



A Business Case for Opening New Markets using Satellite Data for Smallholder Farmers and Pastoralists in Developing Countries

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How “Space for Food Security” works at the local level: an overview of lessons learned in the first years of the geodata for Agriculture and Water (G4AW) Facility

Agriculture is the world’s largest employer and the largest industry. If the world were to grow enough food for the projected population of nine billion people in 2050, agricultural production and productivity will have to increase considerably. And all the while done sustainably, without negative effects for the environment, depletion of water resources, and taking into account possible effects of climate change. This means including the bottom of the pyramid,¹ which is responsible for over half of the agricultural production in the world. This requires an innovative approach to bringing affordable, relevant and accessible information to smallholder farmers and pastoralists to increase income, agricultural production and productivity and to increase resilience. One such innovative approach is the Geodata for Agriculture and Water Facility (G4AW)² commissioned by the Dutch Ministry of Foreign Affairs. Recently a mid-term review of the 17 current projects³ in the G4AW Facility was carried out, and it is now valuable to share experiences and lessons learned from that document. This wider dissemination will help improve the design of future business initiatives for smallholder farmers in developing countries and even in more developed countries.

Geodata for Agriculture and Water

The G4AW Facility promotes and supports private investments for large scale, demand-driven and satellite-based information services. It provides a platform for partnerships of public organizations, research institutes, private sector operators, NGOs, farmer cooperatives, satellite data/service operators, businesses and transmission operators. The goal of the G4AW Facility is to reach at least three million food producers with services that increase income, agricultural production and productivity and/or provide more resilience by 2020. The Facility started in 2013 and will run until June 30, 2020. For the past three years, the Netherlands Space Office (NSO) has been responsible for executing the Facility and supporting the 17 on-going projects.



Why geodata for smallholder farmers and pastoralists?

The majority of farmers and pastoralists are actually smallholders and cover over 80% of farmland in sub-Saharan Africa and Asia⁴. With the introduction of G4AW, a unique approach was adopted to improve food security in developing countries by providing services and products that use satellite data to benefit these smallholders. The provision of more satellite data that is often open and freely available creates new opportunities for supporting smallholders on a scale that was unimaginable before.⁵ Huge amounts of data can be processed quickly and transformed into accurate and actionable agricultural information and advice. Mobile connectivity that is affordable for all makes it possible to get in touch with new target groups that were difficult to reach before and to process feedback from these groups. The business initiatives supported by the G4AW Facility enable smallholders to increase production and productivity, and the businesses provide a safety net in the form of increased resilience in dealing with natural disasters and through insurance schemes.



Improving the lives of smallholder farmers and pastoralists

The information needs of smallholders (with less than two hectares of farmland) were overlooked until recently, or at least not even addressed. When looking at the characteristics of their agricultural practice, it is easier to understand the challenges faced in providing them with accurate data: there is a high heterogeneity in farm practices, crop varieties, and soils. In addition, smallholders face challenges in light of access to finance, logistics, markets and information

The G4AW Facility is especially designed to address some of these challenges. The aim is to:

- Reach at least three million smallholders;
- Provide them with useful and timely (agro-meteorological) advice and/or (financial/insurance) products;
- Improve sustainable food production, increase the effective use of inputs (water, nutrients, seeds, pesticides);
- Support economic development in participating countries;
- Stimulate private investments;
- Establish financially sustainable services after three years; and
- Improve food security and increase income (with at least 10% for the target group after three years).

This article contains short descriptions of interesting cases that examines how to ensure that a project aimed at improving the food security of smallholders actually reaches the target groups.



