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VITO REMOTE SENSING: HARNESSING REMOTE SENSING FOR AGRICULTURE

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Abstract

Agriculture, a pivotal sector which plays a key role in feeding the world's growing population faces numerous challenges in terms of meeting production demands, inefficiencies in supply chain management and limitations in resources. This case study examines the situation of VITO Remote Sensing, a Belgian company that specializes in utilizing earth observation data to combat the challenges faced in agriculture. The study explores the role of VITO remote sensing in precision agriculture and potential strategies for commercialization, including the possibility of creating a spin-off. Key considerations include commercialization strategies, competitive positioning, stakeholder impact, and ethical considerations.

Keywords: Precision Agriculture, Earth Observation, Spin-off, Sustainability, Commercialization, Business Model Innovation

Abbreviations:

EO: Earth Observation

GDP: Gross Domestic Product

IoT: Internet of Things

AI: Artificial Intelligence

CAP: Common Agricultural Policy

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Agriculture, a sector which has been around for the last 12,000 years (Carey 2003), presently finds itself at a historic crossroad. For centuries it has been a key contributor of human sustenance and economic growth, accounting for 4% of the global Gross Domestic Product (GDP) and more than 25% of the GDP in developing countries as of 2023 (World Bank 2024). The agricultural sector however has to continue to meet the unparalleled demands of food production, environmental sustainability, and resource efficiency as the global population is estimated to grow at a rate of 1.1% per annum (United Nations 2017) and reach a staggering 10 billion people by 2050 (World Resources Institute 2018).

One of the key innovators at the forefront of ensuring the future of food security for the growing population while fostering environmental sustainability and taking into consideration the climate crisis, is VITO Remote Sensing, a division of the Belgian research organization Vlaamse Instelling voor Technologisch Onderzoek (VITO). The organization has its roots in innovation and research and its agricultural division has been revolutionizing the future of agriculture through the creation of actionable and data- driven insights using Earth Observation (EO) technologies.

During the warm summer of 2023, Laurent Tits, the team lead for agricultural applications for VITO Remote Sensing found himself in in-depth discussions with Jürgen Decleedt, a seasoned international business developer with over eight years at VITO. Together they pondered about the future of VITO's agricultural solutions. They decided to have a meeting with the agricultural team and as they sat with their team in a conference room, surrounded by charts and posters entailing their groundbreaking advancements, a pressing reality hit. Despite VITO Remote Sensing creating disruptive innovations in using remote sensing for agriculture, its core identity as being a research driven organization had limitations - in particular restricted funding and as a consequence limited reach and accessibility to new customer segments. This left them and the agricultural team

grappling with how they should go about commercializing their products while still staying true to their identity as being a research and environmental and socially sustainable driven organization, for Laurent and his team it was not just a matter of business but rather a way to keep the organization at the forefront of innovation and to keep staying relevant in the rapidly evolving sector, EO for precision agriculture. The path forward for VITO was uncertain but one thing was clear, bold steps needed to be taken to secure the future of VITO Remote Sensing.

The Genesis of VITO Remote Sensing

The story of VITO Remote Sensing began in the year 1991, when the Flemish Institute for Technological Research or Vlaamse Instelling voor Technologisch Onderzoek (VITO) in Dutch was founded in Belgium. It is a public limited company and it was created as a part of the policy domain of the Department of Economy, Science and Innovation (EWI) of the Belgian Government and hence some of the company's board of directors are government commissioners from the EWI. It was founded to be a multi- disciplinary research organization as it was forged out of a desire to address pressing societal and environmental issues. From its creation, it was envisioned to be not just an ordinary research institute but rather a catalyst for change, an organization that combined scientific and theoretical knowledge with practical insights.

By the late 1990's, there was a new field emerging: the use of satellite technologies for downstream applications on Earth. The rapid development of satellite technology and its potential to be used in diverse industries inspired a group of forward thinking individuals at VITO as they saw the opportunity to use space technologies to create practical insights and in the year 1998 it led to the formation of a new subsidiary, VITO Remote Sensing. It was set up with the core mission of transforming raw satellite data into actionable insights and it then embarked on its journey to

bridge the gap between cutting edge technology and real world challenges. From its humble beginnings in Mol, Belgium, the organization kept growing and expanding eventually becoming a global player. It presently uses satellite imagery to tackle pressing issues in agriculture, climate, environment, infrastructure, water and security.

The organizations agricultural vertical was set up along with the creation of VITO Remote Sensing in 1998 as a response to the European Unions Monitoring Agricultural Resources (EU MARS) initiative created in 1988 which was designed with the purpose of applying emerging space technologies to provide timely and independent information on crop areas and yields (Tits 2021).

By the time VITO's Remote Sensing division was established, VITO had already gained a solid reputation for groundbreaking research and advancements as well as its commitment to solving real world challenges. The creation of VITO Remote Sensing was a turning point for the whole organization as it was hence positioned at the forefront of the emerging field of using space technologies for earthly applications¹.

The early years for VITO Remote Sensing were composed of continuous innovation, exploration and experimentation. The team at the time was primarily constituted of researchers, data scientists and engineers and they worked on methods to develop and process satellite imagery. This then evolved into them creating actionable insights using satellite data for various sectors including agriculture.

As of 2023, VITO boasted an exceptional performance; €101 million in business revenue, €63 million in grants, and a workforce of 1,296 experts spread across six continents. Also in the same year, they managed to spin-off two of their innovative technologies for further commercialization

¹ The space economy can be divided mainly into upstream activities (research, space manufacturing, ground systems) and downstream activities (space operations for earthly use, products and services that rely on satellite technology, data to function) (ESA 2019). VITO Remote Sensing's products and services come under downstream activities.

