GEODATA FOR AGTECH AND FINTECH
WHAT HAVE WE LEARNED?

NpM - Platform for Inclusive Finance
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LIST OF ACRONYMS

A-CAT	Agricultural-Credit Assessment Tool
ACRE	Agriculture and Climate Risk Enterprise
AI	Artificial Intelligence
B2B	Business-to-Business
B2C	Business-to-Consumer
CABI	Centre for Agriculture and Bioscience International
FI	Financial Institution
FMO	Dutch Entrepreneurial Development Bank
FtMA	Farm to Market Alliance
G4AW	Geodata for Agriculture and Water
G4IFF	Geodata for Inclusive Finance and Food
GDPR	General Data Protection Regulation
GPS	Global Positioning System
GSMA	Global System for Mobile Communications
ICCO	Interchurch Coordination Committee Development Aid
ICT	Information and Communication Technology
IDH	The Sustainable Trade Initiative
IPP	International Partnership Programme
IT	Information Technology
LPIS	Land Parcel Information System
MAIL	MUIIS Agricultural Input Loan
MFI	MicroFinance Institution
ML	Machine Learning
MNO	Mobile Network Operator
MSA	MUIIS Service Agent
MUIIS	Market-led, User-owned ICT4Ag-enabled Information Service
MYVAS4Agri	Myanmar Mobile Value Added Services for Agriculture
NGO	Non-Governmental Organisation
NMO	National Meteorological Organisation
NpM	Netherlands Platform for Inclusive Finance
SACCO	Savings and Credit Cooperative Organisation
SMS	Short Message Service
SNV	Netherlands Development Organisation
TAHMO	Trans-African Hydro-Meteorological Observatory
TARA	Tool for Agricultural Risk Advice
UCCFS	Uganda Central Cooperative Financial Services
UK	United Kingdom
VHR	Very High Resolution

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ABOUT NETHERLANDS PLATFORM FOR INCLUSIVE FINANCE (NpM)

NpM, Platform for Inclusive Finance, is a leading national platform for inclusive finance worldwide. Established in 2003, NpM brings together Dutch development organizations, social investors and commercial banks active in the inclusive finance sector. Together with the Dutch Ministry of Foreign Affairs, NpM's 12 members share a commitment to expanding access to finance in underserved regions and to anticipate the changing need in the sector to grow towards a responsible industry. We believe that access to financial services offers people the possibility to improve their living conditions, which in turn reduces poverty and inequality.

NpM, aims to increase the effectiveness of its members' investments and activities through coordination of knowledge, bringing together relevant stakeholders and by voicing and promoting the Dutch efforts. NpM works on common policies and statements amongst its members to promote financial inclusion and contribute to reaching the SDGs.

In 2018, NpM established the Geodata for Inclusive Finance and Food (G4IFF) work stream together with Rabobank Foundation, Bill and Melinda Gates Foundation, FMO, the Netherlands Space Office, and ICCO. The goal of this work stream is to improve risk management and to lower transaction costs for financial institutions (FIs) as well as to increase the access to financial services for smallholder farmers by using geodata-based information.

ABOUT NETHERLANDS SPACE OFFICE (NSO)

The Netherlands Space Office (NSO) is the space agency of the Dutch government. NSO's task is to advise upon and realise Dutch space policy. NSO reports, both financially and substantively, through its director to its clients, who are united in the steering group NSO. These are the Ministry of Economic Affairs and Climate Policy, the Ministry of Education, Culture and Science, the Ministry of Infrastructure and Water Management, and the Netherlands Organisation for Scientific Research (NWO). NSO can also carry out assignments for ministries that are not part of the steering group NSO. The Minister of Economic Affairs and Climate Policy is the coordinating Minister.

Netherlands Space Office executes several programmes to support industry, scientists and others. The goal of these programmes is to stimulate the development of space technology and scientific and practical applications of satellite data.

One of these programmes is Geodata for Agriculture and Water (G4AW). This programme stimulates sustainable food production, a more efficient use of water in developing countries, and aims to alleviate poverty by enhancement of sustainable economic growth and self-reliance in the G4AW partner countries. G4AW provides a platform for partnerships of private and public organisations. Together they provide food producers with relevant information, advice or (financial) products.

EXECUTIVE SUMMARY

The aim of this report is to share learnings from the evaluations reports of six projects of the Geodata for Agriculture and Water (G4AW) programme and the Geodata for Inclusive Finance and Food (G4IFF) programme that used geodata to develop services that improve access to finance to smallholder farmers and to provide advisory services to increase crop yield, reduce lending risk and improve monitoring. Another aim of the publication is to help increase impact investor engagement in the field of digital solutions in agriculture, by presenting examples of projects and companies that use geodata to improve their business model.

The six selected projects are: CommonSense (Ethiopia), MUIIS (Uganda) and MYVAS4Agri (Myanmar) from the G4AW Facility and Agri-Wallet (Kenya), Apollo Agriculture (Kenya) and TARA (Kenya) from the G4IFF initiative.

The farmers served in the pilots are smallholders that grow a variety of crops and that sell at least a part of their produce. The type of geodata-based services delivered in the pilots are: geolocation of farms and parcels, support to credit scoring, agricultural advice, risk assessment (for agricultural operations) and (in some cases) support to insurance. The contribution to credit scoring is based on a historical analysis of yields and/or soil moisture, mainly derived from satellite data.

All pilots report positive results on at least a few of the following indicators: higher production, increased repayment rate, improvements in the accuracy of credit scoring, reduction of processing time and reduction of operational costs

Challenges encountered in the implementation of geodata applications were:

- Building trust and confidence between partners takes more time than anticipated
- Receiving organisations need to digitalise their whole business process, not just geodata; and
- Capacity development and staff time input are needed for working successfully with geodata;

Two factors are especially important from an investor's perspective:

- Testing and validation with more growing seasons are needed to assess the real added value of geodata (i.e. more use cases);
- The application of geodata should be considered in the general framework of digitalisation for streamlining operations and not as stand-alone.

The following technical, organisational and cross-cutting factors play a role in future developments:

- Technical: availability of more free and open satellite data, increased application of machine learning and artificial intelligence, more integration of different data sources and methodologies, new ways of data collection, expansion of local networks for in situ observation;
- Organisational: improved partnerships to reach the farmers effectively, increased cooperation with government, more capacity building and involvement of local geodata specialists;
- Cross-cutting: increased combination with impact investment (for inclusive green growth, climate adaptation, circular economy, commodity flows, tenure security, and energy transition) and stricter regulations on data protection and privacy.

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1. THE GEODATA FOR AGRICULTURE AND WATER (G4AW) FACILITY AND THE GEODATA FOR INCLUSIVE FINANCE AND FOOD INITIATIVE (G4IFF)

INTRODUCTION

The aim of this report is to share learnings from the evaluations reports of (G4AW and G4IFF) projects that used geodata to develop services that improve access to finance to smallholder farmers and to provide advisory services to increase crop yield, reduce lending risk and improve monitoring. Another aim of the publication is to help increase impact investor engagement in the field of digital solutions in agriculture, by presenting examples of projects and companies that use geodata to improve their business model.

The six selected projects are: CommonSense (Ethiopia), MUIIS (Uganda) and MYVAS4Agri (Myanmar) from the G4AW Facility and Agri-Wallet (Kenya), Apollo Agriculture (Kenya) and TARA (Kenya) from the G4IFF initiative. The characteristics and outcomes of these projects are discussed starting in section 4 and 5, based on evaluation reports written by Kenyan based tech consultant BonRezo and other background documents (see reference list). This section presents an introduction on G4AW and G4IFF and their contribution to food security, followed by an overview of stakeholders in relation to geodata and agriculture (section 2) and a sketch of the landscape of agritech providers with a geodata component (section 3). The report ends with conclusions (section 6) and future prospects (section 7).

FOOD SECURITY AND DIGITALISATION

Achieving food security for all is both a priority and a challenge. Population growth and urbanisation will increase the future demand for food. On the supply side, climate change and scarcity of resources (land, soil, water) will affect agricultural production. In addition, there is the problem of food losses: approximately one-third of the total world food production gets lost or wasted every year.

This calls not only for a sustainable improvement of agricultural production and productivity, but also for de-risking and building resilience in relation to climate change and disasters. This should be done in combination with national and international governance for (transboundary) management of food systems and associated threats. Smart agriculture improves food system management through facilitating increased production, provision of real-time data and production information, better quality produce, lower water consumption, lower production costs, accurate farm and field evaluation, and a reduced environment, energy and climate footprint.

Sustainable intensification of agriculture, accompanied by land-management tools and appropriate land-use policies are required to ensure food supplies. Accurate data on agricultural production (area, yields, location) and food prices help planning, competition and more stable pricing.

Digitalisation is an integral part of smart agriculture. However, digitalisation is more likely to be quickly adopted by modern, large and commercial farms. But most farmers, especially in developing countries, are small farmers. Still, as they are indispensable for global food security, it is essential that they get easy access to digital solutions. This is what initiatives, such as G4AW and G4IFF, aim to accomplish, as will be highlighted in the section 2.

GEODATA FOR AGRICULTURE AND WATER (G4AW)

The Geodata for Agriculture and Water (G4AW) Facility aims to improve food security in developing and transitioning countries by creating digital advisory services based on satellite data that reach small-scale food producers. The G4AW Facility is a grant programme of the Netherlands Ministry of Foreign Affairs and is managed by the Netherlands Space Office (NSO). The Facility fits in the policy priority of food and nutrition security, which focuses on increasing and enhancing sustainable food production.

The G4AW Facility fills a gap in the current range of policy instruments by stimulating public-private partnerships that use (digital) technologies in the nexus of food security, water productivity and climate change adaptation. G4AW started in 2013, has had three tender rounds (in 2013-2014, 2014-2015 and 2017-2018) with a total investment of € 86 million of which

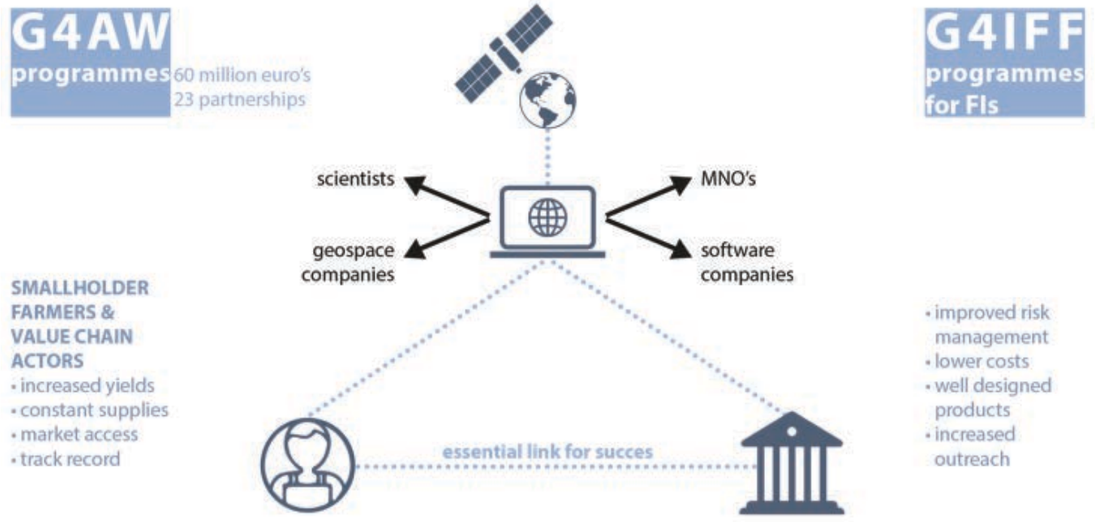


Figure 1: The relation between G4AW and G4IFF (figure free after
www.inclusivefinanceplatform.nl/geodata-for-inclusive-finance-and-food

€ 60 million (70%) is a subsidy from the Netherlands Ministry of Foreign Affairs and EUR 26 million (30%) are private sector contributions. The objectives of G4AW are three-fold:

1. To support food producers to make maximum use of geodata-based products and services;
2. To support an efficient food production and improved risk management (formulated as increased productivity and incomes of food producers, improved resource use efficiency and reduced crop losses);
3. To open up new markets for geodata-based product and service providers.

The programme consisted of 25 projects in 15 countries in Sub-Sahara Africa and South-East Asia: Angola, Bangladesh, Burkina Faso, Burundi, Cambodia, Ethiopia, Ghana, Indonesia, Kenya, Mali, Myanmar, South-Africa, Tanzania, Uganda and Vietnam.