A new market for providing information services in an international setting

For many years, the use of geospatial information for agriculture was considered only to benefit relatively large farming enterprises, which could afford the services and products. The most important reason for this was the scale of farming operations. This problem of scale makes it more difficult to serve smallholders than large farmers. The challenge is to make satellite information relevant at the local level. This entails making a difference in information provision and agricultural advice that really benefits the smallholder. We provide the example of GIACIS for the required “closed information chain” to achieve this. Consortia that received support through the G4AW Facility came up with inventive solutions to crack this challenge. In fact, what became evident from the mid-term review is that the main innovative aspect of the G4AW Facility - the one that is easy to overlook - is that it allows feasible use of satellite data for commercial, or at least self-sustaining, products and services for smallholder farmers and pastoralists in developing countries. Due to the unique approach of G4AW, it is interesting to share experiences and lessons learned to improve the design of future business initiatives. This publication highlights those aspects that are deemed as essential features of the program⁶ and focuses specifically on:

- (1) the partnerships that make it work;
- (2) reaching and understanding the smallholder farmers and pastoralists;
- (3) the services offered and satellite data used;
- (4) the business cases for services and products based on satellite and other data;
- (5) opportunities for climate change, sustainable water use and gender.

The findings of the review show that the G4AW Facility offers a new market for providing information services. The G4AW projects apply a wide range of business models that address a gap in the current global geodata services market by offering locally targeted advice to smallholders based on satellite information. The unique approach of G4AW to encourage innovative public-private partnerships (PPPs) has led to a diverse set of consortia that consist of social development organizations, commercial partners, government organizations and academic institutions, each with their own unique capacities and capabilities.

The main lessons learned from the mid-term review are:

- A clear focus in offered products and services and implementation strategy for these products and services should be clear from the start.
- A local, strong and active business partner with a clear focus increases the chance of success considerably.
- Partners that know and have worked together before the start of the project have an advantage, one that could increase the chance that the initiative will be sustainable.
- A good baseline study of demographics of target group (gender focus), user-demand, and challenges and opportunities for adoption is not only a necessary requirement; it also provides valuable information on agricultural practices.
- In many cases, the direct beneficiary of the activity is an intermediate organization that transfers these benefits to the food producers.
- When benefits are transferred through an intermediate organization, the metrics to measure results become more complicated and are less attributable to the individual food producer.
- Aspects related to sustainable use of resources, climate and gender are not easily captured by the current performance indicators.
- When looking at innovation, the whole chain from research to commercialization should be taken into account.
- There is a need for knowledge exchange to celebrate and copy successes and to learn from and avoid repetition of mistakes.

Scaling initiatives

Upscaling of the activities is an important goal of the G4AW Facility. The biggest challenge is to reach sufficient smallholder farmers and pastoralists to make the service economically feasible. Technically this seems to be very possible as the mechanism and design of the solutions can be copied relatively easy to other situations. Organizational upscaling is more difficult as there is a well-defined plan to reach, as well as inform and train the smallholders which should be in place and be realistic. The success of the projects and the financially sustainable service provision relies heavily on this organizational capacity. However, the limited experiences gained with G4AW Facility until now shows that in practice this is not so easy to realize. The business model, embedding in the local context and possibly the type of partnership, all need adaptation to be successful elsewhere, whether across regions within borders, let alone across borders. There are also issues related to the license-to-operate that have to be dealt with and are more complicated in one country than others. The presence of a strong and active business partner with a good local network is essential.

Impact on food security

Food security is a very important issue for the entire G4AW Facility, as achieving food security is one of the main goals of Dutch development cooperation and the G4AW Facility is entirely directed at achieving this goal. Food security comprises many aspects and the contribution of G4AW in terms of improved food security was difficult to establish in the early stages of project implementation. However, a first conclusion is that G4AW projects address important aspects that can have considerable impact on increasing food security:

- Increase of the production volume, through the increase of the (locally) available food production and increase in smallholder income; and
- Provision of a safety net for smallholder farmers and pastoralists through index insurance and decreased vulnerability to natural disasters.



The challenges to measuring impact

Food security interventions in general are notoriously difficult to evaluate⁷. The Dutch government reported, “Interventions aimed at raising agricultural production and productivity experience relative ease of evaluating, and therefore are producing more results”⁸. However they found that at the level of impact concerning improving food markets, value chains or policy; these aspects were less represented in evaluations and therefore only little evidence exists.



