online), most pay their accountant. Some digitalise their paper invoices with a smartphone and send them in a PDF or JPEG format to their accountant, but the resulting quality is often too low for using OCR techniques. The app AgriNota (developed by the agricultural accounting office Alfa Accountants) supports creating such PDFs and supports farmers in managing them. There is specialised software for scanning with OCR (nearly 20 different brands, including Basecone, Blue10), that are linked to accounting software. Some applications provide the possibility to download PDFs from portals or websites of the trading partner. Often only the header and the total amount are scanned, not the individual lines of an invoice. That is fine for fiscal accounting but does not create management or sustainability information. One of the most advanced applications is Scansys, which recognises the number of the Chamber of Commerce on the invoice and scans individual lines if a template for that firm has been created in advance. If the sender changes the format of the invoice, the template has to be updated.

Although scanned invoices help in documenting, even when OCR is problematic, the scanning itself is labour intensive. Formats differ. Staples and paperclips have to be removed. If OCR is used it has to be checked (one management software supplier even uses a service in Asia that visually compares the PDF with the OCR interpretation and, if needed, manually enters the data). Practices between farm accountants differ. One large agricultural accountancy company requests all invoices on paper, otherwise it charges up to one day for gathering and printing out the PDFs itself. Others want PDFs and charge for sending in paper. The situation is also confusing for organisations that certify farmers, like the organic certification body SKAL. In times of COVID-19 digital compliance audits are attractive for certifying bodies, but they have to deal with many different practices by farmers and a variety of software. Data collection for the Farm Accountancy Data Network faces the same problems. It also leads to an undesirable exchange of passwords for websites between farmers and accountants, advisors or inspectors to retrieve PDFs.

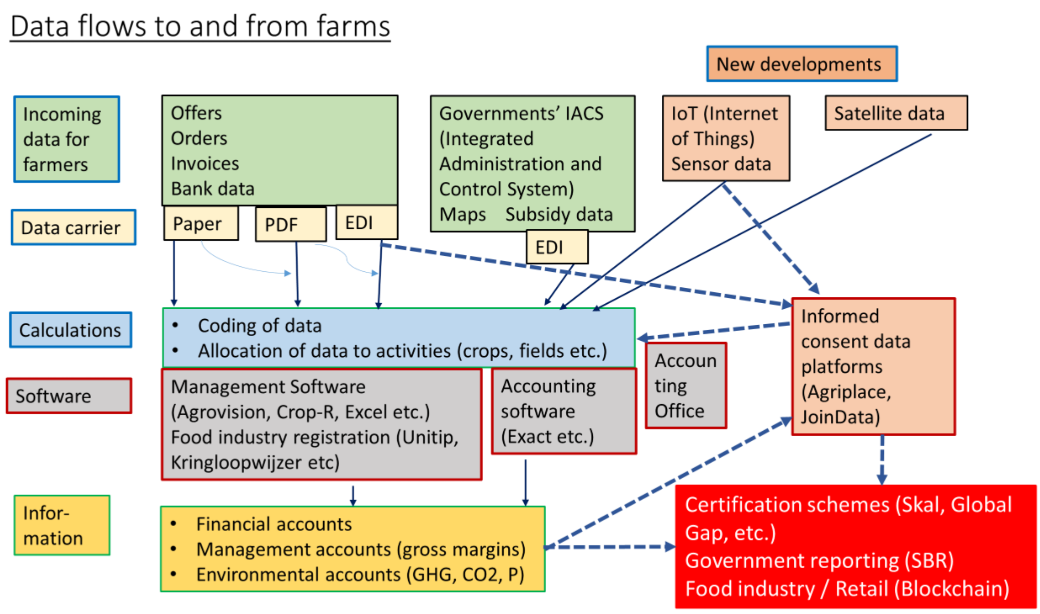

Figure 1. Data flows to and from farms (and their accountant)

Open data and access to government data

A second area of change concerns the access to open data and the integration with government data, like the Integrated Administration and Control System (IACS) and the animal identification and registration system (I&R). Here the developments seem to be more positive. The CAP has made field identification on digital maps obligatory. Given the importance of the subsidy flow and the risk of mistakes, a lot of Dutch farmers ask their accountant to do the application of CAP subsidies. Others do this themselves on the website of the paying agency RVO with or without the use of a farm management system (like Crop-R or AgroVision). These systems are well integrated with the IACS system and can digitally upload and download maps. There is a similar integration with the animal identification and registration system. Such options have made the use of management software more attractive. Some of the data is published by RVO as open data, others have added satellite data and growth indices (see for instance the app BoerEnBunder). However, there are still public data sets that are not digitally available for software developers (e.g. the list of allowed pesticides).