(VITO Annual Report 2023). VITO and its Remote Sensing division continues to expand and grow its research capabilities as it takes on more projects on its own as well as with the collaboration of governments, global and local research institutions and industries.

A Growing Crisis and a Beacon of Hope

Agriculture in its current phase faces a plethora of challenges including declining crop yields, unsustainable resource use, unpredictable weather patterns and limited access to credit for smallholder farmers (EOS Data Analytics 2024). These issues threaten the resilience of the agricultural sector, endangering the food security of the growing population while expediting the climate crisis.

Amidst the growing concerns that the industry faces, precision agriculture emerges as a beacon of hope. This is considered to be a revolutionary approach that promises to transform the way agriculture is done. It utilizes data and technology at its core to optimize all the aspects of the agricultural value chain, from seed production and planting to harvesting (Caribou Space 2020).

One of the key technological breakthroughs that drastically altered the course of the precision agriculture industry was the use of Earth Observation (EO) data. It was considered to be a game-changer as it harnessed the power of satellites to provide near real time insights into agricultural systems. It allowed farmers to make data driven and informed decisions, reduce waste and maximise yield as it captured detailed data on crop health, soil moisture and weather patterns (Niyonzima 2024). For the first time, vast tracts of agricultural plots were able to be monitored from space, identifying problems before they became irrevocable (World Economic Forum 2015). However, the integration of these technologies into traditional farming practices presents itself with challenges. In the European Union, there were 9.1 million agricultural holdings in 2020 and out of

this 63.8% of them were less than 5 hectares in size (Eurostat 2024). The accessibility and reach of EO technologies to these 5.8 million smallholder farmers is limited because of knowledge gaps and lack of technological expertise. Also, high initial costs of implementation constrains farmers who are not well-to-do or lack access to sufficient credit means (Bagheri and Emami 2023).

In addition to challenges with integration, there are growing concerns related to accessing high resolution satellite imagery due to national security, privacy and policy concerns. Currently there is also a lack of cybersecurity for data protection which leaves sensitive data on crops and yields vulnerable to breaches. There are issues associated with data accuracy and there is still a lack of insufficient integration with ground-level data (EUSPA 2023).

From Space to Farm: The Evolution of Earth Observation in Agriculture

The launch of the former Soviet Union's artificial satellite, Sputnik I in 1957 which was able to transmit radio signals that could be received on Earth, heralded the era of hundreds of remote sensing satellites being launched into the Earth's orbit (Britannica 2024). The capability to observe Earth from space brought the opportunities that were once in the realm of science fiction into reality. The first satellite which was specifically created for Earth observation was Vanguard 2 in 1959 but because of technical issues it was unable to collect sufficient data on cloud cover which was its intended purpose (NASA Space Science Data Coordinated Archive n.d.).

The beginning of the use of EO data in agriculture dates back to the year 1972, with the launch of the National Aeronautics and Space Administration's (NASA) Landsat satellites (NASA n.d.) followed by the introduction of the SPOT (Satellite pour l'Observation de la Terre) in 1986 (European Space Agency n.d.). These pioneering missions provided a new lens for customers such as farmers, food processors and scientists and built the foundation of the use of EO data in

agriculture since they provided unprecedented insights into crop yields, growth conditions and yield estimations.

Over the decades however, the use of EO data in agriculture has evolved and become increasingly popular, because of the entrance of a growing number of satellite manufacturers and payload providers and due to technological advancements which have improved the resolution and accuracy of multispectral and hyperspectral satellite images². The accessibility of this data has been improved in part because of the EU Space Policy³. There is also an increasing amount of government investment in the field which leads to a robust and dynamic EO satellite market. It is predicted that 5,401 EO satellites will be launched between 2024 and 2033 which is a 190% increase from the previous decade (Novaspace 2024). Also the integration of the advancements in the internet of things (IoT), artificial intelligence (AI) and big data analytics expanded the capabilities of EO for precision agriculture as it allowed the generation of actionable insights from basic monitoring (EUSPA 2023). Simultaneously external pressures such as the pressing reality of climate change and the demands of an ever evolving regulatory landscape and policy frameworks such as the EU Green Deals “Farm to Fork” strategy which encourages sustainable farming also lead to its increasing use.

The rise of the precision agriculture sector as a whole, has transformed agriculture from being intuition and experience based to that being reliant on a data driven approach. This paradigm shift ensures that farmers can effectively respond to growing challenges, ensuring food security for a rapidly expanding population.

² Multispectral images capture images of specific and few bands of light like visible and infrared light which gives broader and simpler images. Hyperspectral images capture narrow bands of light which results in images being more detailed and deeper in comparison to multispectral images (EOS Data Analytics n.d.).

³ The Copernicus Earth Observation Program is the cornerstone of the EU Space Policy which helps provide access to high-quality and free satellite data. It is served by a group of satellites called the Sentinels (European Commission n.d.).

The economic potential of the use of EO for agriculture is undeniable. It is estimated to be worth €450 million as of 2023 and is expected to grow to €670 million by 2033 (EUSPA 2023). This surge in the importance of EO for agriculture reflects not just technological innovations and policy changes but also a growing awareness of the importance of EO for agriculture amongst various stakeholders.

