Rezatec

MEXICAN COMPASS

MEXICAN CROP OBSERVATION, MANAGEMENT & PRODUCTION ANALYSIS SERVICES SYSTEM

UK SPACE AGENCY

The project rationale is to develop a system, which is independent of the major agri-businesses, that is transparent and benefits all stakeholders.

EXECUTIVE SUMMARY WITH KEY INSIGHTS

The Crop Observation, Management and Production Analysis Services System (COMPASS) uses satellite Earth observation (EO) data to help smallholder farmers manage their sugar cane and wheat agriculture. It helps optimise crop productivity by identifying factors that cause the yield gap between crop potential and actual field performance. It also provides agronomic support to advisory services, agribusiness, farmer co-operatives, crop insurers and governments. The service is offered through a free mobile application for the farmers and a dashboard for the supply chain users.

The system uses Sentinel-2 EO data, in combination with commercial EO data with a 10-metre resolution and a five-day revisit period, which makes it ideal for monitoring crop yield. The EO data is combined with 30 site-specific parameters grouped by soil, management, inputs and environment that determine the production efficiency of wheat and sugar cane crops, e.g. soil type, harvest date, disease control and temperature. It assists the wheat and sugarcane farmers to monitor their crop health every week with satellite and crop model data analysis and advises farmers of the potential gap in their crops forecast yield versus maximum potential yield, optimal sowing and irrigation dates. It also provides a log of crop management activities and reminders from sowing until harvest. The farmers just require a mobile phone or desktop computer plus an internet connection and no other IT infrastructure is required to provide the technology.

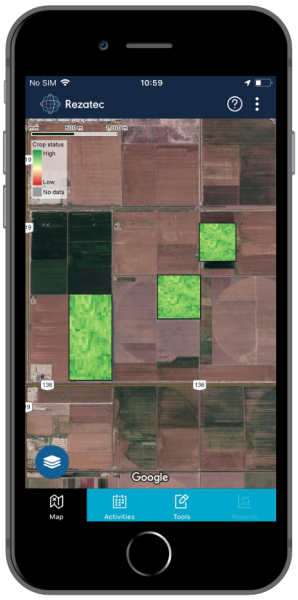
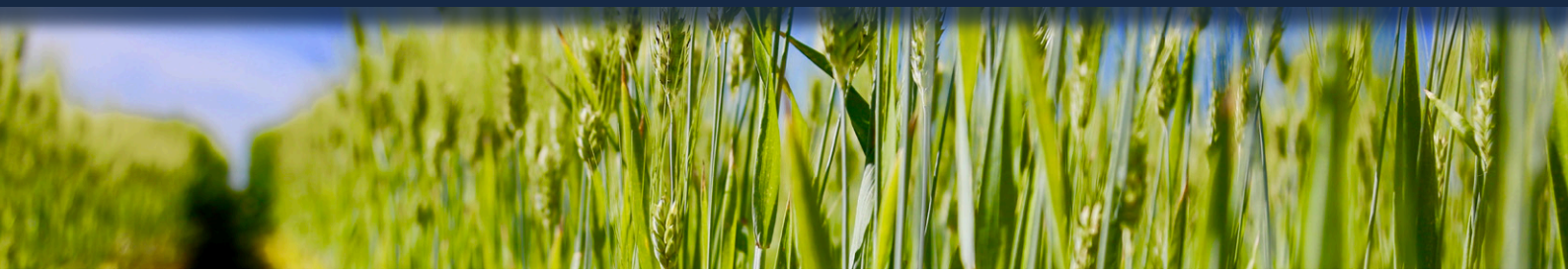


Image: COMPASS App. V2.0 showing vegetation abundance via satellite imagery of a farmer's fields in Sonora Mexico



PROJECT OVERVIEW

Wheat farming in the Yaqui Valley is at the forefront of new technologies for wheat compared to other parts of the developing world, however, the area was hit by a fungal disease (Karnal bunt), and export profits suffered. The effect from droughts from 1996 to 2004, also contributed to an overall fall in income from agriculture in the Yaqui Valley of 40%. Average wheat yields are currently around 6.2 tonnes per hectare, with considerable variability from year to year. Annual profits from wheat production in the Yaqui Valley varied by 60% per tonne from 2009 to 2017, with a steady rise in the total cost of production over time. Better management practices by smallholder farmers for nitrogen application, irrigation and weeds would help to improve yields and productivity.

The Mexican sugarcane industry currently generates more than 930,000 direct jobs and employs another 2.2 million people indirectly, contributing a total of around US$2.5 billion a year to the Mexican economy. The average yield is currently close to 70 tonnes of cane per hectare however smallholder farmers have below average productivity partly because they have not adopted modern methods of agriculture. They are also threatened by drought (especially because of under-developed irrigation infrastructure), pests, disease and weeds.

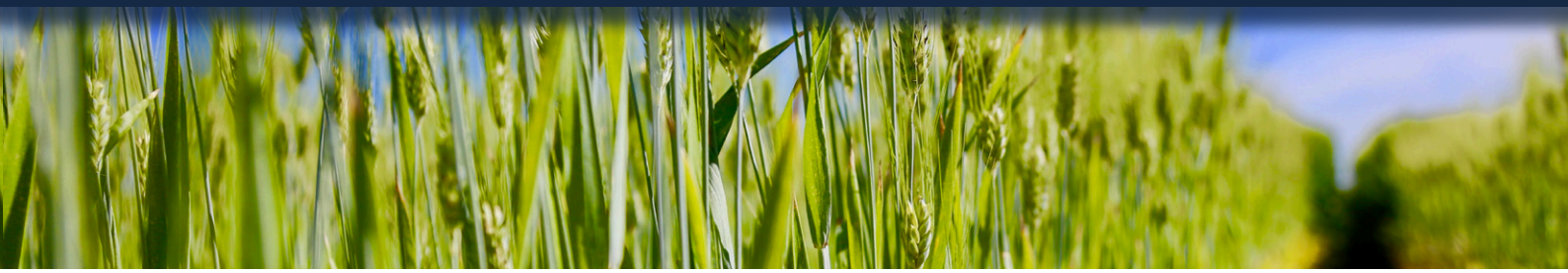
The overall challenge for both the wheat & sugarcane sectors is to transform both traditional extensive as well as modern intensive systems into sustainable systems producing more crop output with better use of resources and this requires better management of the interacting parameters controlling yield.