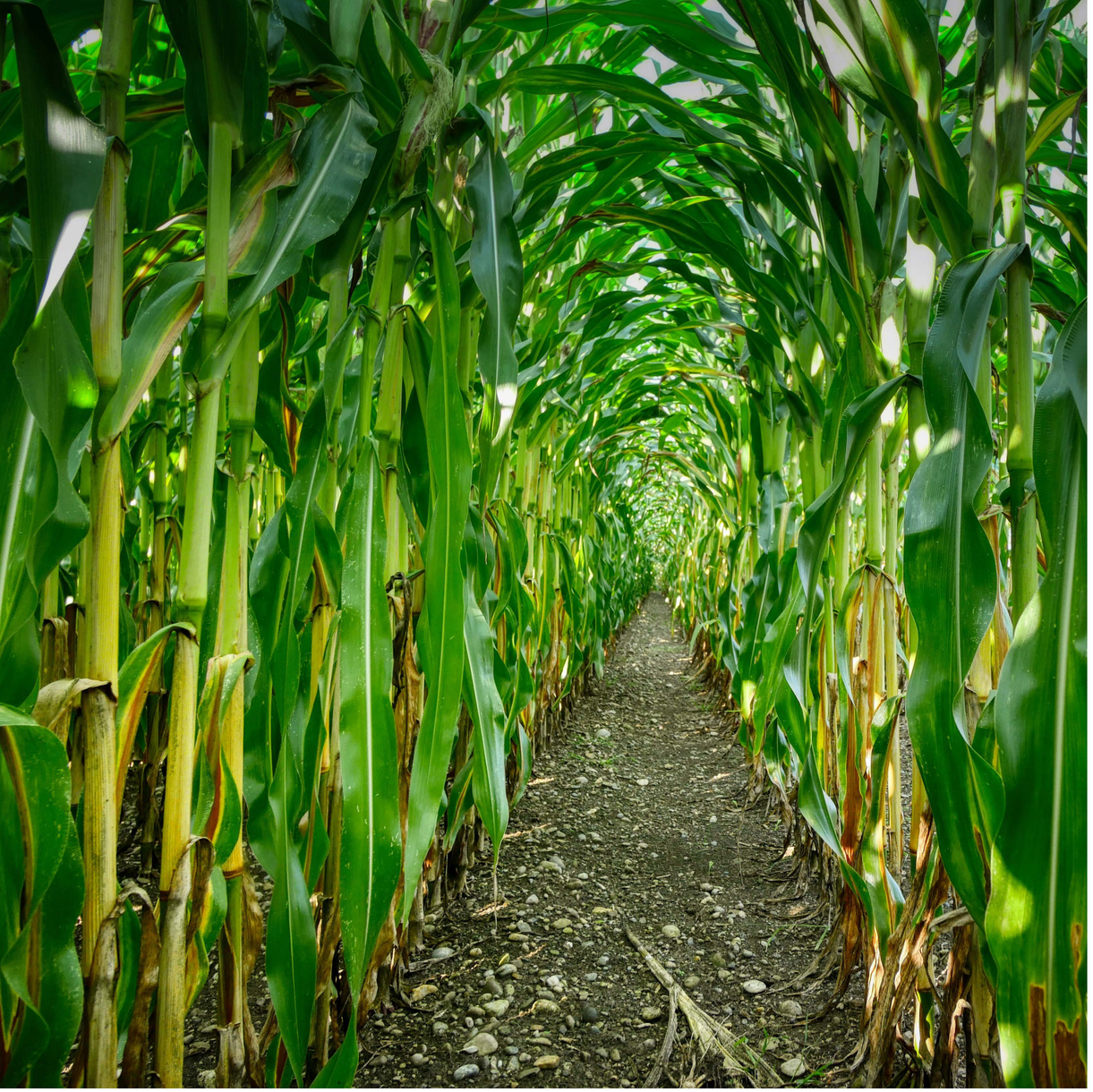
Implementing partners include mobile network operators, geodata/ICT companies, knowledge institutes, NGOs, governments, financial service providers, farmer organizations and other value chain actors such as input providers. These implementing partners are organized in consortia consisting of on average five organizations (minimum one Dutch and one local) with one lead partner per partnership.

In quantitative terms, the goal of the G4AW Facility is to provide agricultural advisory services or financial services to at least 4.5 million smallholders, of which a minimum of 50% will continue to use the created products. Each project should create a financially sustainable business case within a period of three years and reach at least 100,000 farmers (or 50,000 pastoralists). Grant funding for the projects is in the order of magnitude of € 1.5 – 3.5 million per project.

GEODATA FOR INCLUSIVE FINANCE AND FOOD (G4IFF)

To explore the potential of geodata for financial services, NSO started a Geodata for Inclusive Finance and Food trajectory with the Netherlands Platform for Inclusive Finance (NpM) and its members Rabobank Foundation, FMO, ICCO and partner Bill and Melinda Gates Foundation. The Geodata for Inclusive Finance and Food (G4IFF) workstream focuses on the use of geospatial information to increase access to financial services for smallholder farmers.

Financing agriculture is often considered too costly and too risky by Financial Institutions (FIs). The idea behind G4IFF is that use of geodata technology provides an innovative solution for smallholder farmers as it promises higher and more stable crop supply and can improve access to markets. Access to geospatial information improves their



food production and thereby lowers their risk profile, making them viable clients for FIs.

In addition, geodata technology can be used to improve credit scoring models for FIs, for example through data on weather, drought, and soil moisture. This information improves risk management, reduces monitoring and transaction costs, and increases outreach of financial services for smallholder farmers in rural areas.

Elements of the G4IFF include a study on “Geodata and ICT solutions for inclusive finance and food security” (2017), the organisation of a conference on “Geodata for Inclusive Finance and Food”, held in Rotterdam in February 2017, an inventory of technology (2018), a fund database for agritech (2019) and several seminars and webinars. In 2018, the G4IFF innovator’s challenge was held, which resulted in the selection of the three winning proposals that are subject of this study (Agri-Wallet, Apollo Agriculture and VanderSat – TARA) at the Accenture Innovation Awards Summit. Each winner received a prize of € 125,000 to implement the pilot project.

2. STAKEHOLDERS ACTIVE IN “SPACE SERVICES” FOR AGRICULTURE

WHAT IS THE ATTRACTIVENESS OF “SPACE SERVICES” FOR AGRICULTURE?

Space- or geodata-based services for agriculture have been around for a long time. Large, commercial farms benefit from machine guidance, advice on where and when to use which fertiliser, where and when to irrigate and early detection and advice on dealing with pests and diseases. The (optimistic) vision for the future is that complete agricultural value chains will be supported by digitalisation, including traceability, prediction of yields, monitoring of stocks and product flows, asset management, etc. The expectation is then that this will lead to cost reduction, increased transparency and the transformation of business models.

The application of space services for agriculture, especially those that make use of satellite imagery is relatively new. The general advantages of satellite-derived information are that there is a repeated coverage of large areas (including places that are difficult to reach), that they are reasonably accurate, that geo-located information is provided, and that a huge amount of satellite data is available free-of-charge. However, there are also complications: very high resolution (VHR) data, the type that is needed for precision agriculture, is costly, the appropriate data may not be available at the right time for the right place, the processing of data and the transformation of data into actionable information depends on the work of specialists (and carries a price tag), and very often validation and calibration on the ground is needed.

More information on satellite-based information is presented in the NpM inventory of technology (see reference list). This inventory was made in 2018 and since then there have been significant advances in the development and application of machine learning, data processing, the increasing ubiquity of (smart-)phones and the development of alternative solutions, such as the application of UAVs (drones). This will be further described in section 3.

How the potential benefits of space services translate to the improvement of the situation of (smallholder) farmers in developing countries is quite another matter. To assess this, we will first look at the interests and roles of the stakeholders involved.

MAIN STAKEHOLDER GROUPS

In relation to agriculture and food security four main stakeholder groups can be distinguished:

- The **public sector**, with as main interests: stimulating economic growth; feeding the population; improved risk management; effective, efficient and sustainable use of public and natural resources.
- The **agribusiness sector** (including smallholder food producers), with as main interests: increased production and productivity; increased income; improved risk management; good long-term perspective.
- The **financial sector** (with inclusive finance catering to smallholders), with as main interests: improved risk management; lower costs; well-designed products; increased outreach.
- The **academic sector**: high-quality research output; high-quality education; contributing to solving societal problems; affordable education for all.

Admittedly, qualifications can be made about this distinction, but it serves a practical purpose. At the end of this section attention will be given to citizens, gender aspects and environmental perspectives.

The **public sector** consists of the central government in a country, local and regional authorities, sector agencies, such as water authorities and meteorological organisations, and groups that have direct contact with the farmers, i.e. extension workers. Although the interests and mandates of these stakeholder may differ, in developing countries there are common constraints related to effective and efficient allocation of funds, lack of funding and investment, low agricultural production, low productivity in agriculture, a lack of knowledge and capacity in agriculture, the tendency to give short-term economic goals priority over long-term sustainable goals and the resilience of development problems in general. Extension workers

face the additional problem that their target group of smallholder food producers is difficult to reach. The promise of space services for government is that they can help improve decision- and policy-making, and the design and implementation of agricultural development programmes. Another promise is that space services provide ways to reach farmers more easily and more often.

Donors and NGOs support the public sector and/or facilitate the design and implementation of government tasks. Their shared interests are the solving of development problems, the reduction of poverty, the promotion of sustainability and (for donors) often the stimulation of their own knowledge and commercial sector (the G4AW Facility is a case in point). They are grouped with the public sector, because they facilitate the solution of societal problems from a non-profit perspective and therefore (at least in theory) help the government in accomplishing its mission.

The **agribusiness sector** consists of very diverse groups. Smallholder farmers are our main interest. Different segments are distinguished (Anderson, et al. (2019), see reference list).

- **Subsisting**: livelihoods focus on agriculture and are complemented by income from casual labour, often from working on other farms.
- **Commercialising**: the farmers consider farming to be a business and they earn most of their income from agriculture.
- **Diversifying**: livelihoods earn some income from agriculture, though their primary income source is more likely their own business or regular or casual employment.

The general assumption is that interventions directed at improving agricultural performance will benefit commercialising and diversifying farmers and that subsisting farmers are very, very difficult to reach. Smallholder farmers in developing countries face a multitude of problems, such as low production, low productivity, relatively high costs of inputs, exposure to pests and diseases, exposure to (natural) disasters and other risks, post-harvest losses, limited access to markets, limited access to finance, lack of information on prices and developments, lack of knowledge and skills, low income and lack of security (tenure, income). Some of these problems are mitigated when farmers organise themselves into food producers' cooperatives or organisations, especially in terms of collective bargaining power and capacity building. Large food producing enterprises in developing countries face less problems, although they also may be affected (albeit to a lesser extent) by low production, low productivity, high costs of inputs, exposure to pests and diseases, exposure to (natural) disasters and other risks and post-harvest losses. Space services can help both smallholder and large farmers in solving or at least mitigating all these problems, although for some, such as limited access to markets and lack of tenure, solutions depend on many other factors as well.

Commercial providers of fertiliser, pesticides and other agricultural inputs and/or agricultural equipment face problems related to the limiting paying capacity of (potential) clients and the harmful effect on the environment related to the (mis-)use of their products. Off-takers, buyers and sellers, and mills suffer from the same problems as the food producers, although they have more means and leverage to cope with adverse situations. Both groups would benefit from the application of space services, not only for their own operations, but a better performance by their clients, the smallholders, will also increase their revenue.

Tech (technology) and agritech (agricultural technology) companies that provide geodata-based services are also part of the agribusiness sector; they are described in the next section. Mobile network operators occupy a special position. They were at the forefront of facilitating services to smallholder farmers, motivated by a mix of commercial and non-profit considerations. Depending on their role, they are considered as agritech partners or agritechs themselves.

The problems of the **financial sector** related to smallholder farmers are clear: it is difficult to generate sufficient revenue to continue operations or to make a profit with a target group that does not fit the mould of the traditional bank client very well. Within the agricultural sector there are two main types of finance stakeholders: those that provide loans, ranging from traditionally commercial to inclusive finance, and those that provide insurance (of course, overlaps occur frequently). Space services can support the first group with the enhancement of credit scoring models, complementing financial services with agricultural advice and improved risk management. Space services can achieve cost reduction for the second group by reducing the need for field visits (in case of regular insurance) or be developing parameters that can be used to develop and improve index-based insurance. Donors and NGOs, and also governments play an important role in providing financial instruments to farmers. The **academic sector**, both in developed and developed countries, is instrumental in supplying the research that is much needed for innovation and by creating sufficient capacity and knowledge to find local solutions for local problems. There are many international cooperation programmes on the development of space services, some of them dedicated to agriculture.

Photo by: Nilotpal Kalita, Unsplash

ASPECTS THAT DESERVE SPECIAL CONSIDERATION

Citizens in general are of course an important stakeholder group, although most of them (at least the urban ones) will not be in direct contact with the farmer. As indicated in the introduction, urbanisation is an important trend that will have consequences for agricultural value chains and food security. General problems are the narrow focus on low prices of agricultural products and a lack of awareness about the sustainability aspects of agriculture. Space services can help with the sustainability aspects by demonstrating the use or depletion of resources for certain products and through traceability.

Power-relations should not be discarded in any analysis, e.g. many governments in developing countries have a policy to keep food prices low to appease the urban population and to the detriment of farmers' incomes. Gender aspects are equally important. Although space services cannot directly contribute, spatial analysis can provide better insight into factors that are important, such as ownership of land, and geospatial analysis related to membership and governance of producer organisations, establishing who benefits from extension services and capacity building, access to finance, access to and use of technology (including mobile phones), household decision making, time availability and mobility. A positive development is that the percentage of women working in space services, in developing countries as well as developed countries, is increasing steadily. For NpM and G4AW publications on gender, see the reference list.

Determining ecosystem capability in a context of climate change is very important for a sustainable improvement of agricultural production and productivity. Space services are used as basis for environmental, ecosystem and/or water accounting and the analysis of historical trends, providing invaluable information for impact investing and certification schemes.

3. LANDSCAPE OF AGRITECHS WITH A GEODATA COMPONENT

ADVANCE OF DIGITALISATION AND GEODATA

Digitalisation in agriculture and in particular digitalisation with geodata enjoys an increasing popularity. Initiatives, such as the G4AW Facility, show that services based on the application of geodata can contribute significantly to improving the livelihoods of smallholder farmers.

The first initiatives on digitalisation that reached scale were those by mobile network operators (MNOs). The reason for this is that mobile network operators tend to go for reaching large numbers of farmers quickly and then try to improve the content, while the geodata service providers generally started small to get the technical aspects right and then plan to scale up. However, the information provided by MNOs, such as weather forecasts and agronomic advice, was too general to be worth paying for by smallholders, also because a good geodata component was lacking (see the GSMA agritech toolkit in the reference list).