The Business of VITO Remote Sensing

VITO Remote Sensing plays a crucial role in the value chain of EO for agriculture. An understanding of the basic value chain is quintessential to understand VITO Remote Sensing's role in it. The value chain consists of a complex ecosystem of data providers, infrastructure managers, platform developers and product and service providers. It begins with satellites capturing data in the form of images of the earth's surface, followed by infrastructure providers processing and storing this raw data. Platform providers then play a crucial role in making this data accessible in near real time. VITO Remote Sensing's role comes into play as a product and service provider as they turn this satellite data into actionable insights. It uses satellite images, advanced analytics and ground level data to deliver services that empower various stakeholders (EUSPA 2023).

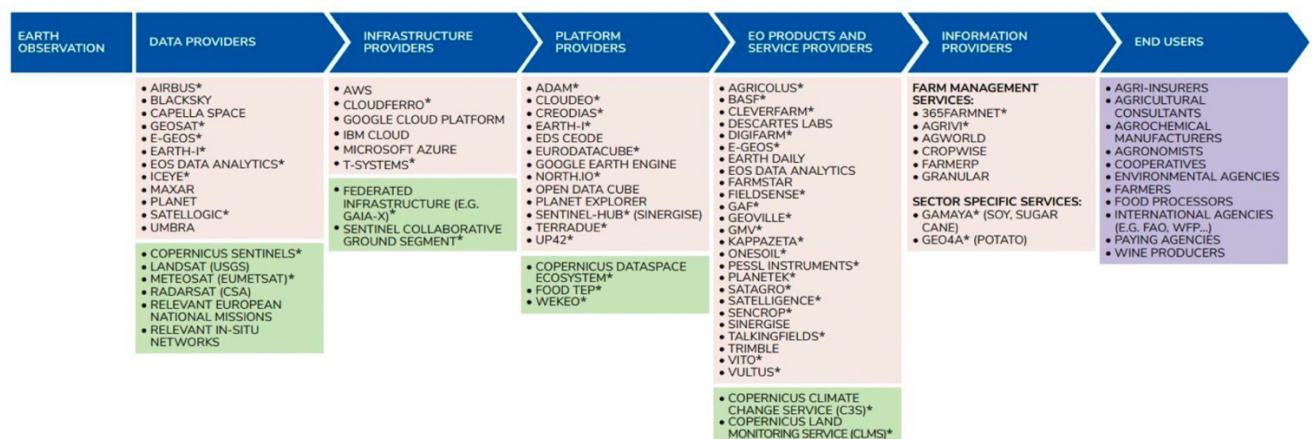


Figure 1: Value Chain of Earth Observation for Precision Agriculture; Source: EUSPA

Their platforms are not solely products but lifelines for farmers and agribusinesses who are navigating uncertain futures. The main sources of revenue generation for VITO's agricultural vertical include their products MAPEO, Terrascope⁴ and WatchITgrow. MAPEO's ability to create digital twins of agricultural plots whilst measuring crop traits with sub- millimeter accuracy offers plant breeders and researchers with invaluable insights (VITO, MAPEO: Satellite- Based Crop Monitoring n.d.). Terrascope democratizes farmers access to near real time satellite data, enabling farmers to view their plots even in adverse weather conditions like heavy cloud cover (VITO, Terrascope: Unlock the Potential of Satellite Data n.d.). WatchITgrow integrates diverse data sources to create actionable insights that encourage farmers to improve yield and make environmentally sustainable decisions (VITO, WatchITgrow: Online Platform for Precision Farming n.d.).

It currently operates through a business-to-business model (B2B) meaning that VITO Remote Sensing sells their products to intermediaries such as input suppliers⁵, food processors⁶ and agro- insurance companies⁷.

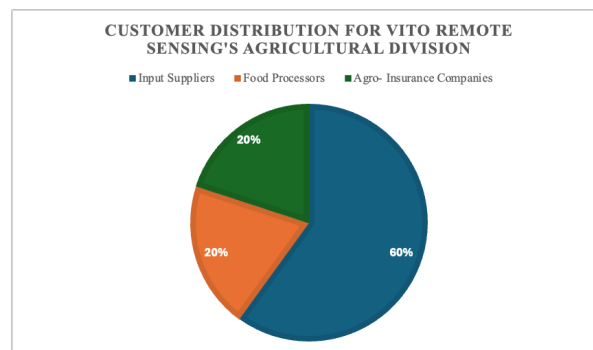


Figure 2: Customer Distribution for VITO Remote Sensing's Agricultural Division

⁴ Refer to Appendix 3 for the user interface.

⁵ Input suppliers are defined as agribusinesses that manufacture, sell or distribute the inputs for agriculture.

⁶ Food processors are involved in the handling, processing and distribution of food for sale for human consumption.

⁷ They provide financial protection to farmers, agribusinesses and other stakeholders in the agricultural value chain.

VITO Remote Sensing primarily relies on institutional project grants⁸ and support from the Belgian Government, a minor part of their revenues come from sales to industries or companies. Should VITO Remote Sensing make changes or modifications to its current business model to expand its reach and distribution? And how can they further differentiate themselves so that they still remain a competitive and relevant player in the marketplace?

Traversing the Competitive Space: Key Players and Market Dynamics

In the ever changing landscape of the use of EO for precision agriculture, VITO Remote Sensing finds itself amidst a dynamic and highly competitive market⁹. The space consists of well established players, up- and- coming and innovative startups and specialized geo- spatial firms each trying to carve a niche of its own.

There are established players such as Airbus's Farmstar which provides satellite based crop monitoring (Airbus Intelligence n.d.) and Agri- Geo developed by e- GEOS which combines geoinformation with big data analytics and AI for personalized agricultural solutions (e- GEOS n.d.). The field is also dominated by notable and innovative startups including Digifarm which uses deep neural networks¹⁰ and high resolution satellite imagery to redefine field boundaries and for precision mapping (DigiFarm n.d.) and EOSDA Data Analytics which combines data from various sources such as weather analytics, soil moisture data and satellite data into a user friendly platform (EOS Data Analytics n.d.)¹¹.