In response to these challenges, Rezatec is launching a free mobile application 'COMPASS' (Crop Observation, Management and Production Analysis Service System) aimed at helping wheat and sugarcane smallholder farmers in Mexico, benefit from using Earth Observation (EO) satellite data within field measurements to reduce production costs and increase crop yields. The ultimate aim is to ensure that farmer incomes become more stable, and therefore directly benefit farming families and rural communities, as well as addressing potential environmental issues.

Mexican COMPASS is an IPP- UK Space Agency funded project started during Dec'16. The UK Space Agency's IPP, funded by the Global Challenges Research Fund (GCRF), aims to deliver a measurable and sustainable economic or societal benefit to those in developing countries, through space-enabled Official Development Assistance (ODA) compliant programmes. Rezatec and the University of Nottingham in the UK, supported by Booker Tate, are working with CIMMYT and COLPOS in Mexico to help smallholder farmers growing sugar cane and wheat to improve crop management. Mexican farmers need to improve crop productivity and stabilise their incomes to facilitate rural community economic development. The technology developed by this 4-year project will use earth observation satellite data (including data from Sentinel) along with in-situ data captured with the farmers to help them identify factors that cause the yield gap between crop potential and actual field performance. The project will provide customer specific decision support tools to help growers, including smallholders, improve their technical, environmental and financial performance.

The project also aims to provide commercial information support, following trials, to advisory services, agribusiness, farmer co-operatives, crop insurers and irrigation bodies on water resources management.

For example, crop management in relation to global climate change is identified to be a major concern. One of the negative environmental impacts from unsustainable farming practises include wasteful



PROJECT OVERVIEW

water consumption. The COMPASS system aims to manage the water resources better for the farmers in the Yaqui Valley where the climatic change has been inconsistent, and availability of water resources are limited during the crop cycles where the farmers are only allowed to access 3 or 4 irrigation cycles irrespective of the demand raised in the Yaqui Valley, Northwest of Mexico.

The overall challenge for both Wheat and Sugarcane crops is to transform both traditional extensive as well as modern intensive systems into sustainable systems producing more crop output with better use of resources. This requires better management of the interacting parameters controlling yield. There are about 30 site-specific parameters grouped by soil, management, inputs and environment that can determine the production efficiency of wheat and sugar cane crops e.g. soil type, harvest date, disease control and temperature. The theoretical effect of these parameters on production is understood. However, there are no practical, evidence based, management decision tools that support smallholders and larger growers by targeting production efficiency per specific field.

Providing a management decision support tool, informed by satellite and other data sources that is both practical and affordable for smallholders with low levels of formal education, will help them make better crop decisions and thus benefit their incomes and farm development. COMPASS aims to provide this solution.

Earth Observation can be best applied to improve crop yield and farming efficiency by using the normalized difference vegetation index (NDVI) to monitor crop health. NDVI can be used to calibrate yield estimates, as well as to identify where crops may need farmers' attention due to crop stress.

While a crop growth model can be used to predict the assumed growth of a crop based on the changing input variables, the actual growth, and potential yield, for any field may vary with time depending on the changing conditions impacting growth. Therefore, there may be a deviation in actual yield as opposed to estimated potential yield based on the crop-growth model. By inputting new time-series information into the crop growth during the growing cycle, this model can be used as a monitoring tool to observe the changing condition (health) of the crop, and therefore its potential yield.

Some earth observation datasets provide data highly suited to regular monitoring activities such as this, with revisit periods of less than a week (e.g. Sentinel 1 and Sentinel 2). By regularly and dynamically updating the prediction of the crop growth model for each field with each new data acquisition that becomes available, the model can output an updated and more accurate crop yield estimate. By comparing the assumed growth (under normal conditions) and the actual growth, deviations between the two can be quantified. The spatial element of the earth-observation data would also allow for this to be conducted on a per-pixel basis, allowing the user to evaluate the changing spatial behaviour of the crop, showing field(s) where the deviation is occurring, potentially allowing for mitigation activities and an active monitoring procedure.

COMPASS targets to support Mexican Wheat & Sugarcane farmers with crop management practise targeting the below UN SDG (Sustainability Development Goals): Primary target UN SDG2.3. Secondary target UNSDG1&8.

Rezatec and the University of Nottingham in the UK work with CIMMYT and COLPOS in Mexico, supported by international partner Booker Tate helping smallholder farmers growing sugar cane and wheat to improve crop management.

PROJECT PARTNERS

Lead Partner – Rezatec Limited (UK)

www.rezatec.com

Rezatec is an award winning and now well-established satellite data systems company specialising in earth observation to assist land managers, governments and insurance companies. For example, it combines satellite ground observation data with weather information by applying agro-meteorological and biophysical modelling to accurately forecast and optimise crop yields. Rezatec is developing a crop production management tool to address the biggest challenge in agriculture: producing more food sustainably with less resource. It provides analytical data products and decision support through a web-based "Life Platform" designed to improve the technical, economic and environmental efficiency of production systems per crop, per field and per grower.

Particular areas of knowledge and expertise of Rezatec on this project include

+ Analysing earth observation data and combining this with other data sources through its 'Life Platform' to support management decision making
+ Tailoring the user interface to different end users e.g. growers; processors; retailers; traders; advice, input and equipment providers; and government, so that the information provide to each meets their specific needs.

Partner – Booker Tate Ltd. (UK)

www.booker-tate.co.uk

Booker Tate has unrivalled international experience in the provision of Development, Management and Technical Services to sugar, ethanol, bioenergy and other agribusiness projects, having successfully completed 1,500 assignments in more than 100 countries over 50 years. In addition, TSB, Booker Tate's parent company, produces over 600,000 tonnes of sugar per year at its three sugar mills in South Africa. Booker Tate is dedicated to be a global leader in the provision of services to the sugar sector and agribusiness.