Geodata service providers often struggled with scaling up, as they were good at developing the technical components, but lacked the expertise and experience for dissemination to large target groups. In some cases, this was solved through a cooperation between MNOs and geodata service providers, a successful example is the Garbal service for pastoralists in Mali and Burkina Faso (see “When satellites guide pastoralists in Sahel” in the reference list).

Lessons learned from the early days were that establishing a sustainable business case for the applications takes quite some time, that the technology has to work, that the transmission channels need to be appropriate for the target group and that proper arrangements should be made for data protection and platform ownership.

Since approximately 2015, the positive effect of different enablers for successful delivery of geodata services can be felt. Contributing factors are:

- The increased availability of (semi-)smart phones (and other connecting devices);
- Increased connectivity in rural areas;
- The availability of free and open satellite data (Landsat, Copernicus);
- Efforts to transfer these gains to developing countries, with special attention for smallholders (examples are GSMA, G4AW and the UK Space IPP);
- Development of new, affordable sensors and the increased use of drones;
- Advances in artificial intelligence and machine learning.

Just as important as the technical development is the business side of geodata services. In the mid-term evaluation of the G4AW Facility the following business models were distinguished (combinations are possible):

- **Freemium model**: Free service provision of basic services to smallholders. A number of other clients pay for additional services;
- **Loyalty model:** Free service provision to smallholder clients to avoid that they switch to a competitor for e.g. input supplies (also called “direct revenue B2B (business-to-business))”, because instead of the farmer the input supplier pays for the geodata services;
- **Direct revenue B2C (business-to-consumer)**: The smallholder pays directly for a service;
- **Inclusive model:** Paid service provision bundled into package, e.g. insurance coupled to credit, advisory services to input supplies. The smallholder and/or other clients pay;
- **Service model:** The client pays a (subsidised) fee for service provision; the subsidy can come from government or from another (farmers’) organisation.

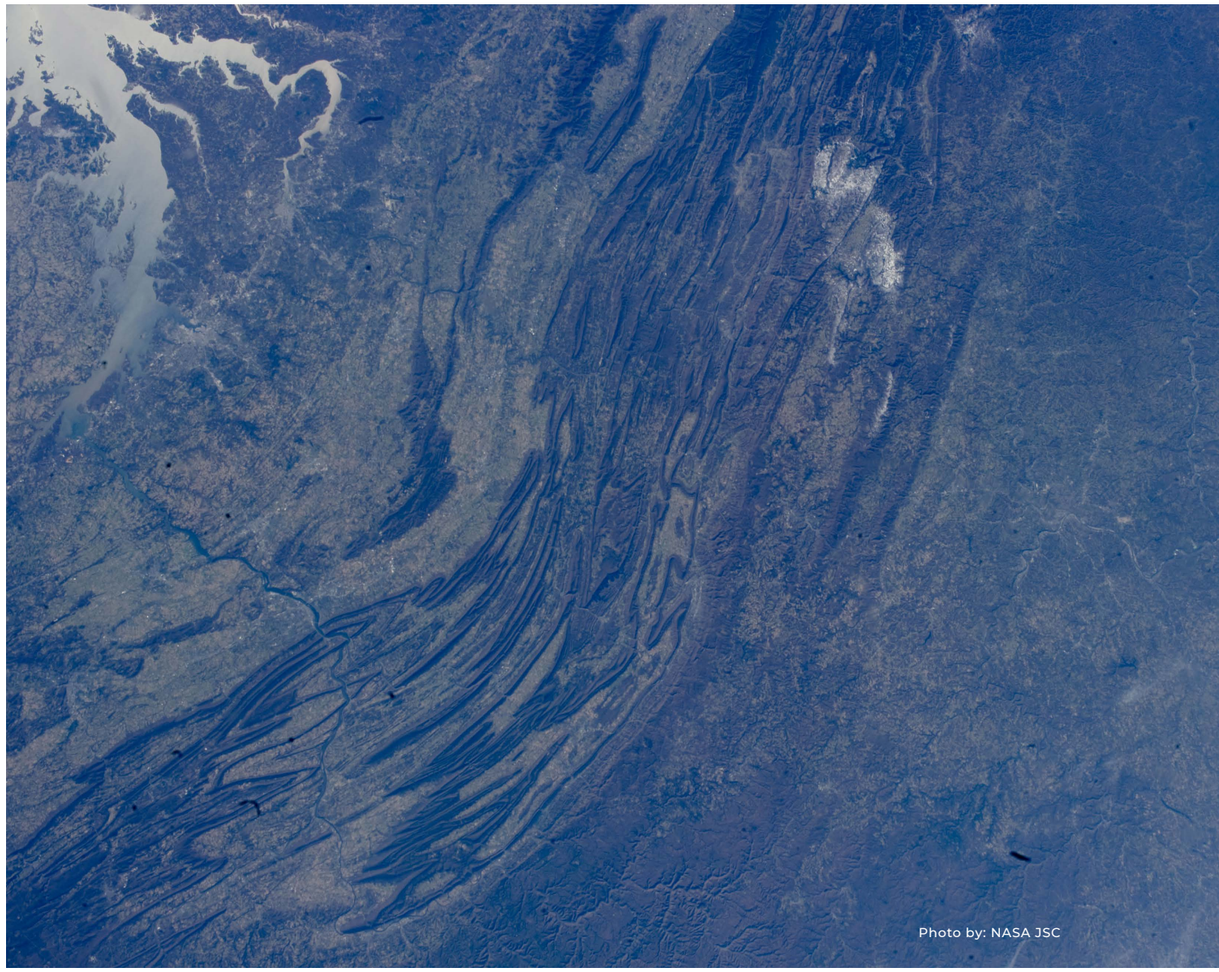


Photo by: NASA JSC

Experience has shown that sustainable delivery of a geodata service, including adoption by clients, depends for a large part on the business owner. The business owner is the entity that will be the main stakeholder and ensures sustainability after initial (external) support, such as innovation funding, has ended. The business owner should have a clear stake in the outcome within the given project timeframe and a forward looking vision for the period after innovation funding. The business owner is the linking pin for upscaling of activities in the country or region concerned.

Figure 2 gives a simplified picture of the way in which a geodata service is typically delivered. Of course different arrangements are possible between partners in an initiative, as will be seen from the case studies in the next section. The business owner is not necessarily the owner of the platform, although this is often the case.

The agritech service providers do not form a homogenous community. When looking at future perspectives, trends, opportunities and challenges, there are four general types of providers (overlap is possible and the order does not give any indication of importance of priority) that can be distinguished as potential players in the market of geodata services for agriculture and water:

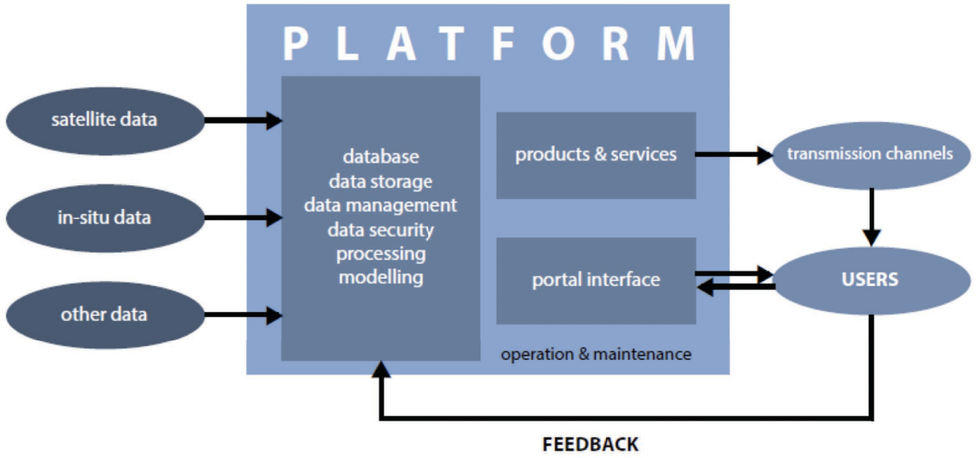


Figure 2. Overview of a typical geodata service delivery scheme.

1. "Big data" players, such as ClimateCorp, Gro Intelligence and 6th Grain, that aim at a potential continental coverage, often with lots of AI and ML, etc. Their strength is processing capacity and access to the latest technology. This proposition is appealing to investors, but a potential weakness is lack of knowledge of the local situation.

2. For African companies knowledge of the local situation is a strong point. They often have a cost advantage and are closer to the target groups. A lack of processing power, IT infrastructure and access to information to keep up with new developments can be bottlenecks.

3. Companies (mostly from the global North) that go for one specific technology where they have a comparative advantage, like VanderSat (TARA) with passive microwave satellite data or Satelligence with combined optical and radar satellite data or with specific sets of algorithms (e.g. eLEAF for evapotranspiration). They are highly specialised, but scaling up capability, making the business case work and their relatively high costs are weaknesses. When finding sufficient capital and partners, companies could go for the no. 1 category, like VanderSat is doing with insurance partners as SwissRe and AXA Climate.

4. Companies from India (such as CropIn) or China that have developed solutions for their large home market. They have a cost advantage, but lack of knowledge of the local situation outside their home country could be a disadvantage.

The table in Annex 1 gives an (incomplete) overview of actors active in geodata services for agriculture in Africa and South-East Asia (corresponding to the area covered by G4AW) that may have activities that are relevant for inclusive finance.

The added value of geodata for finance lies in geolocation, credit scoring, agronomic advice, risk management and index insurance (or a combination of these). Determination of farm location and size usually is done with GPS in a quite straightforward manner and no specific geodata expertise is needed. Geodata for index insurance is a topic in itself and not covered by this report. Case studies on the use of geodata for credit scoring, agronomic advice and risk management are dealt with in the next sections.

4. ANALYSIS OF G4IFF AND G4AW PROJECTS

The six selected projects: CommonSense (Ethiopia), MUIIS (Uganda) and MYVAS4Agri (Myanmar) from the G4AW Facility and Agri-Wallet (Kenya), Apollo Agriculture (Kenya) and TARA (Kenya) from the G4IFF initiative, clearly show that agritech and finance are looking for ways to cooperate. The interest of agritech in finance is primarily caused by the search for paying clients and cost-benefit considerations play an important role in the interest from finance in agritech. Below the main characteristics of the six projects are presented, followed by an analysis of business and financial aspects in section 5.

TYPE OF PRODUCT/SERVICE

CommonSense provides weather information and agronomic advice (based on weather information) to smallholder farmers. A credit scoring model based on expected yield, expected revenue and location was later added to the portfolio.

MUIIS caters to smallholder farmers with agronomic advice, weather alerts, index-based crop insurance and market information. Credit provision was later added through the MAIL system, with support from the Rabobank foundation.

MYVAS4Agri focuses on personalised weather advice (customised for farm location and crop sowing dates), agronomic advice, accompanied by a rice monitoring system and geodata-based credit scoring.

Agri-Wallet started in cooperation with Agrics with the provision of credit (and insurance) to farmers in combination with hybrid maize seeds, training and fertiliser advice.

Apollo Agriculture uses satellite imagery to monitor farms and determine when farmers are likely to harvest their crops, with credit scoring and achieving flexibility in loan repayment data as aims.
TARA contributes to credit scoring based on information derived from soil moisture and other parameters.

CROPS

The pilot projects focused on the following crops:

	COMMON-SENSE	MUIIS	MYVAS4-AGRI	AGRI-WALLET	APOLLO AGRICULTURE	TARA
Maizee	X	X	X	X	X	
Rice			X			
Vegetables*	X					
Potatoes						X
Sesame	X	X				
Soybeans		X		X		
Beans		X				
Coffee		insurance				
Other					X	

* tomato, cabbage, onions

Table 1: Pilot projects crops

Note: the credit scoring exercise of CommonSense started with vegetables and a multi-crop TARA product is under development.

METHODOLOGY AND DESCRIPTION OF OPERATIONS

CommonSense developed the A-CAT credit assessment tool. The A-CAT assessment tool supports microfinance institutions (MFIs) in making decisions on the amount and timing of loans to farmers. The system is based on registration by loan officers visiting potential clients and a desk study by the branch manager at the MFI office. A-CAT contains information on weather, yields, market prices of inputs and crops. In this way a historical track record can be built that gives information on performance and revenue of customers. Buusaa Gonofaa piloted the system in Ethiopia on a small scale. For an overview see **figure 3**.

MUIIS works with sales agents (MSAs), the actual services are delivered by SMS (see **figure 4**). The choice for sales agents has to do with the fragmented landscape of agricultural stakeholders in Uganda: it is difficult to find partners that have a broad (preferably) national coverage. As with CommonSense the link with financial services was developed late in the project. This service, called MAIL is also sold by agents and delivered through (selected) SACCOs and the Uganda Central Co-operative Financial Services (UCCFS). The (envisaged) system is presented in **figure 5**. The advantage of MAIL is risk and cost reduction, because the farmers are already profiled by MUIIS.