⁸ VITO Remote Sensing is the prime contractor of programs like the ESA WorldCereal, Copernicus Global Land and ESA WorldCover (VITO Remote Sensing n.d.).

⁹ Refer to Appendix 4 for the evolution of the number of EO companies in Europe according to company class.

¹⁰ It is a method used in AI that teaches computers to process data like the human brain (Amazon Web Services n.d.).

¹¹ For detailed information regarding competitors, please refer to Appendix 5.

In this crowded space, VITO Remote Sensing particularly stands out with its focus being on accessibility and comprehensive data integration. Their platforms combine satellite imagery with data from IoT sensors, soil analytics and advanced machine learning algorithms to deliver actionable insights. It is even able to gather accurate data regardless of weather conditions. This emphasis on providing high quality, localized insights sets VITO Remote Sensing apart in this marketplace.

Despite all the strengths that VITO Remote Sensing possesses in the field, they still face significant challenges. The continuous and rapid advancement of EO technologies in conjunction with the probable entry of deep pocketed firms into the earth observation space like SpaceX's Starshield which is although primarily intended for national security matters, would continue to foster an environment that requires constant innovation (Space News 2023).

According to Paolo Minciocchi, the senior vice president of Telespazio the challenge is that SpaceX's founder, Elon Musk possesses significant financial resources which is more than the budget of several EU member states. In addition to this SpaceX receives support from the US Government. He asserts that no single European EO company could handle the market entry of Starshield into the EO space alone. In addition, as questions around data privacy, ownership and accessibility emerge as the use of satellite data becomes more prevalent, VITO Remote Sensing must navigate through these regulatory challenges while ensuring that their offerings are still competitive.

The Case for a Spin- Off

The agricultural team at VITO Remote Sensing has worked hard to successfully develop innovative and ground breaking platforms such as MAPEO, Terrascope and WatchITgrow which

are revolutionizing the industry. But there is a grim reality that Laurent and his team needed to confront- as the demand for these products grow, so did the realization that VITO's current model heavily reliant on grants and public funding could no longer sustain the growth and reach to truly create the environmental and social impact that the team has in mind. The conversations at VITO's agricultural division now shifted from innovation to that of commercialization and with it came a complex question: Can VITO Remote Sensing make changes to its current business model to expand its reach and accessibility? Or should VITO Remote Sensing consider setting up a spin-off to scale its agricultural solutions? And if they do consider setting up a spin-off, what form should it take?

The concept of creating a spin-off is neither new to the space sector nor the parent organization VITO. In the space sector there seems to be a general conception that an increase in the number of spin-offs from the space sector results in positive contributions to future space budgets which in turn leads to more spin-offs being created (Goehlich et al. 2005). NASA has successfully spun-off more than 2000 companies since 1976 for the purpose of using space research and technologies for commercialization (NASA n.d.) and in the last ten years, the European Space Agency (ESA) has spun-off over 150 separate technologies (European Space Agency n.d.).

Over the years, VITO has successfully established spin-offs in its other verticals, which helped transform its groundbreaking research into market ready products. In the year 2023, they managed to successfully spin-off two of their innovations. The agricultural vertical however, presented unique challenges of its own. They would need to navigate the complex and competitive landscape of the EO for precision agriculture market while addressing the demands of the ecosystem of stakeholders ranging from shareholders, the Government, its customers, its employees and the environment.

The case for the creation of a spin-off is quite compelling for the agricultural team as it would result in them being able to attract private investors which would be otherwise inaccessible as it is a primarily grant funded institution (Pearce and Patel 2021). This influx of capital would provide the spin-off with the ability to scale up its solutions and improve its technology readiness levels¹², expand its market reach as well as explore new customer segments¹³. This would allow VITO Remote Sensing to remain true to its core identity as being a research and sustainability driven firm while giving its spin-off the flexibility and agility that would be needed to compete in a highly competitive market such as that of EO for precision agriculture (McKinsey 2022).

As the agricultural team explored the possibility of a spin-off they had two models in mind which was based off their experiences in the other spin-offs created by VITO. The first one was a spin-off by separation model, wherein VITO Remote Sensing would contribute its human, intellectual and financial capital to grow the new entity and the entity would possess the intellectual property (IP) of VITO Remote Sensing's agricultural products. The second model they thought about was the spin-off by licensing model where VITO Remote Sensing would license its products to the new entity which would allow VITO Remote Sensing to still remain in ownership of its core assets while not contributing significant resources to its creation.

Despite the numerous benefits of creating a spin-off, each model of spin-off creation presented its own set of advantages and disadvantages. There were other questions that Laurent and his team needed to grapple with. What kind of governance structures would ensure the strategic alignment between the two entities? How can they manage potential conflicts of interest between their stakeholders such as the trade-off between profitability and ESG goals? These questions were vital

¹² Type of measurement system used to assess the maturity of a technology. There are 9 TRL's, with 1 being the lowest and 9 being the highest.

¹³ For a more detailed analysis of various customer segments in the EO for precision agriculture space, refer to Appendix 6.

since VITO Remote Sensing's reliance on Government funding came with expectations of transparency and accountability.

Ethical, Social and Environmental Implications

As Laurent and the agricultural team were contemplating about the future of their groundbreaking agricultural solutions in the conference room at the headquarters, they were acquainted with the fact that the decisions they make would carry complex ethical, societal and environmental implications. VITO Remote Sensing being a research organization primarily focused on sustainability, navigating the intricate balance between commercialization and ethical, environmental and social implications was not solely a business challenge but rather a moral obligation.