Management information systems are also the basis for chain information systems that support tracing and tracking, food safety management (GlobalGap etc.) and sustainability schemes (Animal welfare, organic, On the way to PlanetProof, etc.). The data demand from the chain partners of the farm partly overlaps with data requested by the government. For certification, and especially if the data are used to check compliance and reward or punish farms, data should be auditable. The management information systems are however not linked to the financial accounts, like MINAS in the past [Breembroek et al., 1996]. Data requests from certification bodies are on paper or in PDF, which hampers risk-based compliance auditing. Farmers with more than one product deliver to several food processors and even for one product several export markets could be served that ask for different data and audits. This contributes to administrative burdens of farmers.

Internet of things based on sensor data

A new development is the Internet of Things, based on sensor technology. Machines, from tractors to milking robots and drones, harvest data with the use of sensors (figure 2; based on Rli, 2021). Some of that data are used directly in technical operations, like climate control in storage, or variable rate application of inputs. But some of the data also have a value in management information systems as they replace the manual input in the field book (e.g. pesticide application on a certain date in a certain field and crop). Farm Management information systems can also create task instructions for smart machines. Such information is also of interest for others in the food chain (and for the government). Kempenaar [2020] reports on these developments and technical bottlenecks.

This development leads to information services from technology suppliers, advisory services and food processors and is labelled as 'smart farming'. For example, the Dutch sugar cooperative Cosun Beet Company has put up a sensor network of 450 sensors in the Netherlands that in combination with satellite data and data from the farm (farmers have the obligation to provide data directly from their management information system or enter the data on the website of the company) provide an early warning system and spraying advice against insects. This leads to data platforms in which data are stored and exchanged.

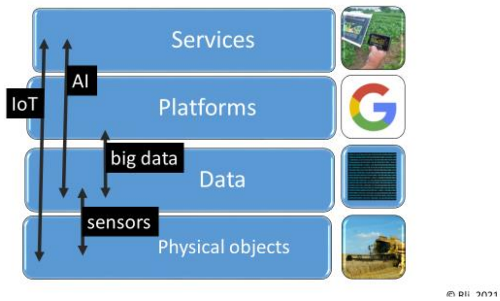

Figure 2. Simple 4-layer model of the platform economy

Platforms

Digital platforms combine data to create services that users find useful, with a business model that maintains and innovates the platform. Data on and from the users are actively collected and analysed to improve the service. Especially that last characteristic distinguishes a platform from a simpler website where data are offered or exchanged and leads to important network economies: the more users there are, the better the services (e.g. via big data analysis and artificial intelligence) and the more attractive it becomes to use the platform [Mansell and Steinmueller, 2020]. More users also lead to lower costs per user as software provides large economies of scale.

As platforms generate information based on data from groups of farms, they can reinforce the practice of benchmarking. There is a long tradition in Dutch agriculture of study groups of farmers to jointly identify weak and strong points in their farms and farm strategies and learn from each other. Although farmers compete on the land market, they seldom do in the commodity market. Such study groups are a predecessor of the operational groups in the current CAP that work on a common innovation challenge. The EIP-Agri Focus Group Benchmarking [EIP-Agri, 2017] argued that learning processes between farms could be improved by sharing data and identified 4 areas for improvement: Automatic data sharing based on data-authorisations, Benchmarking on sustainability and strategic changes, Business models and governance in benchmark systems and Benchmarking for small farms.

In the Netherlands a number of bottlenecks have been identified in the platform economy for arable farmers [Kempenaar et al., 2020]. For farmers it is still impossible to bring all their data together in an easy to use, own dashboard. For arable farmers alone, there are up to 25 data platforms to be confronted with or to choose from. These include JoinData, a cooperative initiative of food chain companies to exchange data with the permission of farmers (including the older EDI-Circle application), and AgriPlace, a start-up where farmers can upload PDFs of their invoices for inspections and certifications and manage the transfer of these documents from one scheme to another.