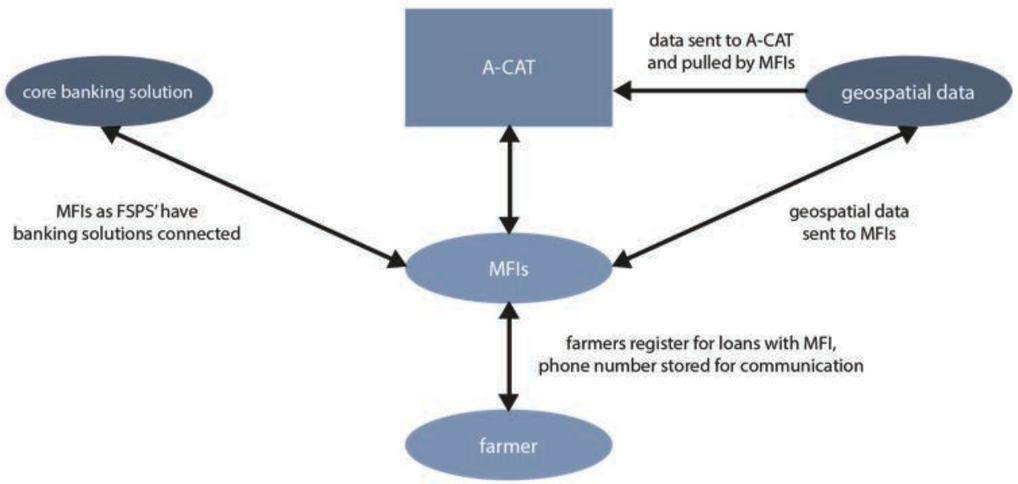


Figure 3: The A-CAT system process flow
(figure free after: BonRezo (2020). CommonSense – Assessment report)

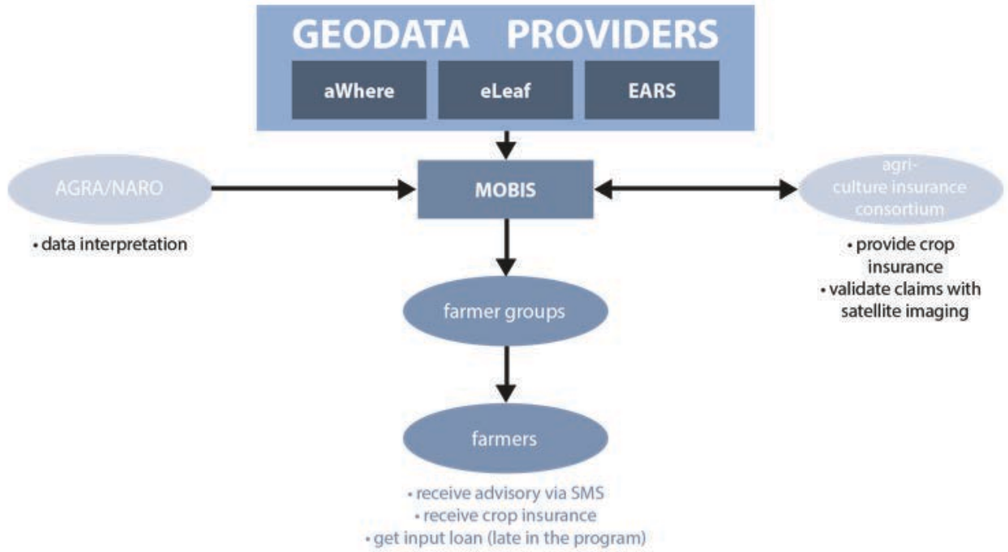


Figure 4: MUIIS system overview
(figure free after: BonRezo (2020). MUIIS – Assessment report)

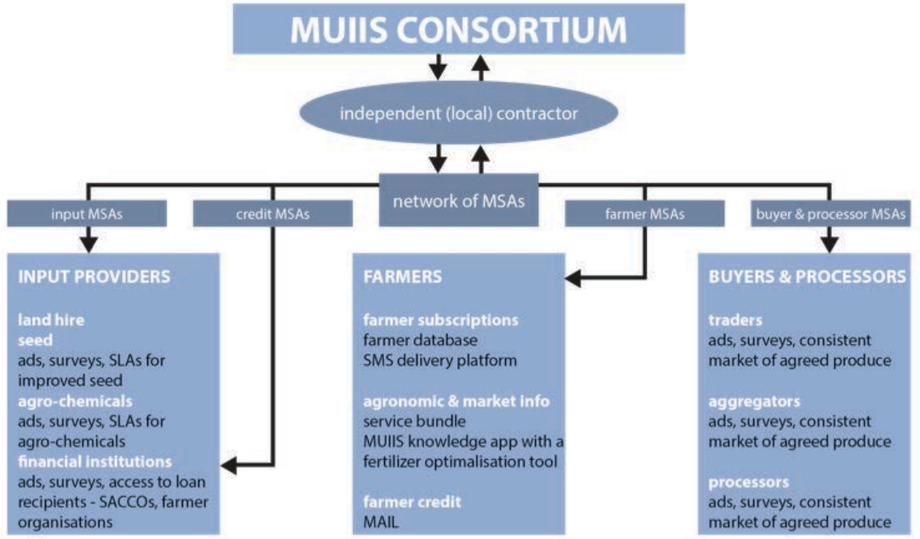


Figure 5: Recommendations for MUIIS operations
(figure free after: CTA (2019). Big data for smallholder farmers: The case of MUIIS Uganda. CTA)

In MYVAS4Agri Village Link and Maha Agriculture Microfinance formed a partnership to provide crop loans to farmers. The farmer registers personal and location data with an app, which is then combined with credit scoring to assess eligibility. Loans are disbursed in cash and repayment is done with mobile money. **Figure 6** gives an overview of the system.

Agri-Wallet provides loans through a mobile farm account that makes use of tokens with the help of a blockchain system. The loans are dedicated to specific, agriculture-related, purposes. The application of blockchain guarantees that this is indeed the case. The interest rate is 1% per month and repayment is due at the end of the season. Agri-Wallet also provides loans to aggregators (at 1,5% per month) to enable early payment to farmers. **Figure 7** gives an overview of service delivery.

Because Agri-Wallet is the only case study that uses blockchain, **figure 8** presents a framework that can be helpful for decision making on whether to use blockchain or not.

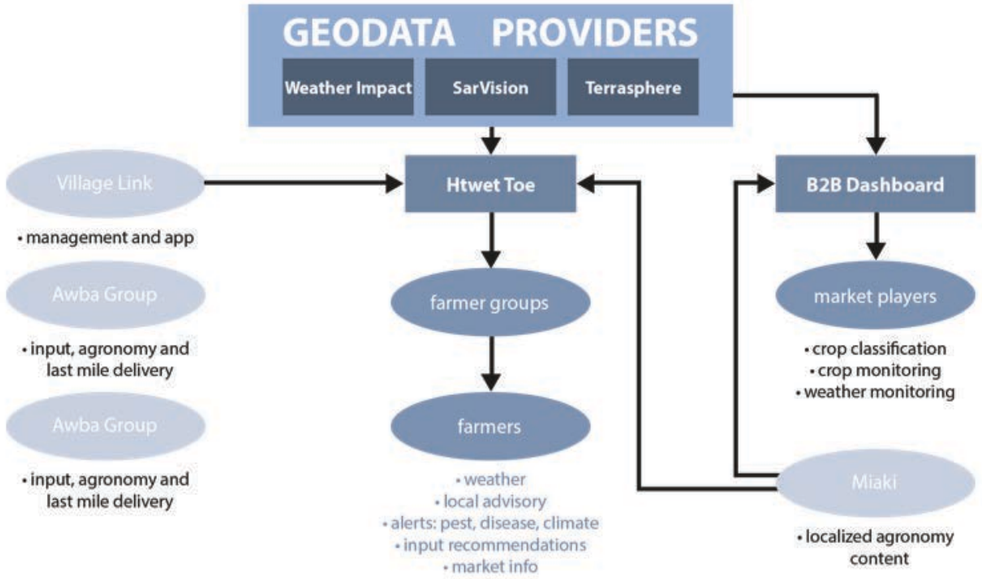


Figure 6: MYVAS4Agri solutions overview
(figure free after: BonRezo (2020). MyVAS4Agri – Assessment report)

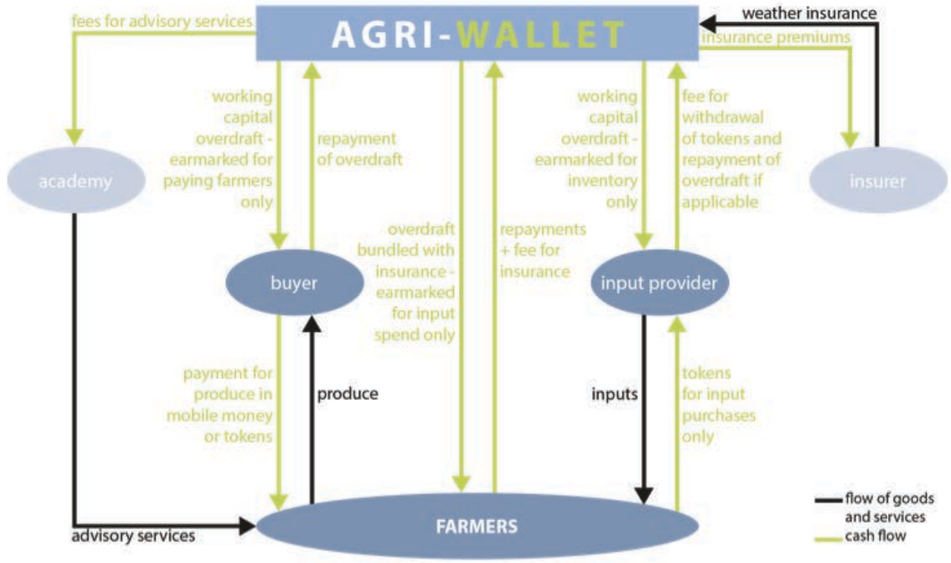


Figure 7: Agri-Wallet service delivery model
(figure free after: BonRezo (2020). Agri-Wallet – Assessment report)

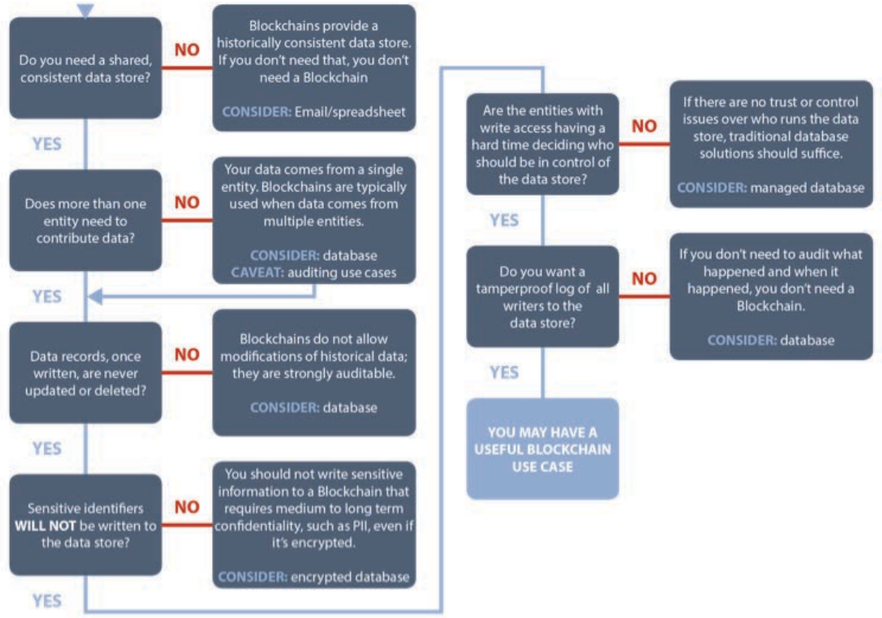


Figure 8: How to make a decision about using blockchain or a database?
(figure free after: FAO / ITU (2019). E-agriculture in action: Blockchain for agriculture – Opportunities and challenges)

Apollo Agriculture works with field agents, who use the Apollo app for data gathering. Credit scoring is done by the Apollo team. To get a loan an initial deposit required. Planting inputs, training and agronomic advice are delivered in combination with the loan. Yield loss insurance is included in the loan. Repayment takes place after harvest; Apollo Agriculture also monitors the approximate harvest time. Promotion is done through radio, SMS, roadshows, agro-dealers and community leaders.

A (historical) analysis of soil moisture is the basis of TARA's contribution to credit scoring in combination with a number of other parameters (for an overview, see **figure 9**). VanderSat provided and analysed the satellite data, ACRE Africa developed the risk scoring model and Tulaa provided the loans. Farmers received loans at an interest rate of 1.2% per month for 6 months with 2% added to the total amount for the automatically included insurance. Tulaa makes use of field agents that register farmers in a mobile app. VanderSat emphasises that through TARA assistance to end users to improve their credit scoring approach, the ambition is not to deliver a complete credit scoring system.

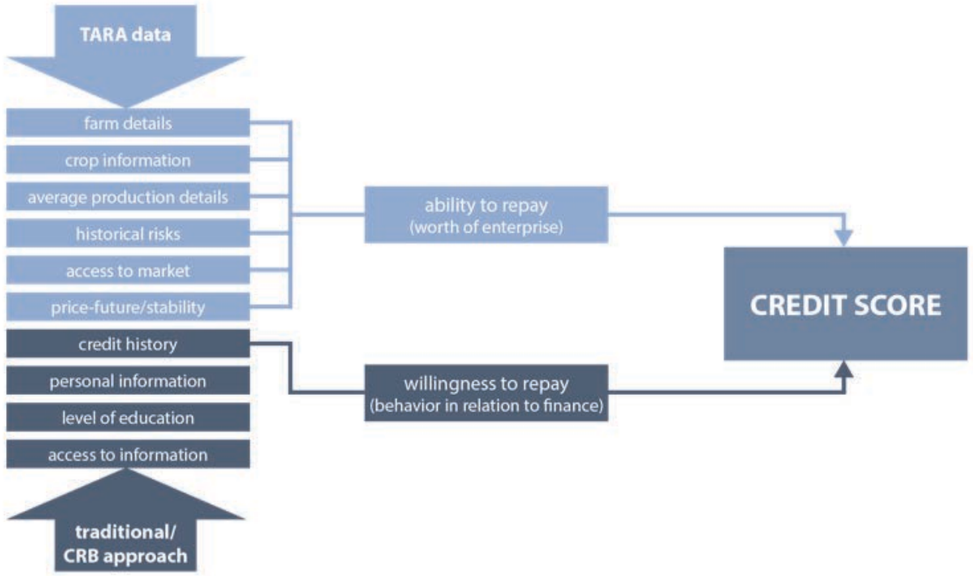


Figure 9: TARA system overview
(figure free after: BonRezo (2020). VanderSat – TARA – Assessment report)

DATA

CommonSense uses a cooperative platform with farmer biodata, farm location and size, types of crops and loan management. In addition meteorological data, optical satellite data and geolocation data are available for advice and credit scoring. Satellite data are used to derive an indicator for vegetation greenness (NDVI), which serves to monitor crops and estimate yields.