One of the most pressing ethical dilemmas that the agricultural team would face is ensuring equitable access to their technologies while maintaining its financial feasibility. Even though there is freely available high resolution satellite data through platforms like Terrascope, it did not necessarily mean that the key stakeholders especially smallholder farmers have the technical capacity or the resources to process, analyse or interpret this data (York et al. 2023). As a matter of fact, smallholder farmers that form the backbone of the agricultural sector, are the most vulnerable to issues that EO for precision agriculture seems to tackle such as climate change, resource inefficiency and supply chain issues and they are most likely to benefit from the tools that VITO Remote Sensing offers. The prospective spin-off could potentially end up prioritizing high margin markets and customer segments to ensure its financial stability which might leave underserved segments like smallholder farmers unable to access these technologies. Laurent and

his team would need to look at how they can further its commitment to enhanced accessibility while maintaining the profit or financially driven goals of the spin-off.

The second challenge came with that of broader societal implications. Although the use of EO data in agriculture has the potential to tackle humanity's most pressing issues ranging from food security to supply chain traceability to climate change. This technology however useful also has the potential to disrupt traditional practices, displace labour as well as exacerbate inequalities if implemented incorrectly. The technologies could further the divide between resource rich agribusinesses and smallholder farmers. Since farming communities heavily rely on generational knowledge for their livelihoods, an introduction of EO into agriculture could render them obsolete resulting in social unrest (Rijswijk et al. 2021). So although the agricultural team were aware that their platforms could empower a large number of players in the agricultural value chain such as agribusinesses, agro-insurances and Governments, simultaneously the team recognized the need to anticipate and mitigate the unintentional consequences of these disruptions ensuring that their technologies contribute to a more sustainable and inclusive future. A delicate balance needed to be achieved between fostering innovation as well as promoting inclusivity.

The third dilemma came with that of environmental implications. VITO Remote Sensing's agricultural products and services are designed to ensure resource efficiency, reduce waste, and promote sustainable farming practices. All these features make it critical to address agriculture's role in climate change. However if the spin-off's products are inaccessible to resource constrained farmers, these innovative technologies will be unable to reach their complete environmental potential. The agricultural sector is one of the third largest emitters of global greenhouse emissions (World Bank 2024) and one of the main sources of resource depletion worldwide, including water overuse and soil degradation and if VITO Remote Sensing is unable to scale its products

effectively, it could significantly limit its impact for climate change mitigation. The agricultural team also need to ensure that the commercialization of their products does not occur at the cost of environmental progress and climate change mitigation.

Charting a Strategic Path Forward

As Laurent and the rest of the agricultural team look at the future of VITO Remote Sensing's agricultural division, they must navigate a complex set of opportunities, challenges and social, environmental and ethical responsibilities. Scaling its innovative solutions would require a cycle of continuous innovation as well as a commitment to ethical commercialization. Whether VITO Remote Sensing decides to go through with the spin-off or modify its current business model, it is clear that they must strengthen their role in the rapidly evolving EO ecosystem and position itself as a leading provider of EO products and services if they want to be competitive and remain a relevant player in this sector.

Teaching Note

Case Summary

The case study introduces VITO Remote Sensing, a company created with the core purpose of transforming earth observation data into actionable insights to further the sustainability goals. The company specializes in various industries, but its agriculture vertical is the key focus of this case as it contributes to a significant portion of its revenue generation. They offer products ranging from millimeter level resolution plant characterization to the mapping of global agricultural patterns. Their platforms provide reliable data delivery even in adverse weather conditions unlike the current platforms available.

The case presents a strategic dilemma faced by Laurent, the team lead for the agricultural division and his team. The issue they face is how will they commercialize its innovative and groundbreaking products while still maintaining its commitment to knowledge sharing and sustainability as its core mission is heavily rooted in being a research organization. Should they keep with its current structure whilst making changes to its current business model or explore establishing a spin-off whose exclusive focus would be on commercialization? If VITO Remote Sensing does want to establish a spin-off there are other challenges that they would need to grapple it. Should they transfer the intellectual property of their products to the spin-off or license them and what implications would they have? What are the ethical challenges and key stakeholders they would need to consider when they commercialize such technologies which are critical for the future of the agricultural industry? These decisions are crucial because it will shape VITO Remote Sensing's role as a research organization and its ability to scale its solutions while aligning with its core mission as a research organization.

Learning Objectives

The case study was designed with the goal of having an in- class discussion on an emerging industry, space applications for agriculture. Students are expected to understand about the key challenges of commercialization of new technologies in an emerging industry for a primarily grant funded institution. The case study aims to make students familiar with the following:

- Understand the business of utilizing space for downstream applications particularly precision agriculture.
- Examine the various aspects of space economics with emphasis on the use of space technologies for agriculture.

- Identify and evaluate changes in business models and commercialization strategies for VITO Remote Sensing.
- Analyze the ethical, social and environmental challenges associated with the scaling up of industry altering technologies.

The case study is aimed to develop students critical thinking by evaluating commercialization strategies for VITO Remote Sensing considering the industry environment and competitors. It also aims to make students think constructively about the implications of their business decisions on various stakeholders. This case is suitable for courses like strategy, business model innovation, business ethics and corporate social responsibility.