In the case of G4AW, projects fall into these same issues as they too are starting to realize “measuring impact of food security interventions is extremely difficult, [and] require[s] complicated techniques and substantial human and capital resources” . Projects are able to show the commercial benefits and figures of the business case in terms of financial returns for the business owners and partners. Only at the end of the project, reporting on food security impact is requested. However, looking at the current situation, the projects may come up short in describing the changes in food security and social and sustainable economic growth for the target group. For example, none of the projects have yet been able to deliver a monitoring framework that is effective in measuring increases in income at smallholder level, and how this sustainably impacts their livelihoods in terms of capital accumulation or household investments.



Future perspectives

In a few years, the projects will have completed their implementation period and it will become clear which business initiatives are successful and deserve replication and further development. To reach smallholder farmers and pastoralists more effectively, there is a need for active advocacy and knowledge exchange and/or the creation of a knowledge base to share success stories and learn from mistakes. The G4AW projects provide a wealth of information that can be used to validate the results of national and global monitoring initiatives, such as the Global Agricultural Monitoring of the Group on Earth Observations (GEOGLAM). This will improve the accuracy of these systems and consequently their contribution to achieving global food security.

Only time will tell what the real impact of the G4AW Facility has been.¹⁰ However, the review provided sufficient indications that smallholder farmers and pastoralists will make use of the innovative products and services based on satellite data that the G4AW partnerships offer. Especially when enough attention is given to understanding the target groups characteristics and needs, and to establish their trust and commitment, the projects do carry strong potential. Still, a convincing focus of the offered product/ service would benefit the business case and has a greater potential to improve food security (in terms of more effective use of inputs, increase in food production, and increase of income). When a strong lead partner carries this focus forward in a consortium of partners that are familiar with each other, the potential of G4AW projects to expedite service and product development and rollout is strengthened.

Although success of individual private sector actions is not ruled out, the best way towards scaling of activities seems to be through partnerships with a strong business partner with government participation or at least government support. Initiatives of the G4AW Facility also provide tools to give more attention to adaptation to climate change, sustainable use of water and gender aspects, which could be further developed if given appropriate focus in future endeavors.



The following sections will explore more details on these lessons

To achieve the overarching goals of the G4AW program, good partnerships are needed and therefore highly encouraged. Application of earth observation-based services for smallholder farmers leads to the creation of new and unexpected partnerships with the involvement of smallholders, farmers' organizations, financial institutions, insurance companies, government, input suppliers, traders, mobile service providers, and technology companies (PPPs). This means that each business case supported by the G4AW Facility is implemented by a mix of stakeholders with complementary qualities and capabilities.

The mid-term review concluded that partners that know and have worked together before the start of the project have an advantage and increase the chance that the initiative will be sustainable. Not surprisingly, the managerial skills of the lead partner are a key factor for successful project implementation. Essential in the selection of the partnerships was their ability to close, what has been coined as "the information chain". Here, emphasis was placed on how well-equipped the partnerships were to absorb and convert satellite data into information that is not only reliant, timely and useful; but also transferred in a commercially viable way that it is able to sustainably reach a hard-to-reach market segment, the poor smallholders.

A "closed information chain" would in an ideal situation and would look something like this: free digital satellite data is collected and (pre-) processed with the appropriate technology (satellite data provider); thematic information is extracted and knowledge is obtained to solve problems (tech and/or knowledge partner); the ensuing information is then transmitted as an easy-to-use and familiar service or product for the farmer (technology provider and commercial partner); farmers are informed of usage and applicability (service delivery agent or aggregator); and after which, farmers use information and improve food security levels.

Such partnerships have a different approach compared to other initiatives that provide satellite-based services because of the scale of operations (many farmers, many plots), and the requirement for a network of stakeholders that enables the offerings to reach new target groups. In practice, this turns out to be greatly dependent on working in collaboration with aggregators such as farming cooperatives that deal directly with smallholders, and local service providers that already offer trusted local services to smallholders. Box 1 provides an example of how such collaboration allows a so-called non-viable business case to reach potential scale.