A lot of these platforms have been developed for a certain type of application or a certain product chain, like sugar beet. Often, they are developed for the food processor or input supplier and their farm advisors and less for farmers. As a result, farmers lack an integral dashboard. Data interoperability is restricted, although standards have been developed. This balkanisation does not only make the systems but also the total quite complex, without giving the farmer much overview.

In addition, farmers are hesitant to share data. A farmer becomes quickly dependent on a certain platform (vendor lock-in) as data cannot be easily transferred at a later stage to a better service provider. Data exchange can be experienced as giving away sensitive data that can be used in contract negotiations against the interest of the farmer. This also applies to sustainability data, where farmers have the feeling that if something becomes measurable, not only the supply chain partners but also the government could start to intervene in their management or punish undesirable behaviour. Sometimes privacy issues are mentioned, although formally the GDPR only relates to natural persons. In the background the insight is relevant that digitisation makes it possible to control parts of the production process and move the decision making from the farm to the algorithms of mightier players. If in such situations the software also demands quite some manual input, and farmers do not know where their data ends up (also due to the large number of systems) it is not strange that the platform economy has not yet really kicked off in agriculture.

All in all, it seems that the digitalisation in agriculture during the last decades has not reduced but contributed to administrative burdens of farmers as more data entry is asked by the food chain partners and by the government to fulfil their information needs. It has delivered better operational technical advice and indirectly it has contributed to better prices for products in some sustainability schemes, but has also led to understandable complaints about red tape.

3 Requirements and design of future solution

Given the developments described in the previous section, in this section we will investigate if monitoring and evaluation for the Common Agricultural Policy (CAP) can be improved with new information and communication technologies without increasing the administrative burden for the farmer.

There are a wide range of data flows to and from farms. These flows serve different purposes and part of the data included in these flows are of relevance for policy evaluation and monitoring. A future monitoring system should make optimal use of these different sources of data and modern ICT-based data capturing systems. Based on our analysis in the previous section, we identified the following requirements:

- Blending of farm management information and accounting systems and satellite and sensor data where this leads to better indicators or less manual data input;
- Chain information systems are becoming increasingly important (i.e. tracing and tracking, labelling and certification), double data entry by farmers should be avoided;
- Permission to utilise/access to data pertaining to individual farms must be provided by farmers, as sensor data and accounting data are not accessible from outside by food chain partners and the government;
- The problem of obtaining permission to share data need to be resolved by giving farmers (and other stakeholders) control of their data and involve them in the governance of the platform;
- Significant improvements need to be made in the technical and semantic interoperability of systems.
- Harmonised indicators are needed and the central management of coding systems is attractive;
- Not everything can be monitored in a technical way (e.g. innovation, farm succession, social sustainability and well-being – this needs a more holistic evaluation);
- For some data needs in monitoring, it is possible to move from the current use of random sampling in statistics, towards data gathering from all farms (big data approach);
- Area-based and farm-based sampling both have a role and ways to connect them should be explored;

Given the bottlenecks described in Section 2 and the described requirements, an improved organisation of the data management around the farm has been designed (Figure 3). From the point of view of monitoring by the government, satellites and open (sensor) data remain important and such data could be offered to farmers as a main component of their farm dashboard. Data from the farm accounting and private sensor data networks could then be added. If these data arrive via platforms in digital, computer readable form, replacing paper and PDFs, robotic accounting could be used to code the data. Allocation to crops, fields or animals could be done based on sensor data. With minimal manual input, this could lead to an automatically generated dashboard for the farmer. The dashboard includes environmental reporting, financial reporting and management reporting. The data of the dashboard could then be forwarded to the accountant for tax (and other) advisory services and to management information systems for operational technical advice and to create task instructions for smart machines and orders for suppliers.

4 Functional design and proto-type

Up till now we have identified six main functions of a proto-type dashboard for data management on the farm (Figure 4). The first is to receive invoices (and other documents like dispatch notes) in digital form (in Universal Business Language format, UBL). In case this is not yet possible with trade partners a link with an OCR solution (like Scansys, see Section 3) could be considered. A second function is data storage in a digital farm locker. A farmer gives others access to parts of the locker by voluntarily giving his consent.