Booke-Tate's role in the project include:

+ Capacity building, training & development
+ Benchmarking and performance improvement
+ Management and technical services: technical management, operational management, corporate management, client's representative
+ Irrigation services: water resource and irrigation development
+ Reconnaissance visits: pre-feasibility & feasibility development plans, strategic planning
+ Due diligence studies for investors.

Partner – University of Nottingham (UK)

www.nottingham.ac.uk

The University of Nottingham has a research portfolio of over £300m, over 2,300 research projects and is 7th in the UK for research power and renowned for strong industry links. Research relevant to food security is UoN's priority and it has particular strengths in agriculture and crop science. UoN will lead the development, application and evaluation of crop models required in the project and participate in their integration into the Life Platform.

Particular areas of knowledge and expertise relevant to this proposal are:

+ Crop physiology and sustainable agriculture
+ Crop resource capture and use
+ Modelling the growth of crops in response to their environment.

PROJECT PARTNERS

Mexican Lead Partner – CIMMYT (Mexico)

www.cimmyt.org/en/

The International Wheat and Maize Improvement Center (CIMMYT) prioritises research relevant to ensure global food security and decrease poverty through the use of new technologies and management knowledge to sustainably increase the food productivity.

The role of the international lead partner, CIMMYT are:

+ Wheat Component Data Collection
+ UAV imagery from Sugarcane component Data Collection
+ Assist University of Nottingham on Crop Performance Gap Analysis
+ Farmer Support Programme: organize workshops and seminars to wheat growers aiming to disseminate the tool developed by the project
+ The contribution of CIMMYT to the project include
+ Leadership of the activities and management of the Wheat component of the project through the provision of staff time and resources
+ Access free of charge to past experiments' database that may be useful to the project objectives.

Partner – COLPOS (Mexico)

www.colpos.mx/wb/

The Colegio de Postgraduados is a Mexican public institution of higher education with international recognition that prepares students for a globally competitive world in which knowledge is the most important asset. It specialises in the generation, promotion and application of knowledge for the sustainable management of natural resources, production of nutritious and safe food and improving the quality of life of society.

Particular areas of knowledge and expertise relevant to this proposal are:

+ Education, research and liaison with the business community
+ Performing relevant knowledge-generating research for sustainable management of natural resources and the production of nutritious and safe food
+ Improving the quality of life of society and providing input to academic activities through dissemination in the community.

The role of COLPOS, Mexico:

+ Data collection from sugarcane component
+ Farmer Support Programme: supporting Booker Tate on the organization of workshops and seminars to sugarcane growers and mills to disseminate the tool.

Both CIMMYT and COLPOS have very close links to farming organisations, grower groups and sugar mills (COLPOS) in Mexico, which are used to recruit and engage farmers, smallholders and agribusinesses in the project.

SOLUTION DEVELOPMENT

Assessing user needs

As part of the Baseline evaluation study during the project's early stage, various farmers have been engaged on formal and informal interview to understand the real needs where COMPASS's objectives were identified. These interviews were held in various regions in Mexico where Sugarcane and Wheat is grown and closer to our International partners facilities. The questionnaires were related to current crop management activities, the technologies being used, in particular related to yield improvement/ resource input optimisation (fertiliser, water etc.)

Design, build and testing of the solution, and iterating the design

The user needs have been collected through informal interviews via the farmers' association and through the network of international partners. The user needs interview was conducted by the international partners with the local farmers, such interviews, surveys and online (WhatsApp) group information gathered has helped the consortium to review the technical requirements necessary to adapt to the farmer's needs. The pilot farmers/ end users' feedback is collected periodically. For example, we have introduced an attractive and sophisticated user interface design on the initial versions of the mobile app and allowed the farmers to use and provide feedback during the follow up interviews during which most of the farmers with little digital literacy have found the app design as 'difficult to use'. This has helped our design teams to build a more robust, very user-friendly version 2.0 after approximately 6 iterations. The new version 2.0 also has a help section in every page of the app with some animation to assist any farmer with low digital literacy or poor education to understand and use the app effectively. We plan to capture end users' feedback from a wide audience across the Yaqui Valley and neighbouring Mayo Valley region in the near future to further improve the app. to suit wider audience as we anticipate this tool to be benefited by the farmers country wide by 2020.

Figure 1 COMPASS App. V2.0 with easy instructions on setting up field boundary.

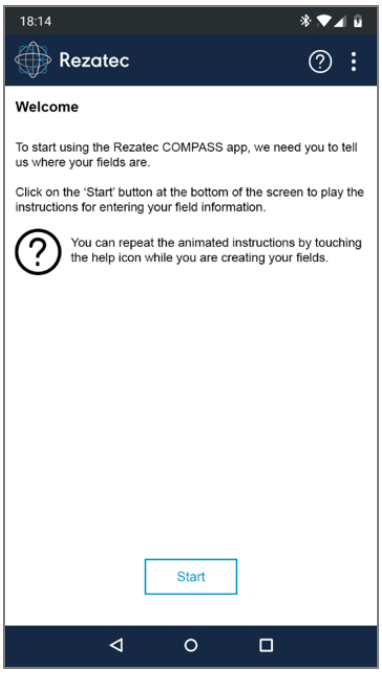
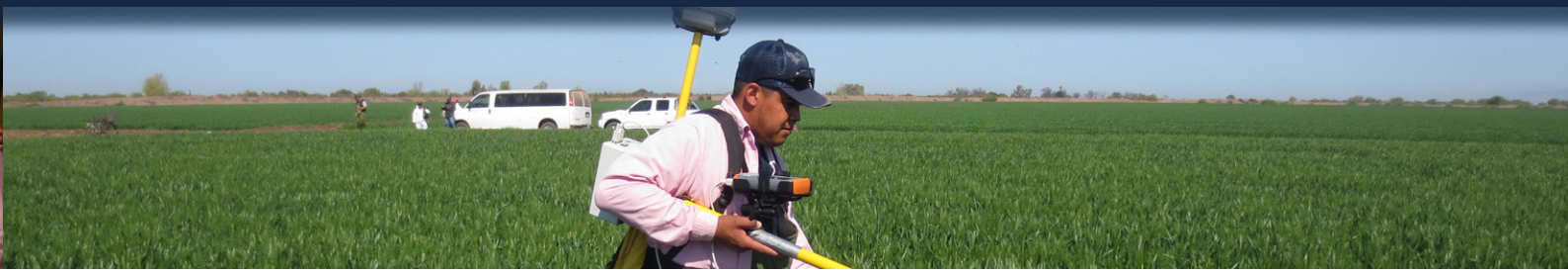


Figure 2 Help Section with a question mark symbol on every screen, to easily navigate through all options and features.