Box 1

GIACIS: a closed information chain

The purpose of the GIACIS public-private partnership is to expand financial service delivery to smallholder farmers in Ethiopia with a geodata-driven risk-mitigation (insurance) product that offers a basic safety net to protect them against weather related risks, such as drought.

The partnership includes: the public Ethiopian Agricultural Transformation Agency; the Ethiopian technology partner, Kifiya Financial Technology; and the information provider, National Meteorology Agency of Ethiopia.

Led by the Dutch-based Faculty for Geo-Information Science and Earth Observation at the Universiteit Twente (ITC), the partnership allows for a complementary set of competencies:

- from provision of satellite data,
- to delivery of technological know-how in how to translate the data to useful informative systems,
- towards a service provider with an existing infrastructure to build on,
- and a public counterpart to support the efforts for potential upscaling.

Due to the unique added value of each selected partner in the consortium, it also means that each partner has a distinct stake in the business. This strengthens the probability of the sustainability of the business after the subsidies have faded. Thanks to the



unique proposition and comparative advantage of GIACIS in Ethiopia, the government has expressed the ambition to take over further rollout of GIACIS in other regions. This implies that probably the target number of farmers reached will be overshoot by a large margin.

The biggest challenge for the current partners is ensuring that the technology know-how that is currently embedded with the lead organization, ITC in the Netherlands, is transferred to local institutions that can carry the developments further after the project subsidy by the G4AW Facility ends. While the consortium itself has a closed information chain, it thus needs to make sure that the chain is as much locally embedded as possible.

Developing services and products for the purpose of smallholders carries great potential in terms of numbers reached and the development impact it could have on their daily lives. At the same time and due to its unique focus, it also carries great risk as the products and services are aimed towards a market segment where the main actors are often illiterate and low-skilled and have limited or no (access to) capital or resources for investment, and are therefore traditionally risk-averse.

This risk-averse nature entails at least two things: (1) smallholders are in need of coping strategies that will help them to avoid or to deal with risks; and (2) smallholders have to be strongly convinced of any type of new service or product as they have everything to lose. Here, it becomes clear how important it is to know your customer as a first step in creating a viable business case for such a cautious target group. The mid-term review concluded therefore that a good baseline study of demographics of target group (gender focus), user-demand, and challenges and opportunities for adoption is a necessary requirement and provides valuable information on the agricultural practices of the consumer.

Once the target groups are defined, the next and perhaps most important step should be taken as G4AW business owners have emphasized: build trust. Smallholders need to be convinced that the service or product they are buying or committing to will actually benefit their agricultural business. If they would use the wrong

type of fertilizer at the wrong time as a consequence of relied upon information, they could lose a harvest and their income for the next half year.

We find in the business cases specific approaches to address trust issues. Some send trainers out to the field for training-of-trainers exercises among high-potential smallholders. As they believe encouragement from within works best, they seek out those smallholders with a strong network to “spread the word”. Others choose to work through aggregators which smallholders turn to anyway for their information needs for their agricultural practices. A third type of business cases places agents of the service providers strategically in the field to inform smallholders personally, and virtually through door-to-door service what they can expect and where they can turn when the service fails them.

What appears is that services and products that are built into systems that are already in place seem to build trust more easily. In the business case of GEOPOTATO, we find that as farmers were already using their products for other extension services, it was only a small step to accept an additional product that served an unmet need. As it was built upon strong knowledge of the local context, the services were more easily transferred. In Box 2, we present a description of their approach. From this example, we learn that having an established and trusted local partner helps in place that has a strong local infrastructure.

Box 2

GEOPOTATO: Reaching out from within

The GEOPOTATO business case has as an objective to sustainably improve resource use efficiencies and profits in potato production in Bangladesh by providing to smallholder farmers a decision-support service to control the late blight fungal disease. The ambition of the partners is to reach approximately 15% of the total of 750,000 smallholder farmers in Bangladesh that produce an irrigated potato crop in the dry winter season. They aim to do this by providing an SMS information service on subscription base.