MUIIS uses data on farmer bios, location, acreage, production seasons, type of crops, yield and (satellite) data for weather forecasts, irrigation advice and the insurance service (based on evapo¬transpiration).

MYVAS4Agri makes use of meteorological data, data needed for crop monitoring (determining the relative performance compared to regional and multi-year averages), data for provision of various types of alerts to farmers and data for market information. The credit scoring is based on crop monitoring.

Agri-Wallet uses transaction data, farm data and geolocation for credit scoring. In the pilot satellite (Landsat and MODIS) data was used for yield estimation, plus meteorological data (temperature, humidity, wind speed). Satellite data (crop monitoring) is also used for the index insurance.

Apollo Agriculture uses farm size, crop type, crop yield, agricultural practices, possession of livestock and distance to the main road as parameters for credit scoring and an estimation of the harvest date to time loan repayment. Auxiliary data are the appearance of the farmer's house and the farmer's ID-card.

TARA uses a combination of passive microwave satellite data for estimation of soil moisture (historical record), rainfall, temperature, soil properties, etc. as contribution to credit scoring. A set of different climate indicators is used (of which a smaller number have very high predictive power). Allowance is made for different stages of the growing season. Other partners provide additional data, in the TARA pilot GPS was used to get data on farms and farming.

The following table gives an overview of the geodata applications used by the case studies. "Risk assessment" refers to reducing risk for the farmer, such as extreme weather alerts, and not risk assessment that is used for credit scoring.

CASE STUDY	GEOLOCATION (GPS)	CREDIT SCORING	AGRICULTURAL ADVICE	RISK ASSESSMENT	INSURANCE
CommonSense	Yes	Yes	Yes	Yes	Planned
MUIIS	Yes	Yes	Yes	Yes	Yes
MYVAS4Agri	Yes	Yes	Yes	Yes	Planned
Agri-Wallet	Yes	Planned, but not used	Yes	No	Yes
Apollo Agriculture	Yes	Yes	Yes	No	Planned
TARA	Yes	Yes	Yes	Optional, but not in this pilot	Optional, but not in this pilot

Table 2. Geodata applications used by the case studies

CASE STUDY	PRODUCTION ↑	REPAYMENT RATE ↑	ACCURACY PREDICTION NON-PAYMENT ↑	PROCESSING TIME ↓	OPERATIONAL COSTS ↓
CommonSense	Yes	Not reported	Not reported	Yes	Not reported
MUIIS	Yes	Not reported	Not reported	Not reported	Not reported
MYVAS4Agri	Yes	Not reported	Not reported	Not reported	Not reported
Agri-Wallet	Not reported	Probable	Not reported	Not reported	Yes
Apollo Agriculture	Not reported	Yes	Probable	Not reported	Yes
TARA	Not reported	Yes	Yes	Probable	Not reported

Table 3. Summary of positive results that are reported on potential performance indicators for credit scoring

RESULTS AND IMPACT

It is difficult to analyse the number of clients, because the impact depends very much on the business model chosen (for an overview, see section 3). If, for example, an input supplier pays for the service as an add-on to selling a bag of fertilizer, it is far easier to reach scale than in a model where each farmer pays a subscription fee. The numbers presented below have to be looked at with this in mind. In addition, it is evident that the G4AW projects are much bigger and received more funding than the G4IFF pilots and therefore have more ambitious goals.

- CommonSense reports 8,500 direct users and 358,000 indirect ones.
- MUIIS indicates that the agents sold approximately 4,000 subscriptions and that 250,000 users are registered.
- MYVAS4Agri (through Htwet Toe) has around 574,000 subscriptions.
- The Agri-Wallet experiment was carried out with less than 100 farmers and
- the TARA credit scoring pilot was implemented with 150 farmers, and the non-payment prediction done for around 400 farmers.
- For Apollo Agriculture the application of space services was more an enhancement of ongoing operations. Therefore they could apply the service to their total client base, which lies somewhere around 40,000 farmers.

A lack of credit history, lack of collateral and a lack of guaranteed income all inhibit access to finance for smallholder farmers. Any geodata-supported measure that helps improve the situation of the smallholder farmer with respect to credit history, collateral or income security counts as a result.

Achieving a **higher production** is used as performance indicator. MUIIS reports a considerable increase in yield: 67% for maize and 60% for soybean. Agri-Wallet, through the cooperation with Agrics, mentions an increase of the maize yield by 80%. Although the increase seems very high, one should consider that smallholder production is very low and that in the first years of introduction of an improvement yield increases of over 50% are not exceptional. CommonSense also reports increased production, but no quantification is provided. CommonSense and MUIIS also mention higher efficiencies in the use of fertiliser, pesticides and water. MYVAS4Agri reports and increase of 78%, although it attributes only around 7% of the increase to the geodata services and the remaining 71% to improved inputs and other advice.

Increase in repayment rate is another indicator. Apollo Agriculture reports a repayment rate of 87% (for maize this is 90%) and TARA a repayment rate of 85%, both improvements on the previous situation. Agri-Wallet also notes a considerable reduction of the default rate, but this is mainly attributed to the use of tokens and the mobile wallet (funds cannot be diverted).

Improvement of the accuracy of credit scoring is yet another indicator. TARA reports an accuracy increase for the prediction on non-payment. Apollo Agriculture also gives a high percentage, but this is more related to monitoring throughout the season, e.g. a long drought increases risk of non-payment. Apollo Agriculture also adds other features, such as night-light detection (as indication of more assets available to the farmer).

A fourth indicator is the **reduction of processing time.** Loan officers report a considerable reduction for CommonSense in time spent for interviews, thanks to A-CAT. Farmers also noted that they received loans quicker than before. TARA mentions a reduction for the loan approval process from five to six days to one day.

A reduction of operational costs would be a fifth indicator. The case studies do not provide sufficient information to assess this aspect, although there are indications that there is a reduction. Agri-Wallet reported that there was less need for field visits, because yields could be predicted with satellite imagery, but this seems to be more relate to the insurance component. Apollo Agriculture uses geodata as one of the instruments to keep overall costs low and achieve scale. Table 3 gives an overview.

REMAINING CHALLENGES

CommonSense stresses the importance of building trust and confidence with end-users and that this is a long process. As many initiatives have experienced, in Ethiopia the government has a very strong mandate in many sectors of society and often the government has to give special permission, e.g. the national meteorological organisation (NMO) is the only one allowed to disseminate meteorological information, agricultural insurance is also not possible without authorisation from the government, etc. With respect to A-CAT CommonSense reported the need to optimise hardware management of MFI branches.

MUIIS noted a reluctancy to pay for digital extension by smallholder farmers and stresses the need for bundling of services. SACCOs faced problems handling loans. This included use of the MAIL system. In addition, the credit concept was not clearly explained to farmers, which led to a perception that the loans were grants or government loans, which in turn led to high default rates. In general, SACCOs need capacity building to strengthen their financial management, technical and managerial skills to serve farmers. Fortunately the MUIIS agent structure is conducive to receiving farmer feedback. As indicated earlier the agent structure was adopted, because the fragmented landscape of actors in agriculture in Uganda makes it impossible to work with a few big players.

MYVAS4Agri found that because the use of geodata is new, it is difficult to establish B2B revenue. The introduction of geodata-based technology is a step-by-step process that needs long-term investment of time, funds and human resources.

A limitation that Agri-Wallet faced, was that although a historical record could be compiled as basis for credit scoring, crop type mapping and monitoring for the current season to assess repayment capacity was a bottleneck. This is partly due to the relative coarseness of the satellite imagery used, but indeed also a problem that is inherent to the use of this imagery for smallholder farming.

Another problem that Agrics faced (in the GEODATICS project) was that the most suitable fertiliser composition for their customers was not available in the market.

Apollo Agriculture reports the need for achieving sufficient scale, also to provide market off-take for maize as a service.

TARA noted the problem of farmers that were annoyed, not only because they did not get a loan, but also because they did not get insight in why they were rejected.

PARTNERSHIPS

The establishment of partnerships is an important element of the G4AW Facility. The projects are therefore carried out by consortia that (in most cases) form a public-private partnership. Consequently, this applies to CommonSense, MUIIS and MYVAS4Agri. However, keeping the partnership going after the project proved to be a challenge and different solutions were adopted. As CommonSense and MUIIS established new partnerships for their G4AW projects, achieving sustainability was difficult. For A-CAT (CommonSense), ICCO-Terrafina is now the catalyst for consolidating the existing partnership and finding new partners. For MAIL (MUIIS), the partnership looks more like a network, with the MUIIS service agents as the common denominator. In MYVAS4Agri, the

G4AW project provided add-ons to an already existing partnership, which in principle is a positive factor for long-term cooperation.

The three G4IFF projects did not establish partnerships specifically for the use of geodata. With Apollo Agriculture, the activities were carried out by the organisation itself. Because Agrics ended its operations, there was no opportunity to form a partnership with Agri-Wallet. VanderSat offers TARA as a contribution to credit scoring, agricultural advice and risk management, leaving open the possibility of cooperation on a case-by-case basis or the formation of a partnership.

DATA PROTECTION AND PRIVACY

Legislation on data protection and privacy is becoming stricter, as the General Data Protection Regulation (GDPR) of the European Union shows. Most developing countries do not have laws or regulations for digital data yet, but this will probably change in the (near) future. This may have consequences for data streams and storage of inclusive finance initiatives, especially when servers outside the country concerned are used. Below is a short overview of the current situation in the countries of the case studies.

In Ethiopia there are some restrictions on the use of personal data, but these are not prohibitive for the cross-border transfer of data. Reportedly, personal data cannot be stored for a period longer than one year by companies, which may complicate operations. In Kenya the cross-border transfer of (personal) data needs special permission. It is not allowed to have personal data of Kenyan citizens on servers outside the country without this permission. Uganda has no significant restrictions on cross-border transfer of data.

There are no specific laws or regulations related to data protection in Myanmar. However, there is a law on the protection of privacy and security of citizens. As long as this law is respected cross-border transfer of data does not seem to be a problem.

Agri-Wallet reports a solution, where personal data of the farmer remain on a local server and are connected to an ID-number, which is then used as an anonymised link to other data, which is stored in the cloud.

Photo by: Sasin Tipchai, Pixabay

5. FINANCIAL SUSTAINABILITY AND INVESTABILITY OF AGRITECHS

Achieving financial sustainability for geodata applications for smallholder farming is not easy, although agritechs and providers of innovation funding, such as NSO and the European Commission, are convinced that there are long-term feasible business cases. The G4AW and G4IFF pilots show promising results, but there is still insufficient evidence to derive a compelling value proposition for investors from the available use cases.

In addition, there are more general constraints for investors related to geodata for inclusive finance: the short track record of many agritechs, a lack of profitability of a project or a company, uncertainty about the future profitability outlook, the need for a relatively large upfront investment, an uncertain rate of return on investment in combination with a long investment horizon, the lack an investment strategy for geodata (especially the in the smallholder agriculture sector), and a small average ticket size (when dealing with smallholders).

Usually this is where governments step in to stimulate investments and remove market constraints, but in developing countries this is only happening on a limited scale. Agritechs, such as VanderSat, try to work around this by cooperating with big, international companies, such as Syngenta or Swiss Re, with a business focus right from the start of development of the application.

In addition to the topics discussed in the previous section and in the paragraphs above, we assess the following aspects: ownership, business model, bundling of services, revenue streams, long-term cost-benefit and scalability. These have been identified, in the G4AW Facility and other initiatives, as important factors for financial sustainability and investability of agritechs that specialise in geodata.

OWNERSHIP

In CommonSense there is a mix of service providers that each own their data and customer information. ICCO is the principal owner of A-CAT (75%, compared to 25% for Gebeya). Together with Gebeya they want to develop the platform and roll out the service further with interested MFIs as customers, starting with Buusaa Gonofaa.

In MUIIS there are different platform owners that cooperate. The central platform is MOBIS, of which Ensibuuko is the owner. Ensibuuko is projected as MUIIS business owner, although a joint venture between a public and a private partner is also envisaged. Possible public partners are identified.

In MyVAS4Agri the Myanmar Awba group is the projected business owner. Village Link, which could be considered a spin-off from Awba, is the platform owner with a dashboard for B2B with crop classification, crop monitoring, crop growth stage tracking, crop performance tracking and weather monitoring and provides the app for farmers (Htwet Toe) with agronomic advice and financial services.

Apollo Agriculture, Agri-Wallet and TARA make use of their own platform. ACRE Africa and VanderSat co-own the TARA web interface. Apollo Agriculture and Agri-Wallet are the business owners for the geodata applications for credit scoring; for TARA Tulaa would be the projected business owner.