SOLUTION DEVELOPMENT

Launch and Marketing

The app and its subsequent version releases are usually launched during Rezatec visits to Mexico with farmers meetings organised at our partners facilities at 4 locations in Mexico. One of our important version releases was V1.6 which was built with new improved features such as NDVI map of farmers' fields updated weekly using Sentinel 2 data, and availability of the app on the Android Google Play store. V1.6 was very popular amongst the Sugarcane and Wheat pilot farmers and was launched at ForoGlobal Agroalimetario, the largest agro food tech forum held in Latin America every year attracting 40-50k visitors. The COMPASS Mobile App was originally launched in October 2018 in Puebla at an event where the President of Mexico was present. The presentation drew attention from a variety of potential stakeholders and the project was covered in the Mexican press which really helped to raise awareness of the COMPASS project.

The next step is to launch Version 2.0 of the app to 100+ farmers in Obregon, the irrigation District of Yaqui Valley and where the largest wheat farmers association, AOASS, has volunteered to support us organising the event with CIMMYT.

Technical solution

The overall challenge for both wheat and sugarcane crops is to transform both traditional extensive as well as modern intensive systems into sustainable systems producing more crop output with better use of resources. This requires better management of the interacting parameters controlling yield. There are about 30 site-specific parameters grouped by soil, management, inputs and environment that can determine the production efficiency of wheat and sugar cane crops e.g. soil type, harvest date, disease control and temperature. The theoretical effect of these parameters on production is understood. However, there are no practical, evidence based, management decision tools that support smallholders and larger growers by targeting production efficiency per specific field.

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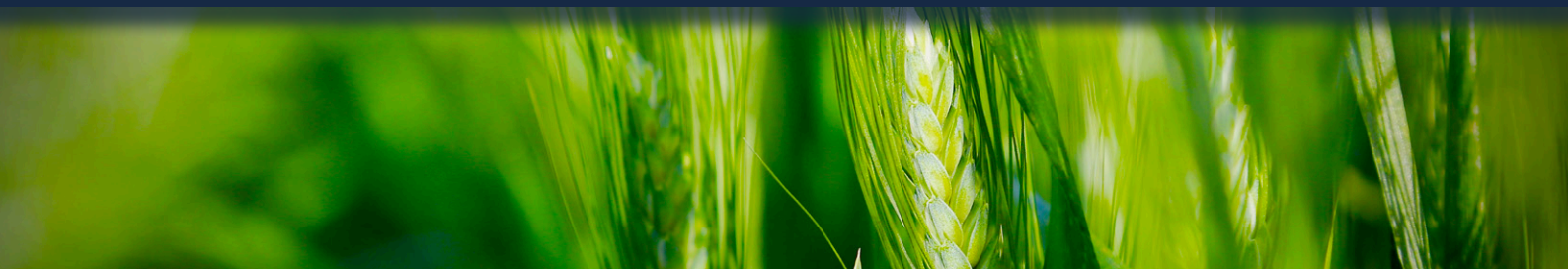
Figure 3 LHS: A sugarcane farmer from Tabasco with COMPASS app v1.6. RHS: COMPASS presented to 5000+ audience at Global Agri-Food tech forum (FGA), the largest forum held in Latin America during Oct'18 at Puebla Mexico attracting 40,000 visitors around the globe.