Innovatively, the partners have taken into account the potential illiteracy levels of the target group and have developed the product to be either based on text messages, or voicemail services that requires no literacy standards. Their cooperation with a development partner with extensive working experience on the ground, the Dutch NGO ICCO, allowed the partners to have a solid understanding of the target group demographics and their needs. The partners were able to build on an existing program in the northern part of the country called Profitable Opportunities for Food Security (PROOF).

This local knowledge contributed to developing an outreach strategy in which the service is implemented at fields owned by



exemplary or lead farmers within the organized farmers groups of the development agency ICCO and other partners, including AIS and Bombay Sweets. They have previously trained local extension agents and business advisors on the ground that already have a trustworthy relationship with the farmers. The “exemplary farmers” have been chosen because of their farm production levels, but also because they are respected and looked up to in the villages. Only with local knowledge of the dynamics and structures of the local communities would such an outreach strategy therefore be possible.

A wide array of services is offered through the G4AW projects. Advice on pests and diseases and advice on water use and drought warning are at the top the list, while weather information, advice on fertilizer application and market information are not far behind. Several projects address index insurance, advice on sowing and planting and provide yield forecasts as well. Table A gives a complete overview. A bit of caution is required as the type of services offered may change during the course of a project to adapt to (changing) user needs. The review concluded that projects that apply a clear focus in offered products and services from the start are more successful (in terms of reaching the implementation stage earlier) than those who don't.

TABLE A: Types of services offered

Type of service	Number of projects
Pests and diseases (early warning, spraying advice)	8
Water use and drought warning	8
Fertilizer application	7
Weather information	7
Crop monitoring	7
Market information	7
Sowing and planting (advice)	5
Index insurance	4
Yield forecasting	4
Crop calendar	2
Pasture availability	2
Pasture quality	2
Livestock concentration	2
Salinity advice	2
Flood warning	2
Soil moisture information	1
Soil fertility information	1
Weeding advice	1
Harvest date (advice)	1

Most use is made of data from weather satellites, MODIS, Landsat (8 and older) and Sentinel 2 and 1. The availability of these free and open data make it possible to develop cheaper services: the client pays only for data processing and the resulting services and no longer for the data itself. The free data from the European Copernicus program¹¹ facilitates the achievement of improved services, both in terms of finer spatial resolution and in more timely delivery as it allows access to more specific and accurate data suitable to the needs of smallholders. It is expected that Copernicus will give a boost to the (further) development of services to smallholder farmers and pastoralists. Table B gives an overview where again, use of satellite data may change as the services are in development.

TABLE B: Type of satellite data

Type of satellite data	Number of projects
Weather satellites	15
MODIS	12
Sentinel 1	11
Landsat-8 (and older)	10
Sentinel 2	9
Proba-V	6
Sentinel 3	4
Envisat	3
SPOT VGT	2
ALOS PALSAR 1 / 2	2
TerraSAR-X	2
Cosmo Skymed / Pleiades	2
ASTER	1
SMOS	1
RapidEye	1

The type of targeted crops also varies per project and determines for a large part which kind of services are developed and offered. A number of projects do not specify any crop type. Rice followed by coffee, potatoes and pasture are the designated crops for at least three projects. Some projects have not decided yet which crops to focus on. Table C presents the current crop selection.

TABLE C: Types of crops served

Type of crops	Number of projects
Crops in general	5
Rice	4
Coffee	3
Potato	3
Pasture	3
Vegetables	2
Sorghum	1
Barley	1
Cereals (not specified)	1
Sesame	1
Teff	1

Developing a business case for satellite data use for smallholders is perceived as challenging. The costs and accessibility of satellite data, and therefore the accuracy of the data, made the heterogeneous farm practices of low-income smallholders less attractive for service providers.¹² The projects supported by the G4AW Facility however have been able to develop business models that build on new innovative partnerships that show promising results of being able to tackle the barriers in the development of a sustainable business case for smallholders.