Questions for Discussion

1. The Business of Space for Agriculture: VITO Remote Sensing operates in an emerging field of space applications for agriculture which presents itself with unique opportunities and challenges.
 - a. How does the use of space technologies like earth observation for downstream applications like agriculture change the way the traditional industry operates? List down the opportunities and threats that this up-and-coming field potentially faces.
2. VITO Remote Sensing's Market Positioning and Business Model Innovation: VITO Remote Sensing operates in a competitive field, and it must consider making changes to its current business model to ensure its long-term success and competitiveness.
 - a. There are several players in this space, ranging from well established companies to startups. What is VITO Remote Sensing's current role in the industry and how can they differentiate themselves from the well-established players and startups?

- b. What innovative changes in the current business model could VITO Remote Sensing explore to scale up its solutions while still ensuring accessibility for small-holder farmers?
3. VITO Remote Sensing's Strategy: VITO Remote Sensing must navigate the complexities of scaling their innovative products while maintaining its core mission as a research-driven organization. It must clearly define its strategy going forward.
 - a. How feasible is it for VITO Remote Sensing to create a spin- off? What are the challenges they might face?
 - b. If VITO Remote Sensing does choose to establish a spin- off nevertheless, what implications does a spin- off by separation or licensing have on the spin- off and VITO Remote Sensing?
4. Ethical and Societal Implications: Due to the major influence that VITO Remote Sensing's products have on farmers and the future of the agricultural sector, they face several ethical dilemmas.
 - a. What moral responsibilities do companies like VITO Remote Sensing have to ensure equitable access to their innovative technologies? And how can they manage potential conflicts of interest between prioritizing profit and ensuring equitable access and environmental sustainability?

Teaching Plan

Please note that the composition of the class is variable and should vary based on the focus of the course it is taught in. Courses that focus on topics of Business Model Innovation could emphasize topic III i while disregarding III ii. Courses that focus on Strategy could emphasize topic III ii while briefly talking about topic III i. Courses that focus on Corporate Social Responsibility and

Business Ethics could emphasize topic IV. If both topics seem to be relevant the professor can attribute 20 minutes to each. A regular class of 90 minutes is proposed to be divided as:

- I. Introduction to the downstream applications of space, VITO Remote Sensing, its products and the strategic challenges they face. *(10 min)*
- II. Discussion on The Business of Space: Identify disruptions in traditional agricultural value chains as well as opportunities and threats that EO for precision agriculture faces. *(15 min)*
- III. VITO Remote Sensing's Market Positioning and Strategy:
 - i. VITO Remote Sensing's Market Positioning and Business Model Innovation: Explore the competitive dynamics, identify key differentiators for VITO Remote Sensing and changes in its current business model for ethical commercialization. *(40 min/ 20 min)*
 - ii. VITO Remote Sensing's Strategy and Spin- Off Feasibility: Analysis of spin-off strategies, that is spin-off by licensing and separation and its implications. *(40 min/ 20 min/ 0 min)*
- IV. Brainstorming on the Ethical, Societal and Environmental Implications: Does VITO Remote Sensing have the moral responsibility to ensure equitable access to its products and foster environmental sustainability? How can they balance profitability with ESG concerns? *(10 min)*
- V. Final remarks by the professor. *(5 min)*

Case Analysis

This section provides potential insights that could be included in the in-class discussion of the case study.

1a. The discussion can start with a brainstorming session about how EO for agriculture disrupts the current industry followed by a discussion on the characteristics of the market classified into opportunities and threats. The arguments could include but are not limited to:

Disruptions in the Industry:

- *Transition to Data- Driven Decision Making:* EO provides near real- time, high resolution data on resource availability and environmental conditions enabling a shift from intuition and manual observation to data driven strategies (Puricelli, et al. 2021).
- *Enhanced Operational Efficiency:* EO allows for the automation of monitoring, assessing and maintenance of agricultural plots initially considered to be time and labor intensive (EUSPA 2023).
- *Global Scalability and Accessibility:* Global satellite coverage allows vast tracts of land to be managed and monitored in near real time allowing for monitoring and scaling of operations which were previously logistically and financially infeasible (World Economic Forum 2015).
- *Emergence in Collaborative Ecosystems:* The emergence of EO allows for a collaborative ecosystem of Governments, private companies and research institutes to share data, resources and expertise for global agricultural challenges (ESA 2024).

Table 1: The Opportunities and Threats of Using Earth Observation for Agriculture

	Opportunities	Threats
Earth Observation for Agriculture	- Advancements in Technology: Improvements in big data analytics and AI along with the resolution and reliability of satellite data contributes to the increased growth of this field.	- Knowledge and Skill Gaps: The utilization of EO for agriculture requires specialized knowledge which may be lacking amongst farmers and agribusinesses (Bagheri and Emami 2022).
	- Support from International Policy Initiatives: Policies like the EU Green Deal’s ‘Farm to Fork’ strategy prioritizes sustainable agriculture using technologies like EO (EU n.d.).	- Regulatory Challenges: Concerns about data privacy, ownership and accessibility are becoming significant as these technologies expand (EUSPA 2023).
	- Reduction in Initial Costs of Implementation: Previously the use	

of EO proved to be costly but advancements in the field led to a more affordable cost of implementation (EUSPA 2023). - New Business Models: The creation of new business models like subscription-based platforms or pay per use services allows for increased accessibility.	- Increased Competition: The presence of deep pocketed competitors and innovative startups creates a need for increased differentiation to maintain a competitive edge. - Exacerbation of Inequalities: Careless implementation could result in widening the economic gap between smallholder farmers and rich agribusinesses (Rijswijk, et al. 2021).
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2a. Students can discuss the current role that VITO Remote Sensing plays in the industry followed by potential differentiators keeping in mind the rapid technological pace of the industry and the increased competition from deep pocketed players and innovative startups.