SOLUTION DEVELOPMENT

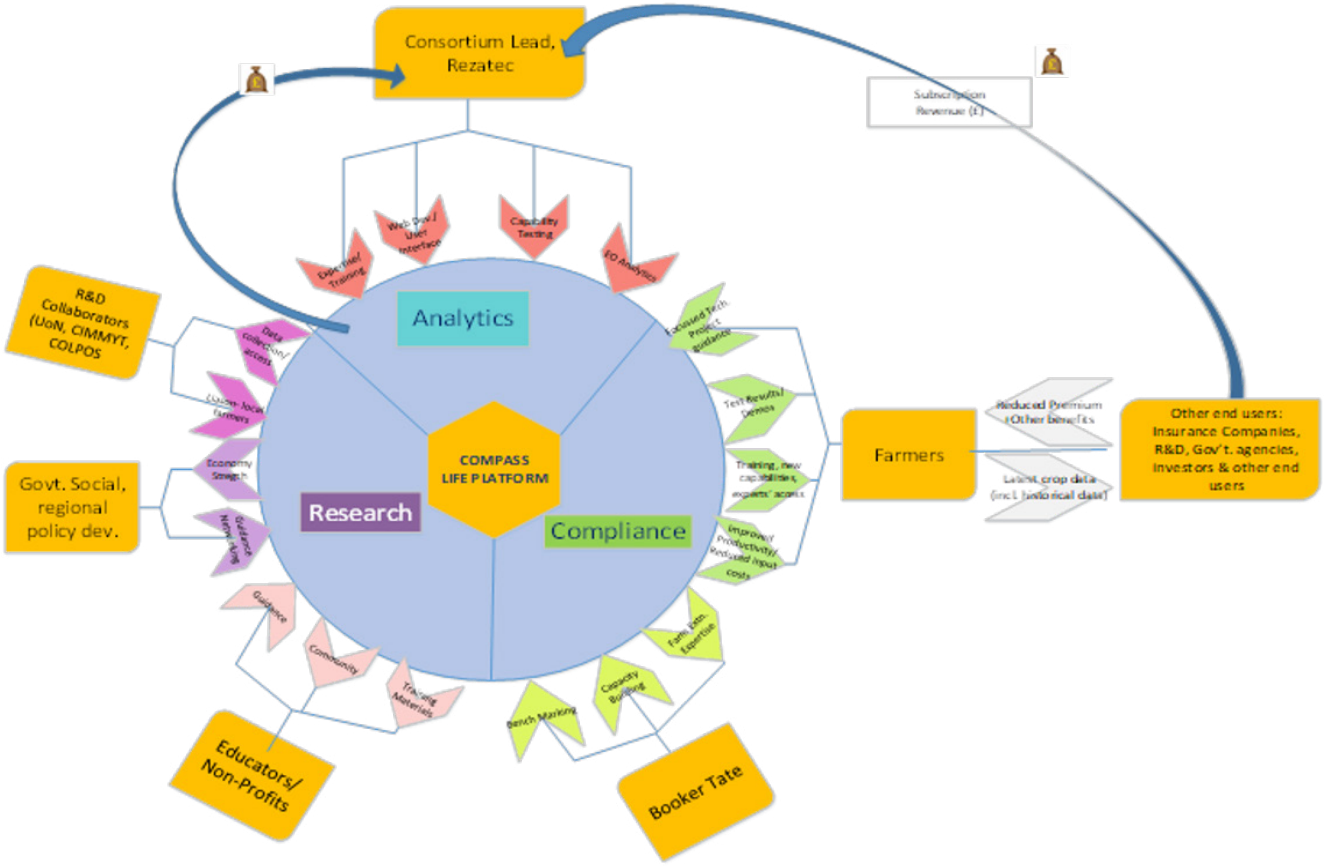


Figure 3 projected value streams for the COMPASS project.

Project Innovations

The overall challenge for both the wheat & sugarcane sectors is to transform both traditional extensive as well as modern intensive systems into sustainable systems producing more crop output with better use of resources and this requires better management of the interacting parameters controlling yield. In response to these challenges, Rezatec aims to launch a free mobile application aimed at helping wheat and sugarcane smallholder farmers in Mexico, benefit from using Earth Observation (EO) satellite data within field measurements to reduce production costs and increase crop yields. The ultimate aim is to ensure that farmer incomes become more stable, and therefore directly benefit farming families and rural communities, as well as addressing potential environmental issues.

SUSTAINABILITY MODEL

Users

The main users and the customers of the COMPASS application include to realise the benefits listed below with priorities:

1. Growers and farm extension services

+ Crop productivity – improving smallholder and farmer crop management
+ Environmental impact – reducing the negative impacts of crop production, targeted at both smallholders/farmers and government agencies

2. Irrigation Bodies

+ Irrigation district in Yaqui Valley- improving the supply/demand optimisation for wheat farmers within Yaqui valley. Water a valuable resource within this region and need for COMPASS app in managing the supply/demand between the irrigation district and the farmers (end users) is well acknowledged.

3. Supply chain users and growers

+ Optimisation – improving coordination of harvesting and logistics by scheduling crops at the optimum development stage, targeted at both growers (to increase their incomes) and processors/logistics companies

4. Crop insurance companies

+ Enabling insurers to target insurance payments at those farmers most affected by factors beyond their control (e.g. extreme weather) and thus reduce the premiums paid by farmers by securing supply chain and government support.

5. Investment companies

+ Helping the equipment and agribusiness sectors target their investments and hedge their risks.

6. Government bodies/Food Security Agencies/ Crop advisory services

+ Crop monitoring at regional/national level – improving market function so that net producer prices increase, and the supply chain operates more effectively

SUSTAINABILITY MODEL

Commercial Model

Our commercial model for sustainability is based on deriving subscription revenue from Rezatec's Life Platform commercial service and its associated data products.

Life Platform is a software platform that allows Rezatec's customers to better respond to challenges presented to their land assets by environmental and climate change. It does this by collating data sourced from multiple satellites, incorporating ground-based data and other ancillary datasets, and processes the data against scientific models and algorithms to deliver commercial Earth Information data products, analysed and visualised using Geographic Information Tools, for non-science users.

Commercial Revenue Streams - Our commercial revenue streams are focussed on the following:

+ A fee-based subscription model whereby commercial companies, government agencies and crop insurance providers pay for access to enhanced datasets, aggregated data and more detailed analysis than the basic free data which is made available to smallholders.
+ The deployment of this business model to other developing countries growing wheat and sugar cane to increase the viability and returns from using earth observation data to support smallholder farmers.
+ Upon successful project implementation for wheat and sugar cane crops, the extension of the LIFE PLATFORM value proposition to cover additional areas and crops, such as corn and coffee in the adjacent territories e.g., Columbia and Mercosur countries (Argentina, Brazil, Paraguay).
+ We have made the assumption that revenues delivered through usage of the Life Platform will increase progressively due to more data users accessing the platform, the availability of historic data and the utility of Life Platform specific decision-making tools.
+ Revenue is also expected to derive from licensing fees from appointed distributors as the international expansion program rolls out. This network of distributors comprises of other data providers, precision agriculture consultants etc.