The different types of business models that are applied in the G4AW Facility are presented in the box below:

Business models used in the G4AW Facility

- **Freemium model:** Free service provision of basic services to smallholders. A number of other clients pay for additional services
- **Loyalty model:** Free service provision avoid switching smallholder clients to competitor (also called “direct revenue B2B” in the case of a seed/nutrient supplier or “indirect benefit” in the case of a mobile telecom operator)
- **Direct revenue B2C:** The smallholder pays directly for a service;
- **Inclusive model:** Paid service provision bundled into package, e.g. insurance coupled to credit, advisory to input supplies; the smallholder and/or other clients pay
- **Service model:** Client is paying (subsidized) fee for service provision; the subsidy can come from government or from another (farmers’) organization

The service model and the inclusive model are the two most often adopted in the current running projects. Table D presents the selection of business models by the projects. A few projects changed business models during the inception phase, for example from direct revenue to loyalty. It is also possible for a project to keep several options open. Depending on the local context and (business) insights, various types of business models are designed and deployed. After project inception or later project execution, these business models may be adapted to fit new insights (which has happened in some cases already).

TABLE D: Business models adopted

Type of business model	Times adopted
Service model	7
Inclusive model	5
Freemium model	3
Loyalty model	2
Direct revenue model	1

There is no preferred business model in G4AW projects and it is too early to tell which business model will be the dominant one. The selection of the business model depends on a number of factors and circumstances that may differ from country to country and region to region. Key success factors for delivering information services are: tackle a well-defined and specific problem by offering a portfolio of services that builds on an already existing delivery mechanism; and that is embedded in the local context.

The following checklist helps to assess the potential of the service or product offered and to identify potential bottlenecks:

- fit-for-purpose (does it solve the right problem?)
- comparative advantage (compared to other solutions for the same problem)
- ease-of-use (complexity to the user)
- elegance (appeal of the solution that the client identifies with)
- cost-benefit
- reliability/continuity of service (including long-term availability of the appropriate earth observation data)
- resilience (is there a backup if one or several elements of the information chain does not function properly?)
- flexibility (can the solution be adapted quickly and effectively to changing conditions?)
- acceptance (of the solution by the client)
- level of knowledge transfer required (to implement the solution sustainably)
- ethics (related to the local situation)

The success of a project, and thus service adoption by clients, depends for a large part on the business owner; the entity that will be the main stakeholder and will ensure sustainability after the initial support from G4AW Facility has faded. As can be seen from Table E where various options are possible, including mixed arrangements. Although companies come out on top (this can be input providers, business agents, insurance companies or telecom providers), arrangements through government or NGOs are not far behind. A distinction is made between an aggregator who provides a platform where a client can shop for different services (such as a farmer cooperative), and an entity responsible for embedding (such as a non-profit organization) who ensures that conditions are created for the smallholder to use the product or service in the best possible way. However in practice, roles are diverse and can overlap. The mid-term review concluded that a local, strong and active (business) partner with a clear focus in their offerings (service portfolio) and their targeting of clients increases the chance of success considerably.

TABLE E: Envisaged business owner

Type of business owner	Times adopted
Company	11
Government organization	8
NGO	8
Farmers’ organization (or union)	4

The business owner should have a clear stake in the outcome within the given project timeframe, but also have a forward focused vision for the period after the subsidy has ended. The business owner is the linking pin for upscaling of activities in the country or region concerned.

Experiences until now in the G4AW Facility are promising. In some projects, the uptake is likely to far surpass the originally envisaged number of clients. This is partly due to higher ambitions of the project partnership and/or the government agency involved or in cooperation with entities beyond the partnership. Still, acceptance by the end-users, achieving a good cost-benefit ratio, and fine-tuning the solutions (real fit-for-purpose) are the main bottlenecks encountered that will require attention in the coming period of project implementation.



Opportunities for climate change adaptation

The FAO describes the effect of climate change on agriculture and food security as follows:

“Climate change affects agriculture through higher temperatures, elevated carbon dioxide (CO₂) concentration, precipitation changes,

increased weeds, pests and disease pressure”.¹⁴ Such

changes will have more or less severe impacts on all components of food security: food production and availability; stability of food supplies; access to food; and food utilization.¹⁵ Clearly, addressing increased production level and improved efficiency of agricultural production through the use of satellite data will therefore directly or indirectly contribute to climate change adaptation.