That consent is an authorisation to share specific data with his business partners, farm advisors, paying agency, statistical organisation and FADN.

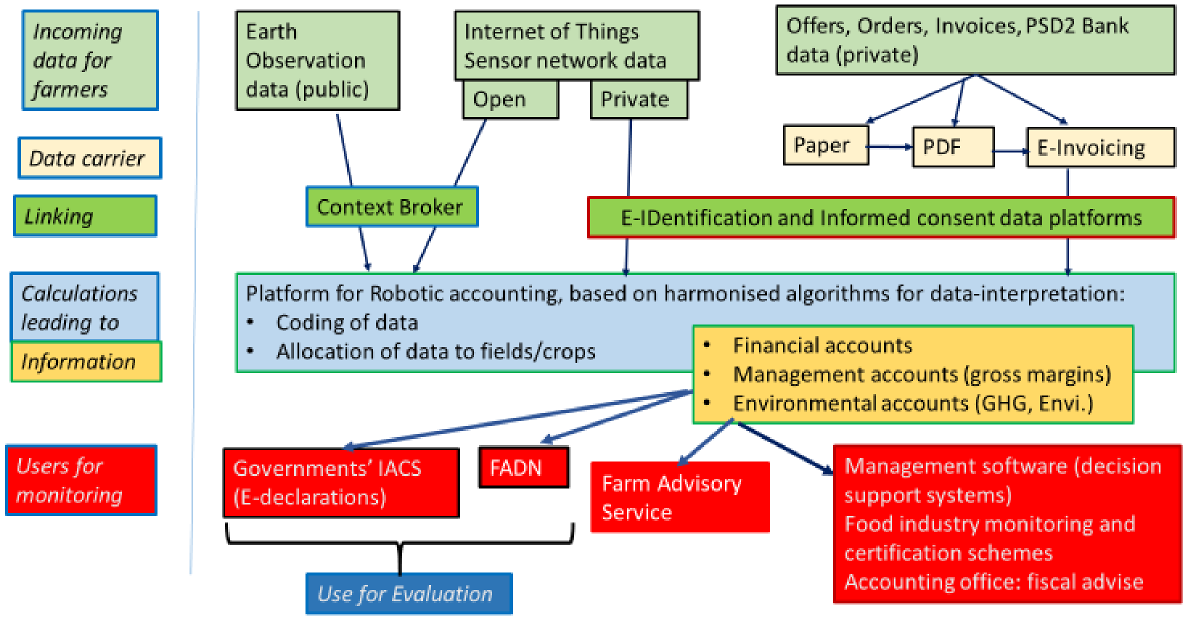

Figure 3. Future design for data flows to and from farms

Satellite, sensor and open data will be added to the dashboard. Some of that data (like open data on fields or data from sensors that measure the use of inputs) will be useful for the financial and management accounting, and improves the auditing like in the MINAS system [Breembroek et al. 1996].

Figure 4. Functions of the proto-type

The output of the proto-type will be in the form of reports (financial, management and environmental accounts, including mass balances) in XML format. Besides data on the individual farm, benchmark reports could be provided based on the consent of other farmers to include their data in these reports.

To create the reports, algorithms are needed that code the incoming data. With an eye on robotic accounting, we foresee some innovations. It looks attractive to have a common management of the tables that link products from suppliers (e.g. Wellington boots, size 45, colour green), that often have a GS1 product code of the supplier used on the invoice, with a standard ledger code. In the current situation each accounting office, management software supplier and many farmers have to create those linkages. These tables can be maintained in a common approach (like a wiki) or software could suggest a code based on concordances created in other administrations on the platform.

A standard ledger coding is essential for robotic accounting. Countries like France traditionally have a coding scheme prescribed by law that supports the work of the tax inspector. North European countries do not have that tradition and give the entrepreneur freedom in arranging his books (as long as it is in line with good business practices). This favours innovation. With robotic accounting, having a national standard becomes more attractive. Scandinavian countries have now adopted standards. In the Netherlands a standard was promoted in the 1980s (GRAS - Geüniformeerd Rekeningstelsel voor de Agrarische Sector) that is partly still in use. For Standard Business Reporting (SBR) that is used by the government for data delivery (Tax office, Statistics Netherlands), a reference ledger scheme (RGS) based on XBRL has been developed.