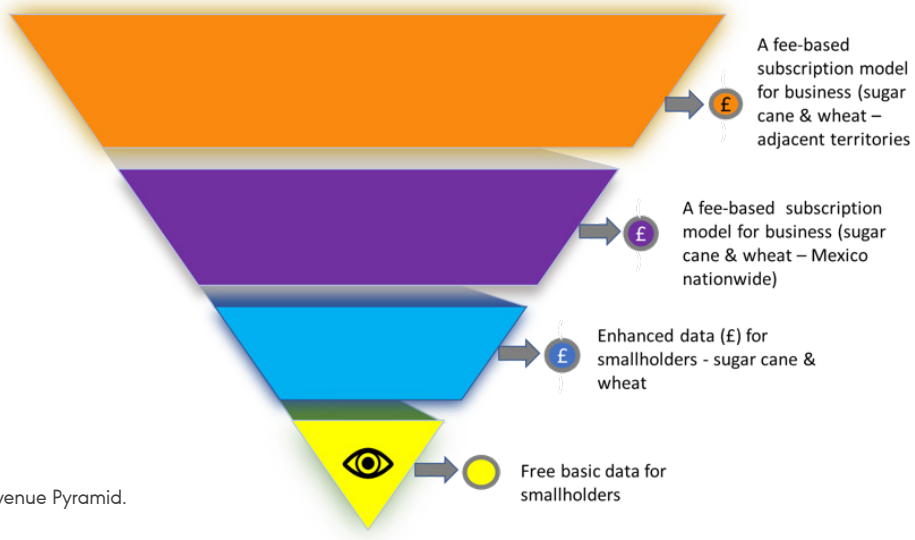


Figure 4 Rezatec Life Platform Revenue Pyramid.

SUSTAINABILITY MODEL

Capacity Building

Capacity building and training is critical to ensure on-going maintenance and evolution of the product.

Rezatec will develop and manage its own network of partners that will provide the personnel and services required in a software platform implementation. This approach will allow Rezatec to select the best partner for each role and function of an implementation. The involvement of internal managers, executives, and other internal personnel working closely with the selected partners will improve the quality of implementations and can reduce the risk of project failure.

Minimum Run and Maintain Cost

Rezatec believes that the minimum 'run and maintain' cost to keep the solution operating and generating impact can be achieved by securing at least 3 portal users. Rezatec already secured interests from three potential end users including as listed below.

1. Major Crop Insurance Firm: Insurance Association – Wheat (and Sugarcane prospectively).

+ They have direct influence in Mexico, and they represent most/all the Agri companies in Mexico.
+ Government run association
+ They are a buyer on a region by region

2. Water irrigation providers in the Yaqui Valley, Mexico

+ Provide irrigation to around 40 irrigation modules within the Yaqui Valley

3. The Wheat chamber: The wheat mill groups association in the country.

+ As an association, they would be an influencer to all of their associated Mills who, as users of the outputs of COMPASS App. would access the Rezatec GIS portal. Each Mill would subscribe to the use of the portal which is gathering information from the farmer app.

SUSTAINABILITY MODEL

Expansion Strategy

Beyond the grant funded project, the expansion strategy in terms of geography and product functionality will replicate, where applicable, the route to market practiced in Mexico. Expansion is anticipated to be phased as follows:

+ **Phase 1 – 2018 onwards - emergence stage** - the plan for this phase is to offer a scalable business solution with large national rollout, which becomes possible because of growing demand for precision agriculture driven by geospatial landscape and crop intelligence, competitive market pressures and regulatory compliance. This phase will create mechanisms for Rezatec to monetise its data assets, while stimulating multi-system, multi-region platform integration and economic growth.
+ **Phase 2 – 2020 onwards - commercial stage** – insurance companies pay Rezatec for accessing data assets belonging to multiple farmers to assess farming practices and encourage usage of the platform in order to lower premiums. A key element is to offer a more compelling fee-based Data-as-a-Service (DaaS) capability that contains enhanced analytics. This phase will initiate an open marketplace for crop/agricultural land data and data services.

The expansion of the Rezatec service into Central & South America wheat and sugar cane markets will magnify the development of the Life Platform. Expanding into new crops will forge new sales channels for Rezatec:

+ The Latin American region is an important net exporter of food and agricultural commodities, accounting for 16% of total global food and agriculture exports and 4% of total food and agriculture imports. (Source: Latin America. Agricultural perspectives. Economic research by Rabobank)
+ The region is one of the few parts of the world with significant resources of unexploited agricultural land (concentrated in Brazil and Argentina), suggesting the region will continue to play a pivotal role in global food production and exports in the future.
+ Many of the region´s countries have achieved respectable rates of agricultural productivity growth in the recent past. Nevertheless, raising productivity will be essential to meet domestic food needs or to maintain or enhance export competitiveness.

Rezatec believes that following successful implementation of wheat crop monitoring in Mexico we can find at a minimum a responsive market in Brazil and Argentina. The agriculture sector in Argentina is export oriented. Market Year 2016/17 features substantial year-on-year increases in planted acreage (from 34 to 36 M ha), the harvest of cereals (from 111 to 125 MMT) and grain and oilseed exports (from 82 to 93 MMT). (Source: speech of Leandro Pierbattisti, a representative of Argentina's Federation of Elevators Association, XIV International Conference "Black Sea Grain, April 2017).

The project is expanding to a new country, Argentina with wheat and maize. Also, a new crop, Maize is being added to Mexico. The development of the tool is in progress.

PROJECT OBJECTIVES & RESULTS

Impact and benefits of COMPASS will be:

+ A 5% increase in yield value, net of input costs particularly for smallholder farmers, in two of Mexico's major crops, wheat and sugar cane.
+ Up to 1200 wheat and sugarcane farmers benefiting from the use of COMPASS tool on crop management activities.
+ Improved resource use efficiency (optimum irrigation management) to the environment; through balanced application of inputs.
+ Improved market function as farmers, traders, government and other stakeholders will have improved information on likely crop yields, allowing much better planning of crop marketing, which helps to stabilise incomes.
+ Through improving technical and market performance, the project will assist rural economic development in Mexico, improve food security (wheat) and generate increased export earnings (sugar cane).
+ The project will also introduce a focus on managing crop performance enabled by a range of satellite data which is currently not used in Mexico, this stimulating the uptake of this innovative technology. At present satellite data is only used for nitrogen management via the GreenSat system.

This international collaboration represents a new opportunity for the UK because:

+ It takes UK developed technology using space data and applies it to a new country, Mexico, and new context, tracking crop growth performance for smallholders growing wheat and sugar cane in a developing country. Trials in the UK and Ukraine with sugar beet grower groups and sugar factories have shown the potential to increase yields using this technology by 5%.
+ Opens up new markets in Latin America for UK companies in an area with strong growth potential for the UK commercial and academic partners.