BUSINESS MODEL

During the G4AW-project CommonSense shifted from a B2C model to payment by input suppliers or agro-processors and the use of eVouchers, because the financial sector is heavily regulated by the government. For A-CAT no business model is defined yet, several options are considered, including subscription, freemium and pay-per-transaction.

MUIIS works with a subscription model (for groups and individuals) and the MUIIS service agents get a transaction-based commission (they were salaried during the G4AW project). As the costs for MAIL can be kept low, because use is made of an already existing platform and data, revenue generated from loans should be sufficient to cover operations and to pay the agents.

MyVAS4Agri works with a subscription model, the added value of geodata-derived services in this model is not entirely clear yet.

The (envisaged) business model of Agri-Wallet, Apollo Agriculture, TARA is that eventually all costs will be covered by loan revenues.

BUNDLING OF SERVICES

Both CommonSense and MUIIS apply a combination of weather information, agronomic advice and credit scoring. MUIIS also includes insurance and for CommonSense this is planned. MYVAS4Agri integrates the geodata-based service into their already existing portfolio with agricultural advice and market information.

Agri-Wallet, Apollo Agriculture and Tulaa (for TARA) increasingly add agronomic advice to their financial portfolio, which includes credit and insurance. The insurance is already included in the loan. Apollo Agriculture also offers an off-taking service. CommonSense and MUIIS started with a geodata-based approach and added other services, one could say out of necessity. MYVAS4Agri, Agri-Wallet and Apollo Agriculture added the geodata to their existing services. TARA was set-up as an experiment for the combination of geodata with finance. Although the starting points are different, there is a clear trend towards bundling and integration of services, motivated by both a push factor: the need for more impact, effectiveness and efficiency, and a pull factor: the demand by smallholders for more actionable information and services.

REVENUE STREAMS

In general, the revenue streams for CommonSense are still uncertain, but A-CAT offers opportunities for new business partnerships, with the involvement of ICCO and several interested MFIs and the willingness to invest further by consortium partners.

MUIIS generates revenue through subscription fees paid by individuals and groups of farmers, support from development partners, and monetisation of the database (data sales related to farmer profiling, sale of data products, survey results, advertising) and insurance. The idea is that revenue of monetisation of the database would subsidise service delivery to SACCOs and farmers. Until now costs for MAIL superseded revenue, but that is partly due to start-up problems.

MYVAS4Agri also generates revenue from a variety of sources: advertising, market surveys, sponsored content and referrals, data analytics, and the call centre service. Farmers use the Htwet Toe app free-of-charge. Agri-Wallet, Apollo Agriculture and TARA-partner Tulaa generate their revenue from loans.

LONG-TERM COST-BENEFIT

The outlook for the CommonSense advisory services is not very well defined yet: the aim is to establish an ecosystem with different types of clients (public and private), served through a bundling of services. For A-CAT the benefits lie in the reduction of the time to collect and process data. A-CAT also helps to better estimate the farmer's cash flow and thus the optimal size of the loan. As an extra benefit the software contributes to minimising the risk of wrong decisions taken by loan officers. This shift towards a data-informed business should be attractive for local MFIs to invest in, also because they regard it as an opportunity for broader digitalisation of their operations.

MUIIS adopted a diversification strategy which may well work, with geodata components as part of virtually all the services that are on offer. The challenge will be to keep the costs low on the supply side (data processing, provision of relevant advice), while maintaining sufficient momentum to expand the client base in Uganda. This applies also to the MAIL system, which was a more recent addition to the portfolio.

MyVAS4Agri noted a lack of willingness to pay for generic sets of geodata and a lack of perception of what can be achieved with geodata among the customer base. The added value of geodata-based services is still not clear. As cost-benefit depends on the revenue from the B2B business model, this is a point for attention.

Agri-Wallet aims at financial sustainability by serving the whole production chain from aggregator (working capital, steady supply, reduces administrative and operational costs) to farmer (fast payment, mobile money immediately available, automatic input savings, easy transactions). The aim is to serve as a technical platform that can be used by FIs and that also makes use of geodata, e.g. for the provision of a multi-crop, perennial extreme weather insurance.

Apollo Agriculture chose to accept a lower loan repayment rate (80 – 95%) to keep costs down and make operations sustainable. The use of geodata is already part of operations. The approach is to automate as much as possible and keep costs low. The growth of Apollo Agriculture is facilitated by grant funding in combination with venture capital (Series A investments) and other ways of generating working capital loans (e.g. through crowdfunding platform PlusPlus).
TARA reports a reduction of loan processing time from five or six days to one day, but also identifies a need for additional funding for further development of the service. For Tulaa the long-term costs were not sufficiently clear, which made them reluctant to commit.

SCALABILITY

The Ethiopian market is in principle big enough for CommonSense to achieve sufficient scale, but there are constraints. Licence-to-operate restrictions and, more recently, the security situation complicate matters. The concept of a bundle of geodata-based services, with the provision of specific farm advice, start of rainy season alerts, establishing an agro-meteorological value chain and downscaling services (with the help of indigenous knowledge and crowdsourcing) is interesting, but needs to be developed further. The pathway for scaling up the A-CAT component seems to be promising, with expressed interest from a number of MFIs.

MUIIS struggled with the fragmented landscape of the agricultural value chain in Uganda. The solution with MUIIS agents and the addition of the MAIL service is promising, but as the numbers show, sufficient scale is still a long way off.

In MYVAS4Agri Village Link with its Htwet Toe application has already reached sufficient scale in terms of numbers. How to capitalise on the added value of geodata in terms of increased profitability is still a challenge, as income has to be generated from businesses that are not familiar with geodata-based services. The Agri-Wallet experiment did not succeed in using geodata for credit scoring. The crop monitoring that was applied for yield estimation seemed to be more in service of the insurance part. To reach scale with respect to geodata-based applications Agri-Wallet would need an agritech partner that can provide an effective solution at low cost.

Apollo Agriculture has already integrated the use of geodata into its regular operations. The goals of Apollo Agriculture are very ambitious, but the stated number of 60,000 farmers to break even seems to be well within reach. Automation and digitalisation are applied to facilitate scaling up.

The technical aspect of the TARA application is most probably ready for scaling up, but more development funding is requested to transfer the methodology to other crops than potatoes and to different environments (need for more validation).

The three G4IFF-pilots were quite small and therefore focused on the (sub-)national level, but there is potential for scaling up internationally. The set-up to deliver geodata services in the three G4AW-project is more context dependent (adapted to local requirements), although the methodology for credit scoring could also be applied in other countries.

RECENT INVESTMENTS

Agri-Wallet received a grant from the Rabo Foundation and partners with the Farm to Market Alliance (FtMA) and cooperates with IDH Farmfit. The perspective is to function as a technical platform that facilitates lending operations from local FIs that are backed by FtMA. VanderSat received an investment of several million Euro from Social Impact Ventures to improve the financial sustainability of smallholder farmers. Apollo Agriculture recently raised $ 6 million in Series A funding by Anthemis. As indicated above in the long-term cost-benefit paragraph, the three G4AW projects (CommonSense, MUIIS and MYVAS4gri) aim to grow gradually without considerable external investments. In CommonSense, ICCO is added as a new partner to explore the opportunities for the A-CAT credit scoring tool. Of course, this financial support is for general development and not specifically for geodata applications.

INVESTOR PERSPECTIVE

All the six pilots have positive aspects and are promising, one cannot say that one approach is better than the other. Two factors are especially important from an investor's perspective:

- More growing seasons are needed to assess the real added value of geodata (although this could be partly compensated by simulating results based on a time series of satellite and other data);
- The application of geodata should be considered in the general framework of digitalisation for streamlining operations and not as stand-alone.

As indicated elsewhere in this document, keeping costs low to survive the difficult period before reaching scale and generating sufficient revenue and taking sufficient time to establish a good working relationship between partners, are requirements for long-term success.

6. CONCLUSIONS

Digitalisation in general can be considered a paradigm shift, also for inclusive finance. Geodata applications are an integral part of the digitalisation process. **Geodata for credit scoring improves the current business process**. This can clearly be demonstrated and measured by performance indicators: higher production (CommonSense, MUIIS, MYVAS4Agri), increased repayment rate (Apollo Agriculture, TARA), improved prediction of non-payment (TARA), reduced processing time (CommonSense, TARA) and reduced operational costs (Agri-Wallet, Apollo Agriculture).

However, **more time and development is needed** to arrive at mature solutions that are accepted by the market, as the general experience of the G4AW Facility shows. Although the number of farmer customers is increasing, the amount of revenue generated is still relatively low and reaching scale is a condition to break even or make a profit (Apollo Agriculture). As indicated in the previous section, a modular approach, consisting of readily applicable technical building blocks (plug-and-play), in combination with tailor-made context-dependent organisational adaptations can help mainstreaming geodata services.

The proposed solutions are **fit-for-purpose** and have a comparative advantage over current practices. However, the application of space services has limitations, e.g. the identification of crop type on individual plots is difficult, especially in areas with a very diverse cropping pattern and small farms (Agri-Wallet could not use it for credit scoring). Checking that loan amounts are equivalent to the size of the farm (or the area sown) is therefore difficult. Systems that can do this exist, the European land parcel identification system (LPIS) in combination with the results of the Sen4CAP initiative (Sentinels for the common agricultural policy) is an example, but the investment needed does not make such a solution realistic for developing countries.

Perceived **complexity and ease-of-use** for those working with the system are issues that need attention. As MUIIS reported, SACCOs faced difficulty handling loans and, more in general, working with or interpreting geodata requires certain skills. Especially if the application of space services is one of the first experiences of an organisation with digitalisation, there is a need for adjustment and there will be start-up problems. A general finding (also from other projects in the G4AW Facility) is that farmers need actionable insights that are presented to them in a way that is easy to understand.

All projects put lot of effort into **design**. This resulting in an appealing interface with the farmer, usually through the combination of an app and direct contact with an agent. The workflow and the division of tasks is also very well thought out, as figures 3 to 7 and 9 attest. How elegantly space services fit in the delivery mechanism differs per initiative. This is of course easier when working with geodata was part of the set-up from the start (as with Apollo Agriculture), than when geodata services were added later to an already existing system (as with MYVAS4Agri), although the latter has the advantage of an established client base.

Most pilots report positive expectations on **cost-benefit** (see table 3), but the applications have to be operational at scale to get a clear picture. Some pilots (e.g. Tulaa for TARA) expressed fears about the high costs, especially up-front, that are needed for development. Different business models are proposed, all feasible and adapted to the local context. Different business models are possible, all have their own merits and possible drawbacks. It is obvious that it is easier to get good results when dealing with relatively large quantities of high value crops with easy access to a clear market, than with occasional surplus production from dispersed farms in remote areas.

The pilots take good steps in direction of **business sustainability**. In virtually all pilots the business ownership is clearly defined, only for CommonSense A-CAT this still has to be arranged. All projects work with a bundling of services, which is a good and conforms a trend that can be seen in more G4AW-projects. Perhaps the most important finding is that the role of geodata services as an enabler for the connection of agricultural advice, risk management and inclusive finance is considered a logical step in the development of the sector.

Resilience of the geodata services does not really seems to be a problem, for most types of satellite imagery nowadays alternatives are available to cover temporary lapses in data provision. The methodologies adopted by the pilots are easily adaptable to changing circumstances. All projects require connectivity, which sometimes leads to problems (as reported by CommonSense). This can be remedied partly by building in buffers between data collection and data transfer. Digitalisation has advantages in dealing with the consequences of the COVID-19 pandemic, but visits by field agents (that have a key role in many projects) may be affected. The delivery of geodata services is of course vulnerable to insecurity in the country or region (as currently in parts of Ethiopia and Myanmar), but these are risks that are very difficult or impossible to mitigate.

As indicated in the previous section, the methodologies developed by the pilots are well suited for **scaling up**. However, more investment will be needed to expand to new regions and countries and to cover a wider range of crops. This will also be a good test for the flexibility of the geodata-based solutions.

Acceptance of geodata services is a process that generally takes more time and effort than anticipated. CommonSense reports that building trust and confidence takes time. MUIIS also identifies that the farmers need time to get used to geodata services and MYVAS4Agri reports the same for its institutional clients. TARA reports that farmers do not understand the mechanism behind credit scoring (although this may apply to almost everyone, who wants to borrow from a financial institution). The challenge is to present insights and to provide information in a way that, although not understood, it is actionable and delivers results (this type of reasoning is probably also behind the inclusion of insurance in a loan without the farmer knowing).

A certain **level of knowledge transfer** required: CommonSense reports the lack of computer savviness and hardware problems at the local level and MUIIS the difficulties that SACCOs (initially) faced in handling loans. Any digitalisation effort requires capacity building in working with the system and in business skills, but as the work on algorithm development and associated machine learning, etc. is done by a specialised geodata service provider, the amount of training needed for the other members of a partnership is quite limited.

GDPR issues will have consequences for geodata services operations, but what these exactly will be is not quite certain yet. Apart from this, there is a possible ethical issue that needs attention with the selling of data on farmers and farming to third parties, as is part of the business model of MUIIS and MYVAS4Agri. Although there is a very good rationale for the use of algorithms, their application could be subject to future scrutiny, as there are discussions in society about their potential to discriminate.

The **general business environment and institutional setting** are not mentioned as limiting factors by the pilots. Willingness to pay (by MUIIS for farmers and MYVAS4Agri for business clients) are mentioned as constraints. The ease of doing business differs per country, in Ethiopia the government has more dominant role in matters that relate to finance and agriculture than in other countries, as CommonSense reports. Until now Kenya has the most stringent restrictions on cross-border transfer of data. Fragmentation of the agricultural sector in Uganda forced MUIIS to set up its own business ecosystem. Overall there seem no serious limitations for geodata services for inclusive finance that cannot be overcome, apart from those associated with serving a difficult sector in a difficult situation.