5 Governance and business model aspects

The governance and business model aspects of the platform proto-type, as a solution to share farm data with government agencies or research for monitoring and evaluation, are crucial given the reserves of farmers to share data. These aspects are also important for the sustainability of the solution.

The trust issue as such is not new, and in the past solutions have been found (see Section 3 for the extension of financial accounting from a tax obligation to a benchmark tool). A first issue is to build trust with partners in the food chain to move from paper to a digital format. The root of the problem is that these partners have to make some costs, while the benefits are for the accountants and certification bodies of the farmer, that hopefully translate those benefits in a reduction of their price (although these markets for accounting and advice are not very competitive). Partners in the food chain use their scarce IT capacity first of all to improve their own processes, and are not necessarily interested in improving those of the clients or (in case of cooperatives) members. The Dutch government is hesitant to intervene to support the farmers, although invoices to the government have already to be delivered in XML (or SBR/XML)[2].

A second issue is the governance of the platform itself. With the farmers we will investigate a number of options. For the moment we think that farmers should have full control over their own data, meaning that their data cannot be accessed by others without their consent (this is often referred to as full data ownership, although ownership of data is not a legal concept – but data access, IPR rights or GDPR rights are relevant). It could be attractive and trust-building to run the platform with the dashboard as a data cooperative or data trust with the farmers in full control. An IT supplier would then act as a service provider. The design rules of Ostrom could be useful to investigate options [Ostrom, 1990; Poppe et al., 2018].

An independent platform with a dashboard for farmers that helps them to manage their data and link to existing and future agricultural technology platforms that are set up for different food chains or technology suppliers (like Original Equipment Manufacturers), could also be a useful countervailing power for farmers. A data sharing platform for sustainability management, run as a utility or data cooperative by farmers is different from the current agricultural technology platforms (table 1) and could empower farmers in their relations in the food chain.

Data access has also to be discussed from the angle of the government for monitoring and evaluation, for instance for the use by a paying agency, organic control body or the FADN. There are three options for the government: "ask" farmers to hand in all basic data that were entered into the dashboard, or have access to the dashboard and its output files and audit files, or a construction in which the use of the dashboard is obligatory. In the last two options it could be a condition that the algorithms used in the platform have been checked by an Electronic Data Processing (EDP) accountant and certified as consistent with the rules of the government agency.

6 Discussion and future steps

Current proposals for the new CAP and ambitions in the Farm to Fork strategy have consequences for monitoring and evaluation of the policies, at sector level with tools like FADN, as well as for compliance auditing at individual farm level. The EU proposes to develop the FADN into a Farm Sustainability Data Network. In the Netherlands the need for new indicators has been acknowledged and the government has been advised to create a dashboard for circular agriculture, with KPIs as well as a sensor network.

An analysis of data management in Dutch agriculture shows that the platform economy is being created, but farmers lack a good dashboard for data management. Input suppliers and food processors take initiatives but an integration of management information and accounting, as larger companies do in ERP systems, is lacking and ERP systems are not scaling down to farm level. This could provide an opportunity to install a dashboard that helps farmers in their struggle with administrative burdens, and helps the government to mimic big data strategies of supply chain actors by supporting farmers and research to set up such a platform.

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[2] In line with European Directive 2014/55/EU. It states that all organisations that have to tender their orders have to be able to accept digital invoices. (European Norm EN 16931-1. that includes a semantic data model of a basic invoice. Its lay-out has to follow one of two syntaxes: UBL 2.1 or UN/CEFACT XML CII D16B (both are XML implementations) to be able to receive and process the digital invoice. A program office PIANOo supports companies in e-invoicing to the government.