Monitoring & Evaluation methodology

The project followed a robust M&E methodology under the guidance of Caribou Space who support IPP. At the start of the project an M&E Plan was defined, and a baseline evaluation conducted to assess the context within Mexico before the project was implemented.

A midline evaluation was conducted in 2019 to measure progress at the halfway point. An endline evaluation will be completed in 2021 to capture the results and lessons at the end of the project.

The partners' Cost Effectiveness Analysis Narrative Report finalised in October 2019 compared the cost of COMPASS's satellite data against similar data collected using unmanned aerial vehicles (UAVs). The main finding from this was that the total cost of developing the COMPASS system from 2017 to 2020 will be £4.6 million, compared to total costs of £5.34 million to develop an alternative system based on using UAVs (drones). The Cost Effectiveness Report also found that the costs of maintenance and services to farmers per field – after the project is over – from 2021 to 2024 would be £30,777 using COMPASS, against £40,476 using UAVs. This means end-user costs 31% higher using UAVs, so COMPASS is clearly more cost effective than the alternative.

[1]Rezatec (2018) Cost Effectiveness Narrative Report: Mexican Compass. Harwell: Rezatec.

PROJECT OBJECTIVES & RESULTS

Impact stories from end users and communities

The pilot user farmers have been interviewed periodically who have been using the app for the past 2 years approximately and have provided us with regular feedback. This allowed development of a user-friendly version built with functional features including irrigation schedule and sowing date recommendations which were not initially part of our project objectives. They were established upon several interviews held with the end users to understand the real requirements where the EO data and the crop model can be best utilised in combination with the weather data.

Farmer engagement

Farmers interest in the work was encouraging. Many were keen to discuss the irrigation and sowing date recommendations and they were interested in how they were made. Understandably doubts were expressed over making a change in established farming practices. Farmers were acutely aware of the financial risk of applying the recommendations at a whole field level and it was not surprising that many expressed an interest in testing the approach on sub-area of fields. However, the regional system of irrigation governance (IRRIGATION DISTRICT) does not allow this, therefore the farmers had to make all or no decisions. Due to these constraints no farmers changed their practice to follow the irrigation recommendations, although some farmers' plans coincided with the model-based advice given to them. Sugarcane farmers from Campeche are some of the highly enthusiastic group of farmers who have been highly engaged on feedback activities. The common functional feature which interested all these sugarcane regions is the NDVI access. Female farmers while interviewed did state that access to NDVI reduces the need for accessing the remote farms more frequently to monitor the crop's status and this also mitigates the safety issue which they face regularly. They also expressed a need for an NDVI time series of their fields for historical comparison on field performances between the seasons. However, some sugarcane farmers did have access issues where there was cloud cover. Rezatec is currently analysing the NDVI generated from SPOT data which are more frequently updated (provided by SIAP as part of the Mexican Ministry of Agriculture's collaborative agreement).

Further farmer interview is planned during Q4 2019 to assess the introduction of a new functional feature which estimates the average yield loss with respect to the age of the ratoon cycles. This request was initially raised by farmers of Cordoba region (one of the three Sugarcane regions) and need to be further investigated with the other 2 regions prior to development of this new objective during 2020.

PROJECT OBJECTIVES & RESULTS

Irrigation District

IRRIGATION DISTRICT is a limited liability company located in Obregon, Sonora, created by producers to serve them and committed to contribute to the sustainable development of the community, providing solutions to solve current water needs, and of future generations. IRRIGATION DISTRICT being an essential part of southern Sonora's economy its mission is to 'Manage and preserve the concessioned waters with the participation of the Users- Producers to achieve the sustainable and efficient use of the resource."

The irrigation district's major functions include:

1. Water Supply

The functions of the Yaqui River Irrigation District are to provide the service of operation, conservation and administration of the largest network of channels, drainage network, their respective roads and other hydro-agricultural infrastructure of the Yaqui Valley.

2. Economic partner function

It has the important task of taking care of water, which in addition to delivering it to farmers, who produce food, supplies the city and rural communities where the industries that generate jobs are installed, which are the economic engine of the region

3. Ecological function

Improve overall health along drains, canals and roads, thereby eliminating the proliferation of insects, pests and other harmful fauna that pollutes the environment.

Following discussions and negotiations with IRRIGATION DISTRICT who a potential commercial stakeholder is, they are pleased and have agreed to grant farmers the flexibility to trial the irrigation recommendations on sub-areas of their fields in the 2019-20 season and this will substantially increase the interest of more farmers.

IRRIGATION DISTRICT who are part of the COMPASS Pilot Study on developing an environmental impact decision support tool are currently engaged with the consortium using our trial farmers in Obregon. Irrigation is a key factor affecting the health of the crops, and with limitations on the availability of water, careful monitoring and understanding of usage is essential. The Irrigation Module takes the irrigation requests made by the farmers through the app, alongside some generated predictions of when they would expect future irrigations and uses this to show how the demand of water is expected to proceed.

Major activities on this pilot tool development include:

+ Mapping IRRIGATION DISTRICT's Irrigation Channels within the Yaqui Valley on Rezatec's portal
+ Communicating the live farmers crop management activities via the COMPASS mobile app. with IRRIGATION DISTRICT
+ Heatmap showing Sowing date and the yield gap
+ Water supply & Demand analysis
+ Time series of expected irrigation demand through the season.