Current Role of VITO Remote Sensing:

- Acts as a data translator, turning raw data into user- friendly platforms and services that provide actionable insights.
- Serves as a research and development leader as it is a hub for cutting edge research on technological advancements and industry applications in EO.
- Acts as a trusted and reputed partner for Governments, NGO's and private entities as well as an advocate for the UN's sustainable development goals.

Potential Differentiators:

- *End to End Integration Across the Value Chain:* VITO Remote Sensing could develop a comprehensive end- to- end solution that integrates data collection, processing, and actionable insights into a singular platform.

- *Flexible Business Models:* Tiered subscription¹⁴, pay-as-you-go¹⁵, freemium¹⁶ or results-based financing models¹⁷ could be introduced as current EO solutions in the market rely on traditional sales models that limit scalability.
- *Commitment to Sustainability and Ethical Practices:* VITO Remote Sensing could position itself as being a leader in sustainable EO practices by maintaining a strong emphasis on ESG goals.
- *Collaboration over Competition:* It could continue to foster collaboration with governments, research institutions and private companies to co-develop innovative solutions as well as agri-businesses and cooperatives to expand the reach of its products.

2b. The current business model could be analyzed using the business model canvas (Osterwalder and Pigneur 2010) and changes could be suggested based on that. The following are the potential alterations that could be suggested:

- *Customer Segments:* VITO Remote Sensing could expand its customer segments to include smallholder farmers since they account for a large portion of the agricultural value chain. They can also expand to agricultural cooperatives and farmers associations.
- *Value Proposition:* They could develop low-cost affordable solutions for smallholder farmers such as a simplified version of WatchITgrow. They could also incorporate sustainability metrics to aid their customers in measuring their environmental footprint.
- *Revenue Streams:* Freemium or tiered subscription models, pay-as-you-go or results-based financing could be explored (Space News 2024).

¹⁴ Allows for affordable pricing for smallholder farmers and premium pricing for rich agribusinesses.

¹⁵ Enables farmers to access VITO Remote Sensing's products during critical stages like harvesting.

¹⁶ The model could offer free basic services for smallholder farmers and charge for extra features.

¹⁷ Fees could be tied to measurable outcomes like yield increase or reduced resource use.

- *Distribution Channels:* Partnerships with local entities and bundles with microfinance institutes could be used to strengthen distribution channels. They could also leverage partnerships with Governments, agricultural cooperatives and NGOs for distribution to smallholder farmers.
- *Cost Structure:* They could use public- private funding models which would leverage grants and partnerships to offset costs for smallholder farmers or open-source technologies to reduce development costs for localized applications.

3a. The feasibility of the spin- off could be analyzed using a balanced scorecard (BSC) (Kaplan and Norton 1996). A discussion on the potential challenges could be done.

Table 2: Feasibility Analysis Using Balanced Scorecard

<i>Perspective</i>	<i>Feasibility</i>	<i>Key Insights</i>
Financial	Moderate	VITO could attract private investments or public- private partnerships for its spin off which would improve its economic value (McKinsey 2022).
Customer	High	The spin- off could address the unmet needs of smallholder farmers and potentially reach agricultural cooperatives and more agribusinesses, agri-insurances and Governments.
Internal Processes Learning and Growth	Moderate	A spin- off could improve the time to market as well as introduce new business models that minimize costs and increase profitability.
	High	A spin- off would allow for greater innovation due to increased agility and focus on commercialization (McKinsey 2022).

The feasibility of the spin-off based on the BSC could be moderate to high.

Challenges of the Spin- Off:

- *Revenue Generation:* If customer adoption is slower than expected, then generating constant revenue streams might prove to be difficult.
- *Initial Capital Requirements:* Developing the infrastructure and workforce for the spin-off requires a high capital investment which VITO Remote Sensing may not have.

- *Market Acceptance:* Customer segments like smallholder farmers may be hesitant to accept these technologies due to trust issues, financial constraints or limited technical knowledge (Bagheri and Emami 2022).
- *Intense Competition:* Since the market is dominated by large players and innovative startups, the market share of the spin-off could be drastically limited unless it is well-differentiated.

3b. The implications of creating a spin-off by separation or licensing can be analyzed using the open innovation theory (Chesbrough, 2003), the arguments could be as follows but are not limited to:

Table 3: Implications for Spin-off by Separation and Licensing using Open Innovation Theory

<i>Aspect</i>	<i>Spin- Off by Separation</i>	<i>Spin- Off by Licensing</i>
<i>Independence</i>	High: Due to full autonomy, the spin-off can adapt to market needs and innovate quickly.	Moderate: Reliance on VITO Remote Sensing's core technologies limits autonomy.
<i>Financial Risk</i>	High: Requires significant initial investment and resources from VITO Remote Sensing.	Low: Avoids major setup costs and revenue is earned via royalties or fees.
<i>Market Responsiveness</i>	High: Market demands can be quickly adapted to without any constraints from VITO Remote Sensing's governance.	Moderate: Reliance on the parental organization might slow down market responsiveness.
<i>Scalability</i>	High: The spin-off can easily attract private investors.	Moderate: Dependence on licensing framework and collaboration with VITO Remote Sensing.
<i>Governance Complexity</i>	Low: The governance is simplified so the spin-off operates independently.	High: Supervision on compliance with licensing agreement and mission alignment is needed.