Table 1.
Types of platforms

Agricultural Technology Platform	**Data Sharing Platform for Sustainability Management**
Operated by one provider (John Deere, Claes, Lely Dairy Robot, Cosun Beet Company)	**Operated** by a farmers data cooperative for farm management information / certification / accounting
Users: large farmers, contractors Data linked to business secrets, IPR	**Users:** relevant for all farmers to deal with "red tape" and run sustainability programs / eco-schemes Data in family farms linked to privacy
Risks that farmers face: • Industrialisation, increase scale • Farmer becomes franchiser • Vendor lock-in • Lack of competition	**Imperfect market**: Farm-oriented dashboard does not exist. Why do FMIS / Accounting software not scale up or ERPs not scale down: • A business model problem? • How to mix public and private data?
Potential government reaction: • Promote start ups • Support frontier research like AI • Regulate algorithms (sustainability) • Regulate competition (e.g. data portability / number of vendors)	**Potential government reaction**: • Create a dashboard with data locker for farmers as infrastructure (utility) governed as a data trust/cooperative • Also as countervailing power • Oblige the use of UBL in paper work

To investigate the feasibility of this solution, we will engage with a group of farmers to see if this solution is attractive and if it can be realised. A proto-type will be developed and tested. Given the issues around trust in data sharing, the discussion on the design of the governance structure of the solution is also very important in investigating the feasibility of the solution.

We will test the ideas of using a platform to reduce administrative burdens for the future CAP and its need for new indicators by developing a proto-type of a dashboard for data management by farmers. For this we will seek the interest of a group of organic farmers in the FADN. We have selected the organic farmers as a pilot group as the Farm to Fork communication proposes to enlarge the organic sector to 25% of the agricultural area. Furthermore, a new organic control regulation, based on a risk assessment approach is about to be implemented. Given the reluctancy of farmers to exchange data, we cannot take this interest for granted. Even if we are successful with this group of farmers, there is the risk that they are more cooperative (being partner in the FADN and being active in organic farming that has a positive attitude to transparency) than the average farmer. On the other hand, it seems an attractive point to start. Critical success factors of this pilot are not so much in the technical domain as we build upon proven technologies already used in the Dutch FADN.

Convincing the actors in the supply chain to move from paper to a digital format like UBL and designing an acceptable governance structure and business model for the platform is the real challenge.

Besides the development of a proto-type of a data platform and farmer's dashboard, its governance and business model, we will have to reflect on change process required to move from existing systems to new systems. Vested interests might feel threatened and farmers might be uncomfortable with change. Attention has to be paid to psychological or cultural barriers to moving to new systems. It could be important to pay not only attention to reducing administrative burdens with a smarter data-integration based on robotic accounting, but also to increase value from the integrated data.

In more detail, we plan to select a group of organic dairy and arable farms that take part in the Farm Accountancy Data Network. This choice is based on a number of considerations:

- Monitoring and evaluation requirements for these farms are high: they not only have to comply with CAP requirements but also with organic certification by control authorities that are guided by the (renewed) EU's organic regulation. In addition, supply chains have their certification schemes (like GlobalGAP, BRC, etc.) for such farms.

- Transparency is an important issue in organic production, producers try to build trust of the consumer in their production system.
- There are less supply chain and management information systems available. We assume that a specific dashboard can be relatively interesting and that there are less vested interests from supply chain partners with a big data strategy.
- There is an interest from the Dutch organic certification and inspection authority SKAL, that needs more data from organic growers to move to risk-based auditing and digital inspections to keep costs under control (and to deal with Covid-19 issues).
- The FADN is an important tool in monitoring and evaluation of the CAP.
- Farmers in the FADN already supply a lot of data and algorithms are available to calculate their financial and environmental accounts. These data and algorithms can be used in the proto-type, which saves costs in the project. We can then concentrate on some specific organic data (like mass balances for the organic inspections) and the linking with sensors and satellite data to show how such data becomes more reliable by linking them to accounting data – and how government bodies like SKAL can inspect those data.
- The proposed solution links with current ideas within DG Agri and DG Sante (Farm to Fork communication) to develop the FADN into a Farm Sustainability Data Network and link it much more with the Farm Advisory System. This would create a voluntary platform in which farmers can have their primary data converted to indicators that they share with advisers and with research institutes for policy analysis and wider research purposes [EU FADN, 2020].

Assuming that the challenges will be overcome, digitalisation and robotic accounting will provide excellent opportunities to provide data on indicators for monitoring and evaluation of policies that are not directly observable from the outside of the farm and are auditable as they are linked to the financial accounting of the farm.

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