PROJECT OBJECTIVES & RESULTS

Directorio de módulos de riego:

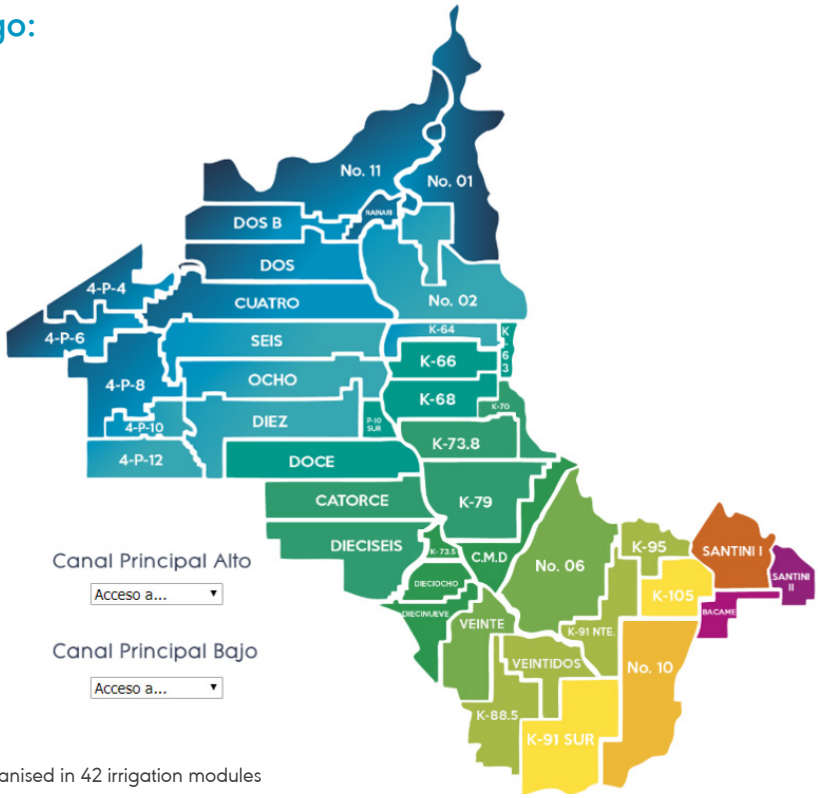


Figure 5 The irrigation district has 22,000 users organised in 42 irrigation modules

Crop Insurance Company

The Mexican Government Insurance Company, whose principal commercial activity is the reinsurance of agriculture activities. As a national insurance institution, it contributes directly and indirectly to the economic and social development of the country whose mission is to protect the heritage and productive capacity of the rural sector. They will benefit from the Rezatec's Geospatial portal which will be developed during this pilot study scheduled until Nov'19. The portal will assist with data layers with the following features:

+ Dashboard to see the COMPASS app user farmers
+ Wheat farmers field boundaries
+ Crop management activities relevant to the crop insurance
+ Live NDVI maps, updated using satellite imagery

Future activities will involve developing a communication channel between the portal and the COMPASS mobile app for direct communication between them and the farmers. This will further assist the insurance company to prompt the farmers for any missing crop management activities or prompts to alert farmers, if there are issues identified via Vegetation Index Map (NDVI).

Pilot study plan with the insurance firm is in progress and will progress to prove the technology during the Nov'19-20 season in Wheat.

PROJECT OBJECTIVES & RESULTS

Farmers Association

AOASS- Asociación de Organismos de Agricultores del Su, The Agricultural Association located at Obregon, Yaqui Valley represent the wheat farmers in both Yaqui & Mayo Valley in Mexico. AOASS is an Organization of Producers of the private sector concerned about making efforts and defending the interests of its producer's union, to integrate a solid and efficient company. Currently, it is made of 7 Producer Organizations, which come together to seek a better integration of the agricultural sector. AOASS are currently working closely with Rezatec to ensure that the COMPASS technology is well received by the targeted number of farmers within Yaqui & Mayo Valleys. AOASS are the largest wheat farmers Association in Mexico, haven been constantly engaged on our progress update visits to Mexico in Obregon and have recently volunteered with provision of up to 50 new pilot user farmers to adopt the COMPASS tool and engage on the validation exercise during the season 2019-20.

Impact on gender equality

Currently more than 55 farmers have been engaged during our regular famers meetings with the consortium and are represented by both genders. COMPASS app especially with the NDVI feature did prove the impact on work life balance in particular with the female farmers. For example, during the recent farmers meeting held in Campeche female farmers attended expressed that access to NDVI feature on the compass app reduces the need for accessing the remote farms more frequently to monitor the crop's status and this also helps mitigating the safety issue which they normally faced on field monitoring.

Image: Field visit in Sonora, Mexico by the project partners

Rezatec

MEXICAN CROP OBSERVATION, MANAGEMENT & PRODUCTION ANALYSIS SERVICES SYSTEM

CONCLUSIONS AND LESSONS LEARNT

Conclusions

There is potentially significant and economically important variation in yield due to the timing of irrigation. Generic recommendations for the timing irrigation can be improved upon using farm specific information to underpin model simulations, which can increase the yield by up to c. 10%.

To date these recommendations have been provided to the participating farmers through discussions with CIMMYT staff. Next phase of the work will deliver these recommendations via the mobile app, which increases the reach.

Farmers did show reluctancy to follow recommendations fully without an opportunity to test them on their small field areas. Very encouragingly the irrigation district has agreed to make this possible for the 2019-20 season for 80 farmers with 2 farmers in each of 42 irrigation modules in the Yaqui valley. This will be a huge progress on validating the technology on a higher scale covering the whole Yaqui valley. This in return help us to reach more farmers in the region reaching our targets.

Lessons learnt

Initially some farmers did have less trust over the COMPASS team. So, the ability to directly engage them through meetings and promote the use of the COMPASS tool among the farmers and engaged them to be pilot users were difficult. But this was mitigated via contacting the influencers within the supply chain contacts with whom they have established a trusted relationship. For example, we built a good relationship over the last 3 years with the local farmers association, Crop insurance firms, Crop advisors and exposed the tool and kept them up to date of the progress via direct visits, teleconferences etc.

Farmers engagement through regular meetings and external support such as WhatsApp group works in building relationship and confidence of the COMPASS team.

Approaching some potential stakeholders were also difficult initially. For e.g. Wheat Chamber, Mexico and Processor, Obregon). Having established a good relationship with the Mexican Government entities including, SADER, SAGARPA (Mexican Ministry of Agri.), SIAP, DIT etc. and having an MOU in place has helped us significantly to further reach potential contacts for exploring commercial opportunities.