The topics presented below illustrate how G4AW projects were directed at adaptation to climate change:

- Identification of grazing grounds and water availability for pastoralists. The experience gained and time series of data created allowed the target group to adapt to conditions hampering their livelihoods.
- Sustainable use of water, including water harvesting. Water harvesting was applied in one project where the stored water was used for irrigation in dry periods (and for fish farming when the water was not needed). The projects dedicated to drought and excessive rainfall insurance also generated valuable time series for adaptation planning.
- Insurance (apart from creating time series with data on natural phenomena) and the existence of the insurance scheme itself provided a tool for dealing with the consequences of climate change.
- Advice on the crop calendar helped the target group adjust to changing circumstances. In addition, the time series of data on which crop calendar advice was based provided a valuable input to local climate modelling from which adaptation plans can be derived.
- Similarly, (near) real-time local weather forecasting (or improved local weather forecasting in general) improved the quality of adaptation plans through an analysis of the wealth of gathered data.



Opportunities for sustainable water use

Although advice on water use and drought warning are important elements of many G4AW projects, water use was never the main topic. The scale of satellite data for water poses challenges to providing services to individual smallholders as the

resolution of free images is too coarse to provide relevant advice at parcel level. Cloud cover also poses a problem.¹⁶ This is why many G4AW projects take water on board as a part of the general agricultural advice portfolio (e.g. drought insurance and early warning, insurance based on general evapotranspiration estimates measured over a large area, and water harvesting). A European study¹⁷ estimates that irrigation advice costs between € 2.5 and € 4.3 per hectare, which implies that such a service would be financially feasible in the European context, but how this translates to the situation of smallholder farmers in developing countries is still an open question.

Satellite data on water use has certainly a comparative advantage when looking at larger areas, such as a watershed, an irrigation scheme, or the aggregated land of a farmers’ cooperative. Adoption of water accounting schemes or water markets is a solution that makes business cases based on sustainable use of water economically feasible. This would address the problem of water pricing (often not priced at all, or too cheap (subsidized) and leading to inefficient and unsustainable use), and the fact that water scarcity will be one of the biggest problems in the coming decades at a global scale. One way out of the problem is (enforcement of) regulation by government or by the community itself. There are (historical) examples of successful self-regulation, especially in times of drought.

A third and closely related solution is the application of certification of agricultural production that is based on a monitoring and evaluation system that includes sustainable water use. The introduction of certification mechanisms gives farmers a reward for good practice while improving their farm efficiency. Again, the application of satellite data is very relevant here, as the analysis takes place over large areas and not at the level of the individual smallholder farmer.



A business case for gender

Women comprise an average of 43% of the agricultural labor force of developing countries.¹⁸

According to the FAO, should women farmers have the same access to productive resources as men, they could increase yields on their farms

by 20-30% and lift 100-150 million people out of hunger. It is important to note the wording: “should women farmers have the same access”. Development organizations worldwide concur that many obstacles still exist for women in terms of access to finance, land, technology and decision-making power.^{19,20} Such aspects are essential components of the farming business as credit is essential to invest, land ownership helps to ensure sustainability of the business, technology allows access to crucial information, and the power to decide determines whether women can choose what fertilizers to use this season or how to re-invest profits.

A proper understanding of the target group from a gender perspective is essential if the product or service is expected to be used by those actually benefiting from the provided services. Culturally embedded structures and beliefs can hamper women to own mobile phones, for example. While many of the G4AW projects emphasize that a large proportion (sometimes the majority) of their target group is female, their business cases would be even more supported if a gender analysis would underlie their outreach strategies. This would help them to unravel how their services and products could be developed in such a way to address specifically the needs of both women and men.