The application of geodata services for inclusive finance opens up possibilities of the inclusion of other data and methodologies that contribute to informed decision-making for impact investment in the broader context of climate mitigation and adaptation and environmental management. The first priority is however with the operationalisation and mainstreaming of geodata services for inclusive finance as such.

Photo by: Mrinal Verma

7. FUTURE PROSPECTS

The focus of this section is on credit scoring, provision of agricultural advice for farmers and risk assessment (also for farmers). The application of geo-positioning is relatively mainstream (although apparently new for some FIs, such as Tulaa) and not very complicated. Provision of (index) insurance services falls outside the scope of this report.

The pilot projects show that the first steps have been taken, with respect to space services for inclusive finance, although there remain issues to resolve (see also the next section). The initial results show gains related to production, credit scoring, repayment rate, prediction power, processing time and operational costs, which is promising. Future work can focus on a modular approach (e.g. building blocks for credit scoring) with tailor-made adaptations for different clients and circumstances. The building blocks would consist of technical improvements (e.g. historical analysis of soil moisture), while the tailor-made part would concern the organisational arrangements that are context-dependent. Most of the pilots already have the ingredients for such an approach, but are still in the process of making it work in local conditions. Low-hanging fruit, although not trivial, would be to develop the methodology further to expand operations geographically (to other regions and other countries) and to cover more crops. Of course, this is easiest in cases where only a few crops are grown over large areas (e.g. rice, maize) or if the crops are of relatively high value (e.g. vegetables).

As a result of the G4AW-project there is a tendency for each company to develop and market their own niche product(s). There is nothing wrong with this, but as we have seen that the pilot projects all evolve towards a bundling of services, integrating different aspects and marketing a general concept has probably more impact. An example, and outcome of G4AW, is the Garbal initiative (coordinated by SNV) that provides information on water bodies and grazing opportunities for pastoralists and is now rolled out over Africa, building on experiences in Mali and Burkina Faso. The six pilot projects revised in this report all have the potential to do so, although some will be limited to a national context, because the business owner is a local organisation. Still, the concepts of the pilot projects as such are valuable to serve as example and inspiration for other organisations that work in finance and agriculture and that want to innovate. Below **three types of trends** are sketched, dealing with **technical, organisational and cross-cutting issues**. These trends are likely to have an impact on both space services and inclusive finance.

At the technical level there will be **more free and open satellite data available**, which creates new opportunities for improving and developing new applications, but also requires more processing power. **Machine learning and artificial intelligence will become more mature and mainstream** (and will also require more processing power). This opens **opportunities for integration of different data sources and methodologies**. Consolidation in the space service sector may also contribute to this (two MUIIS partners, eLEAF and EARS, are now one organisation).

New ways of data collection will be introduced or their use and range of applications will be expanded in developing countries. Drones are an example, they are now used for delivery of medicines, for flood mapping and at an experimental level for agriculture. Local operators are trained and generally there are less restrictions on flying drones than in developed countries. **Local networks for in situ observations will be expanded and improved**, such as the TAHMO weather stations (desperately needed to make weather forecasts more relevant at the local level), soil mapping and testing (such as by AgroCares) and the use of smartphones for citizens observations will increase. This will have a positive effect on the accuracy and effectiveness of space services.

The **demand for yield estimates by off-takers and local government**, as already provided by MUIIS and MYVAS4Agri will increase, also in relation to the assessment of and coping with climate risk. Thanks to the technical developments listed above, the results will be more accurate. The revenue can be used to provide services to farmers.

At the organisational level **partnerships will be explored further to reach the farmers effectively with innovative solutions**. Constellations may change, depending on circumstances, but working with field agents seems to be a good solution for linking the farmers with space services and inclusive finance. Although they can be useful, Especially the

partnerships are not a panacea for success and long-term sustainability. Especially the building of relations and trust demands more time than usually allowed in a project-based approach. If this is combined with the introduction of new technology, such as geodata applications, and the target group consists of smallholder farmers in developing countries, the situation becomes even more complicated. The most prudent and promising strategy seems to be to take sufficient time to operationalise innovations and to keep costs low (to survive the period after start-up funding has ended and before sufficient revenue is generated).

Increased cooperation with (local) government is needed. Not only when one is forced to do so, but also as a matter of principle: government has a development mandate for the wellbeing of the smallholder farmers. Many countries have increased their production and productivity by considering agricultural advice as a public good and by investing in extension. An example of an NGO that works through government agencies is CABI, which is quite successful with its Plantwise system for dealing with pests and diseases.

Not only is capacity building important, but also the involvement of local geodata specialists. The number of good quality geodata experts is increasing (a considerable number of them was trained in the Netherlands) and their deployment could also lead to cost reduction.

Several **cross-cutting issues** deserve attention in relation to future developments that affect both inclusive finance (decisions) and space services. These are:

Impact investment needs to take many aspects into account, such as inclusive green growth, (payment for) ecosystem services, **climate adaptation** (and where possible, mitigation), certification and **achieving a circular economy**. Space services are an important component for the assessment, monitoring and evaluation of the related processes and in providing the basis for measuring and accounting systems (natural capital accounting, ecosystem accounting). Here again, cooperation with the local government is a condition for success.

The **mapping and monitoring of global commodity flows becomes more and more important and sophisticated** for the monitoring of effects on climate and sustainable development. Space services provide insights on de- and reforestation, crop type mapping and monitoring, encroachment on wildlife reserves, etc.

Tenure security is considered an important asset for access to finance. Implementation of a conventional cadastre is a very slow process. New approaches, based on cooperation with local communities that make use of digitalisation and satellite imagery are deployed to speed up the process.

The **energy transition** results in an increased demand for finance to acquire assets, such as solar pumps for irrigation and solar dryers. Space services help with the assessment of the potential for solar energy and the short-term prediction of available solar radiation.

The COVID-19 pandemic may have had a positive effect on the need for space services, because field visits have become impossible or undesirable. However, the total effect on the smallholder sector is probably negative. In addition, the deteriorating security situation in several countries (Ethiopia, Myanmar) may hamper progress of activities, starting with connectivity.

Most countries will design and enforce stricter regulation on data protection and privacy, affecting both inclusive finance and space services.

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ANNEX 1: SAMPLE OF GEODATA SERVICE PROVIDERS IN AGRICULTURE THAT ARE ACTIVE IN AFRICA AND ASIA

ORGANISATION (PRODUCT)	COUNTRIES IN AFRICA (MAIN OFFICE LOCATION)	DESCRIPTION
6th Grain	Africa, including Tunisia, Kenya, Zambia, Mozambique & South Africa (USA)	6th Grain offers an annual cropped area model for US$ 20,000 for wheat, barley, maize, soybean, sunflower (and some crops on demand) at 10 m resolution, produced 1 – 2 months after harvest. Ground photos are used for calibration and validation.
Gro Intelligence	Global ambition - not yet active in Africa (USA)	Crop type mapping with machine learning, making use of different types of datasets and satellite imagery. Gro Intelligence offers a platform with datasets on yield, production, imports, planted area, consumption, exports, prices, markets, trade flows, economy, education, demographics, labour statistics, weather, climate and environment.
Stanford Sustainability and Artificial Intelligence Lab	Global ambition - not yet active in Africa (USA)	Crop type mapping with machine learning, making use of different types of datasets and satellite imagery; published an article on crop type mapping in Africa. Predicting crop yields by using a combination of machine learning, remote sensing, in situ data, historical data and statistics; published an article on smallholder yield variation in Africa·
tTechno Brain	Malawi, Tanzania (Kenya)	Techno Brain is a company that partners with Microsoft to provide agricultural advice to smallholders through SMS and IVR. The initiative started in 2018, in Malawi and Tanzania.
WeFarm	Kenya, Tanzania, Uganda (UK)	Farmers connect with one another to solve problems, share ideas, and spread innovation, for free, and without needing an internet connection: Wefarm works through SMS. To help the farmers communicate with each other, Wefarm uses automatic translation.
Econet (EcoFarmer)	Zimbabwe	Econet's EcoFarmer started as a weather-index insurance initiative in 2013. EcoFarmer added other services to its portfolio, including agricultural advice. The service is subscription-based and focuses on maize, groundnuts, tobacco, cattle, goats, bees, and sorghum.
Green Dreams TECH (iCow)	Ethiopia, Kenya, Tanzania (Kenya)	iCow provides farmers with information on how to improve their agricultural practices through SMS messages and with the iCow app, not only on livestock, as the name suggests, but also on crops. The services are provided in different local languages. Apparently, the initiative is sponsored by a number of partners, including USAID.
Precision Agriculture for Development – PAD	Kenya, Rwanda, Ethiopia, Uganda (India)	PAD provides advice based on mobile soil lab analysis, satellite and drone data and weather information. They work with local partners, for example with ATA in Ethiopia (8028). The services are mobile phone-based and feedback from farmers is used to improve the services. The initiative is entirely funded by donations.
Digital Green (FarmStack)	Ethiopia, Kenya (India)	FarmStack provides information to smallholder farmer families about soil, inputs, pests and diseases, and weather, with a special focus on women. The connection is made through trained frontline workers. What data are used and how these are obtained is not entirely clear. The initiative is still in the exploratory phase.
Manobi (mAgri)	Africa (Senegal)	Manobi offers a range of mobile-based services with a focus on market-related aspects. Georeferencing of plots and transmission of information on weather, spread of pests and diseases, and yields are included. Manobi cooperates mainly with institutional partners, such as NGOs and donors. Together with ICRISAT they developed an agricultural management system called agCelerant that also includes agricultural risk management and tools to develop insurance instruments. The geographic focus is on French-speaking West-Africa: Senegal, Côte d'Ivoire, Benin, Mali, Burkina Faso, Niger, although they also work in Nigeria.
VITO	Africa (Belgium)	VITO has decades of experience in crop monitoring in Africa, mainly using SPOT Vegetation. They recently co-developed a system for potato monitoring in Europe, called WatchItGrow, which can also be used for Africa. VITO has developed an insurance application that measures yield deficit with the help of a vegetation index (fAPAR) derived from SPOT (and now probably Sentinel) imagery. As an R&D institute, VITO will not commercialise the applications they develop.
VISTA	Africa (Germany)	VISTA is the lead partner of the ESA project "Food security thematic exploitation platform" (FS-TEP) that aims to provide cloud-based services for agricultural monitoring and advice, mainly based on Copernicus data. VISTA focuses apparently mostly on advice of the use of fertiliser. Activities have focused primarily on Europe.
eLEAF (Fruitlook)	Mali, Uganda, South Africa, Sudan (Netherlands)	eLEAF offers products and services for water management, irrigation and water productivity, based on satellite data, but also agricultural advice derived from evapotranspiration data and modelling. It offers products on crop monitoring and yield prognosis. An example is Fruitlook, which is an operational service for vineyards (South Africa). EARS, now part of eLEAF, was one of the frontrunners in developing index-insurance applications, based on satellite imagery. The methodology is based on evapotranspiration that is derived from Meteosat imagery in combination with other data and models. Despite the rather coarse resolution, the application has been rolled out successfully in Mali and Uganda (and perhaps other countries), thanks to the sound methodology and efforts to partner with key players in the field. As the application was developed with public funding, the methodology is very well explained in publicly available documents. EARS is also is active in crop monitoring for Africa. eLEAF and EARS have many activities in Africa, most are on a project basis.
Satelligence	Burkina Faso, Ghana, South-East Asia (Netherlands)	Satelligence is a company that builds on its expertise in the use of satellite radar data. It therefore focuses primarily on tree-like crops, such as oil palm, coffee and (to a lesser extent) cocoa. Satelligence is engaged in several activities related to agriculture in Africa, although its strong point remains monitoring of deforestation. Other Satelligence services, where radar imagery has an advantage, are fire early warning and monitoring (mainly applied to tropical forests) and flood mapping and monitoring. Practical applications until now in Vietnam and Bangladesh.

SARvision	Africa, South-East Asia (Netherlands)	The technology focus of SARvision is similar to that of Satelligence, which is not surprising as SARvision is the company from which Satelligence originated. SARvision, however, is more research oriented and has close links with Wageningen University. Apart from deforestation, monitoring of wetland rice and flood early warning and monitoring with satellite radar data are strong points.
Waterwatch	Burundi, Ghana (Netherlands)	Waterwatch offers a global vegetation database and early alerts for crop diseases, both based on satellite data. Waterwatch is active in projects on good agricultural practices in Ghana and Burundi. Waterwatch also provides services related to prediction and monitoring of droughts and floods and water management. One of the activities of Waterwatch is to provide advice on increasing water productivity ("more crop per drop"), based on satellite information. Cooperates with SAP to increase its impact.
RIICE	Global (Philippines)	Although the project "Remote sensing-based Information and Insurance for Crops in Emerging economies" (RIICE) has worldwide ambitions, it now focuses mainly on Asia. The results and follow-up may be relevant to future African applications, as there are big gains to make in the increase of production and productivity.
Cropin	Global ambition – not yet active in Africa (India)	Cropin offers a Smart Farming app that provides a range of information products for farm management, mainly based on satellite information. Cropin provides agricultural risk assessment at the regional level with its SmartRisk tool. Like many Indian companies, Cropin aims to expand its activities to Africa.
Esoko	Ghana	Esoko is a social enterprise with the aim to support farmers through mobile technology. The services include weather forecasts and agriculture advice and are delivered through text and voice messages and SMS. Market information, farmer profiling and financial services are also part of the portfolio. Field data collection includes farmland mapping and tracking yield and crop production.
VanderSat	Global ambition (Netherlands)	Vandersat offers soil-moisture products for different applications: irrigation, fertiliser application, spraying and (on a larger scale) crop production estimation. The products are based on the processing of satellite data (passive microwave). Drought risk assessment and monitoring and index insurance parametrisation are other services. VanderSat has been quite successful in terms of marketing effort and partnering with big (potential) clients.
NEO	Kenya, Bangladesh (Netherlands)	NEO provides drought monitoring (and crop monitoring services, mainly in support of in situ soil measurements), based on Copernicus data. Although the main focus of activities is in the Netherlands, several projects are carried out in Africa and Asia.
Weather Impact	Angola, Kenya, Burundi, Ethiopia, South Africa,	Weather Impact offers operational forecasts and weather analytics, making use of global weather data and field information. Weather Impact's work is based on the ensemble prediction of ECWMF, local weather data and satellite data. The insights are translated into agricultural advice, such as irrigation advice, early warning for pests and diseases and spraying advice. Weather Impact provides services related to extreme weather and drought risk assessment and monitoring.