Technology paves the way for upscaling

Although the technical aspects of upscaling are easier than the organizational aspects, they are by no means trivial. Technological innovation in the areas of mobile connectivity and processing of satellite data facilitates upscaling. The selection of the transmission channels to reach the target group is especially important. If the same channels can be used in all circumstances, then upscaling becomes much easier. Almost all G4AW projects make use of text messages (projects dealing with insurance being the only one that seems to do without). About half of the projects make use of apps, web portals and old fashioned face-to-face contact (which is recorded in mobile devices or laptops, usually linked to a central database). Apart from the improved mobile connectivity that makes new transmission channels possible and the free availability of satellite data (including time series), there are other factors that favor upscaling. Semi-automated satellite image processing and automation of processes in general help to streamline information flows and to make them more efficient. Once the technical components are in place, the focus can shift to addressing organizational challenges.

 For more information about the Geodata for Agriculture and Water Facility, please visit: <http://g4aw.spaceoffice.nl/en/>

- ¹ Smallholder farmers with less than two hectares of farmland or pastoralists that manage less than 10 head of livestock. The equivalent of two hectares of average quality farmland is one hectare of very fertile land or 10 hectares in semi-arid areas.
- ² For more information, see <http://g4aw.spaceoffice.nl/en/About-G4AW/Brochure/> and <http://g4aw.spaceoffice.nl/en/>
- ³ The current 17 projects are carried out in the following countries: Bangladesh, Burkina Faso, Ethiopia, Indonesia, Kenya, Mali, South Africa, Tanzania, Uganda and Vietnam.
- ⁴ FAO (2012). Smallholders and family farmers. Sustainable pathways. http://www.fao.org/fileadmin/templates/nr/sustainability_pathways/docs/Factsheet_SMALLHOLDERS.pdf
- ⁵ Lobell, David (2013) The use of satellite data for crop yield gap analysis. *Field Crops Research* 143: 56-64. <http://www.sciencedirect.com/science/article/pii/S0378429012002754>
- ⁶ The lessons learned presented in this article are distilled from a mid-term review that was conducted for the Dutch Ministry of Foreign Affairs and executed by the Food & Business Knowledge Platform by the authors Daniëlle de Winter and Mark Noort, October 2016.
- ⁷ IOB (2011). Improving food security - A systematic review of the impact of interventions in agricultural production, value chains, market regulation, and land security. IOB study 363. <https://www.oecd.org/derec/49558328.pdf>
- ⁸ Ibid.
- ⁹ Ibid.
- ¹⁰ External impacts, such as political instability, have not been taken into account in this study, but of course their effect may be huge.
- ¹¹ <http://www.copernicus.eu>
- ¹² This was an important rationale for establishing the G4AW Facility.
- ¹³ A special purpose vehicle is a legal entity established specifically and separately to be the business owner of the G4AW project (and beyond).
- ¹⁴ FAO (2009). How to feed the world by 2050? http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf
- ¹⁵ Ibid.
- ¹⁶ For a more detailed discussion, see World Bank (2016). Earth observation for water resources management - Current use and future opportunities for the water sector. <https://openknowledge.worldbank.org/bitstream/handle/10986/22952/9781464804755.pdf>
- ¹⁷ Vuolo, F. et al. (2015). Costs and benefits of satellite-based tools for irrigation management. *Frontiers in Environmental Science*. <http://journal.frontiersin.org/article/10.3389/fenvs.2015.00052/pdf>
- ¹⁸ FAO (2012). Smallholders and family farmers. Sustainable pathways. http://www.fao.org/fileadmin/templates/nr/sustainability_pathways/docs/Factsheet_SMALLHOLDERS.pdf
- ¹⁹ AfDB (2015). Economic empowerment of African women through equitable participation in agricultural value chains. http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/Economic_Empowerment_of_African_Women_through_Equitable_Participation_in_Agricultural_Value_Chains.pdf
- ²⁰ BSR (2016). Women's empowerment in global value chains – A framework for business action to advance women's health, rights and wellbeing. https://www.bsr.org/reports/BSR_WomenDeliver_Womens_Empowerment_Value_Chains_Consultation_Draft.pdf

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