SERVIR Africa	Africa (USA)	SERVIR Africa, a programme sponsored by NASA and USAID, works on drought risk assessment and monitoring, hydrological mapping and flood early warning and monitoring in several African countries. African partners are the regional centre for mapping of resources for development (RCMRD) for eastern and southern Africa and AGRHYMET for West Africa.
CSIR (AFIS)	South Africa	The advanced fire information system (AFIS) is a satellite-based information tool that provides near real-time prediction, detection, monitoring and alerting information to improve fire risk management.
SNV (Garbal)	Mali, Burkina Faso (Netherlands)	SNV and partners have developed the Garbal service, which is operational in Mali and Burkina Faso. With simple phones pastoralists can reach call operators or send a text message to instantly obtain information on biomass quality and availability, surface water availability, herd concentration and market prices for livestock and staple grains along the different transhumance routes. The service is based on satellite information. The initiative is sponsored by the phone company Orange. Because of its success, rollout efforts are started to set similar services for livestock management in other African countries.
KLIP	Kenya	The Kenyan Livestock Insurance Programme (KLIP) is an index-based livestock insurance program that uses satellite technology to protect pastoralists in the remote, arid and drought-prone rangelands of Kenya from the impacts of extreme weather. The programme is sponsored by the Kenyan Government and donors. It results from the IBLI (index based livestock insurance) initiative that was set up by the World Bank and other donors. The index is based on NDVI, derived from Landsat imagery.
Hydrologic (HydroNet)	South Africa (Netherlands)	Hydrologic provides a water management platform called HydroNet that includes a tool for reservoir management and an international water basin control room. The platform can also be used for weather- and water-related agricultural advice·
Starlab	Global ambition (Spain)	Starlab provides soil moisture information products, derived from a combination of satellite radar data and in situ measurements. Until now, activities have been mainly project-based·
IrriWatch	Global ambition (Netherlands)	IrriWatch is a new company that provides irrigation advice to farmers based on 10 x 10 m satellite-derived measurements of soil moisture and evapotranspiration.
aWhere	Kenya, South Sudan, Ghana (USA)	aWhere provides weather data and agronomic data, derived from weather stations all over the world, for analytics, software development and management. Users can access the data and services through the aWhere platform. aWhere also offers weather-related advice for agriculture and advice and early warning for extreme weather events.
Vodafone Farmers' Club	Ghana	Vodafone Farmers' Club is an agricultural value-added service (Agri VAS) with a free call bundle launched by Vodafone Ghana and VAS (value added services) partner Esoko. The package offers farming advice, weather updates, market prices and free calls between Farmers' Club members. Membership is paid for by the farmers.

Airtel Malawi M'chikumbe 212	Malawi	M'chikumbe aims to transform farming using mobile technology and to increase Airtel's subscriber base, revenue and brand loyalty in rural Malawi. The service provides farmers with access to practical information about agriculture and Airtel Money via interactive voice response (IVR) and short messaging services (SMS). Users dial 212 to access the agriculture-specific IVR service for one of the 15 crops they registered for. Information on market prices and weather forecasts are also provided. The platform is operated by HNI (human network international).
M-Kilimo	Kenya	M-Kilimo provides information services to smallholder farmers in cooperation with KenCall. The service consists of a farmer helpline, where an expert provides information on agricultural tips and efficient farming practices, questions on plant and animal diseases and treatment, agriculture-specific weather forecasts and market price information. Text messages (in Swahili) are also used as a transmission channel.
CABI (Plantwise)	Worldwide (United Kingdom)	Working closely with national agricultural advisory services CABI establishes and supports sustainable networks of plant clinics, run by trained plant doctors (in most cases government extension workers), where farmers can find practical plant health advice. Plant clinics are reinforced by the Plantwise Knowledge Bank, a gateway to practical online and offline plant health information, including diagnostic resources, best-practice pest management advice and plant clinic data analysis for targeted crop protection. As the farmers visit the plant clinics in person, CABI makes limited use of geo-located information.
LocateIT	Horn of Africa (Kenya)	LocateIT is a Kenyan company that provides geospatial services. LocateIT aims to develop and market services related to crop monitoring. LocateIT develops a county agricultural management information system (CAMIS), a crop and livestock insurance programme (CLIP) and a an early warning and response information system (EWARIS) for several types of disasters.
AgroCares	Worldwide (Kenya, Netherlands)	AgroCares gives advice based on the results of soil tests with its scanner. They also sell scanners to other organisations. Activities in Africa are mainly carried out on a project basis.
AGRA	Africa (Kenya)	The alliance for a green revolution in Africa (AGRA) is supported by many donors. Its aim is to facilitate and accelerate the agricultural transformation in Africa. To achieve this, AGRA is interested in digitalisation and has supported and contributed to several publications on the issue.
Wageningen Plant Research (GEOPOTATO)	Bangladesh (Netherlands)	The GEOPOTATO project aims at setting up a sustainable business service for early warning related to the late blight disease in potatoes, in cooperation with a fertiliser company. An important finding is that more accurate and localised information on relative humidity is needed, than can be derived from satellite data.
BayWa	Worldwide (Germany)	BayWa provides services related to monitoring of soil moisture and soil organic content (nitrogen uptake). The services are mainly provided to large farms in Southern Africa.

FAO (dLocust, eLocust3, EMPRES, FAMEWS)	Worldwide (Italy)	FAO is the only organisation that provides a comprehensive system for monitoring, early warning and preventive control of desert locusts. The system is based on a combination of data from satellites, drones and in situ observations. Unfortunately, as recent events have shown, the system or the taking of action based on the output are not always effective. FAO also launched an app called FAMEWS for early warning and combatting the fall army worm.
IDH (Farmfit)	Africa, Asia (Netherlands)	IDH is an initiative supported by the Dutch government. FarmFit is an IDH programme to strengthen SDMs (service delivery mechanisms) for smallholder farmers.
Syngenta (Farmforce)	Worldwide (Switzerland)	Farmforce is a mobile service that links smallholder farmers to other actors in the agro-value chain. Its strategic value proposition is to reduce transaction costs for contract farming, aid compliance with food standards, improve traceability of goods from the field and agronomy of scale. It has a yield forecast component, but the main component seems to be traceability. Kenya was one of the pilot countries.
CTA – now part of Wageningen CDI	ACP countries (Netherlands)	CTA, the technical centre for agricultural and rural cooperation, has digitalisation of African agriculture as one of its priorities. Although CTA is mainly a research centre, it participated in the development of advisory services for smallholders in Uganda (in cooperation with eLEAF and EARS). The services provide weather forecasts and alerts, crop management and agronomic tips, combined with index-based insurance. The use of service agents, equipped with smartphones, facilitates direct contact with the target group.
Dodore (Agri-Wallet)	Kenya (Netherlands)	Agri-Wallet provides fintech services to smallholder farmers, making use of blockchain technology to increase transparency (and to ensure that the credit is used for agricultural purposes). To enhance its services, Dodore has cooperated with several providers of geospatial information.
GeoSAS	Ethiopia	GeoSAS is a geospatial company, involved in the design, development and implementation of evidence-based continental and national programmes for Sub-Saharan African (SSA) countries. One of its activities is the development of the Geospatial Platform for Africa (in cooperation with NEPAD and others).
CERSGIS	Ghana	CERSGIS provides GIS and remote sensing services to public, private and non-governmental organizations and promotes the use of these technologies as decision, policy and research support tools for sustainable social and economic development. CERSGIS has participated in several initiatives for agricultural development. An example is the creation of an agricultural database for northern Ghana. CERSGIS also develops a water use and irrigation service and services on disaster monitoring and flood early warning.
AGRHYMET	Sahel (Niger)	The Centre Régional AGRHYMET aims at achieving food security and increased agricultural production in Sahel countries. As one of its activities AGRHYMET provides a regular bulletin with agricultural trends and advice to its relations in the Sahel region. AGRHYMET is involved in several initiatives related to geodata and agriculture. AGRHYMET also develops services for water bodies mapping and monitoring, fire early warning and monitoring, and drought risk assessment and monitoring.

Trimble (GreenSeeker)	Worldwide	The Trimble GreenSeeker is a handheld device (there is another version that can be mounted on a machine) that scans crops and provides a digital reading of their general health. The price (around € 500) is prohibitive for most African farmers.
Draxis - Agroapps	Europe+ (Greece)	Agroapps is a spin-off company from Draxis that provides farm management advice on tillage scheduling, irrigation scheduling, pests and diseases, crop growth monitoring and crop yield estimation. The services are based on remote sensing. Although Agroapps focuses on Europe, similar services could be offered to African customers through the Draxis platform. AgroApps also launched a credit scoring app in Greece.
WorldCover	Ghana, Uganda, Kenya	WorldCover provides crop insurance to small farmers. Farmers pay for the insurance through a mobile app. The pay-out is based on rainfall and there are ambitions to extend the service to climate insurance.
ACRE Africa	Tanzania, Rwanda, Kenya	ACRE (agriculture and climate risk enterprise) positions itself in between a local insurer and an aggregator or farmers' organisation, providing an array of services to facilitate insurance provision to smallholders. It develops index-based products that can be used by insurers. Examples are weather insurance and replanting (germination) insurance.
MicroEnsure	Africa, Asia (United Kingdom)	MicroEnsure is an insurance company with a weather index insurance in its portfolio. It partners with MNOs to provide the service to farmers and it has a considerable customer base of 55 million people (although maybe not all for the weather insurance), making it a big player in the field.
ITC - University of Twente	Ethiopia (Netherlands)	ITC developed an NDVI-based index-insurance model. The model has been tested with the Ethiopian insurance company Kifya and is now rolled out in several woredas (districts). As part of a university, ITC is not expected to commercialise the application itself.
GeoVille	Global (Austria)	GeoVille has developed a radar-based index-insurance application, which makes use of soil moisture in the top layer. There is information about pilots, but not on operational schemes that make use of this method.
FEWSNET	Global	FEWSNET is a cooperation of several partners, with the US organization USDA as the main player. It delivers a MODIS-based yield deficit estimate, which can be used by other parties to develop geodata applications
IRI – Columbia University	Global (United States)	IRI has developed an insurance index based on rainfall deficit that is derived from NOAA imagery. As part of a university, IRI is not expected to commercialise the application itself.
Akvo (Caddisfly, Flow, Lumen)	Africa, Asia (Netherlands)	Akvo provides a system to test and monitor water quality using the Caddisfly add-on. A smartphone is connected to water quality testing equipment that tests groundwater and surface water for over 30 parameters and monitor changes over time. Akvo also has developed other tools, such as Akvo Flow (to capture baseline data and to monitor programmes on key performance indicators) and Akvo Lumen (used to analyse and visualise the captured data). In Africa Caddisfly has been successfully applied in Sierra Leone.
Aerobotics	Global (South Africa, United States)	Drone-based insights and advice on tree-like crops and grapes, mainly focused on South Africa.
Syecomp	Ghana	Syecomp offers geodata-based solutions to smallholder farmers and agribusinesses, including traceability.
Kitovu	Nigeria	Kitovu is a mobile based platform that collects, analyses and aggregates soil and geo-location data, as a tool to provide farmers with soil and crop specific fertilizers, improved seedlings, and agro-chemicals, while connecting farm produce to off-takers.
Farmcrowdy	Nigeria	Farmcrowdy provides credit, agricultural advice and market information to almost half a million farmers in Nigeria.
Nelen & Schuurmans	Global (Netherlands)	Through its Lizard platform, Nelen & Schuurmans provides information services and decision support for crop monitoring. Outside Europe the company is mainly active in Asia.
Pula	Kenya	The main activity of Pula is index insurance, but it also provides marketing services, business intelligence, agronomic advice to farmers and supply chain tracking.
Terrasphere	Asia, Africa (Netherlands)	Terrasphere analyses satellite data for crop monitoring, yield prediction, early detection of pests and diseases, agribusiness intelligence, credit scoring and crop insurance. Terrasphere is a partner in several G4AW projects, including MYVAS4Agri.
Impact Terra	Myanmar	Impact Terra operates the Golden Paddy crop insights portal (that provides business intelligence and crop information for agribusinesses, financial institutions and NGOs) and an associated farmer platform with digital extension and financial and market information. Impact Terra coordinates the SAM G4AW project in Myanmar.
ADCC Infocad	Asia, Africa (India, Kenya)	ADCC developed an app-based decision support system for crop disease control that makes use of crowdsourcing and geo-tagged images of the diseased crop.
Cropio	Global (United States)	Cropio offers a crop monitoring and yield prediction system with field history, alerts, vegetation map, weather forecast, soil moisture and other features related to precision agriculture. The focus is on commercial farming.

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