4a. From an ethical perspective, Laurent and his team need to consider the consequences of their decision as they can impact a variety of stakeholders and the future of the planet Earth. A plethora of theories can be brought forward to justify VITO Remote Sensing's moral responsibilities. The following two theories can be used to justify their moral imperative to ensure equitable access to their products:

- *Utilitarianism:* The key idea of this theory is that actions are ethical if they produce happiness for the greatest amount of people (Mill, 1861). In the context of VITO Remote

Sensing, they should ensure that their products are accessible to a variety of stakeholders including farmers who are often marginalized. Prioritizing accessibility can ensure widespread social benefits such as improved crop yields and decreased use of resources which could contribute to an improvement in the quality of life of farmers in addition to conserving the environment.

- *Rawls' Theory of Justice*: The theory states that inequalities are permissible only when they benefit the least advantaged members of society (Rawls, 1999). This implies that VITO Remote Sensing has a moral obligation to choose business models that do not exclude vulnerable farmers as ensuring equitable access aligns with the idea of distributive justice which in turn promotes fairness in the agricultural sector (Wasowski, 1991).

A further in- class discussion can take place using the utilitarian theory as it is one of the most prominently applied ethical theories. A discussion could also take place of the social, environmental and economic consequences of their decision to commercialize.

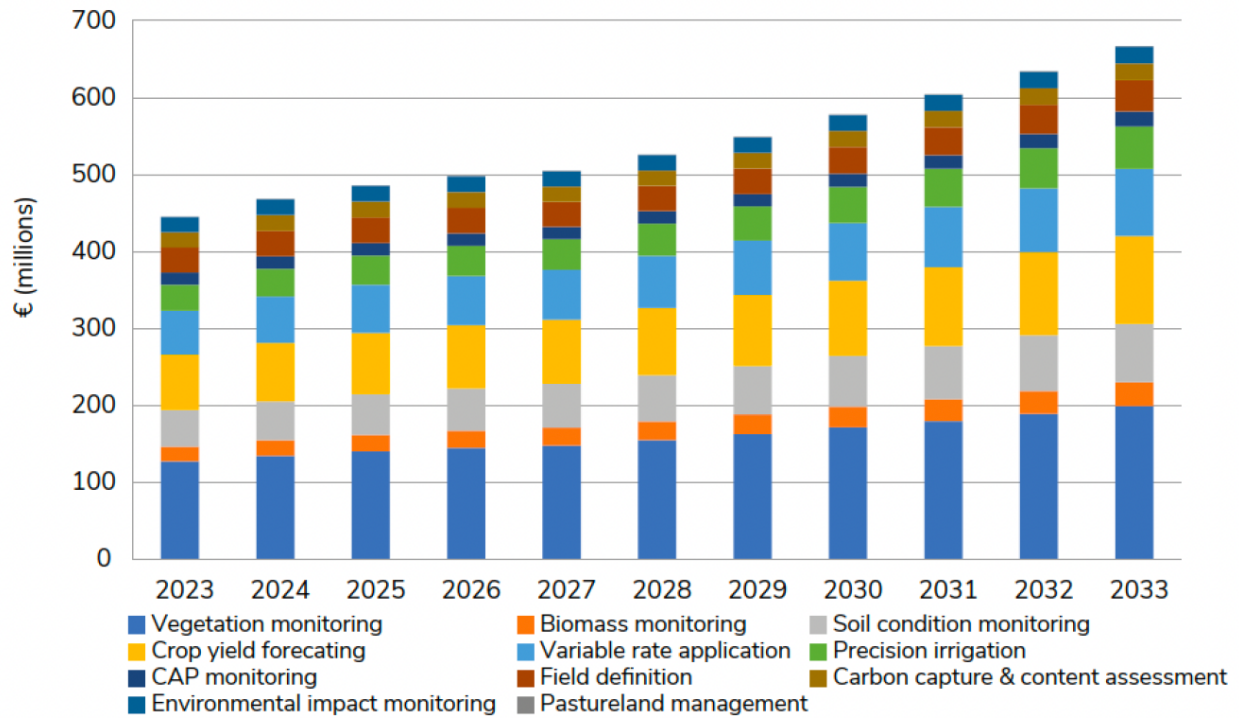
The classical stakeholder theory proposed by Freeman (Freeman, 1984), states that companies must aim to provide value for not just shareholders but all stakeholders.

Table 4: List of Stakeholders, their Interests, Potential Conflicts and Strategies for Mitigation

<i>Stakeholder</i>	<i>Interests</i>	<i>Potential Conflicts</i>	<i>Mitigation Strategies</i>
<i>Smallholder Farmers</i>	Affordable access to precision agriculture tools.	High initial costs and limited financial resources could hinder them.	Implement tiered pricing models or partner with NGOs for financial support.
<i>Agri-businesses</i>	High- performance, reliable solutions for operational efficiency.	Focus on them could lead to neglecting smallholder farmers.	Use revenues from this segment to cross-subsidize affordable solutions for farmers.
<i>Governments</i>	Equitable access for marginalized farmers and sustainability focused development.	Potential conflict if profitability goals overshadow social ones.	Collaborate on programs that help reach underserved farmers.
<i>Shareholders</i>	Profitability and enhanced return on investment.	Incentive to prioritize profits over ESG goals.	Communicate long term value of ESG initiatives and associate ESG KPI's with financial KPI's.

Supplementary Material

Appendix 1: Predicted Revenue from Earth Observation Data and Services by Application



Source: EUSPA 2024

Appendix 2: Key Events in the History of the Agricultural Division of VITO Remote

Sensing

Year	Event
1991	Creation of the Flemish Institute for Technological Research or Vlaamse Instelling voor Technologisch Onderzoek (VITO).
1998	Setting up of the remote sensing division of VITO. Creation of the agricultural vertical as part of the EU MARS initiative.
2016	Launch of the platform Terrascope for satellite data access.

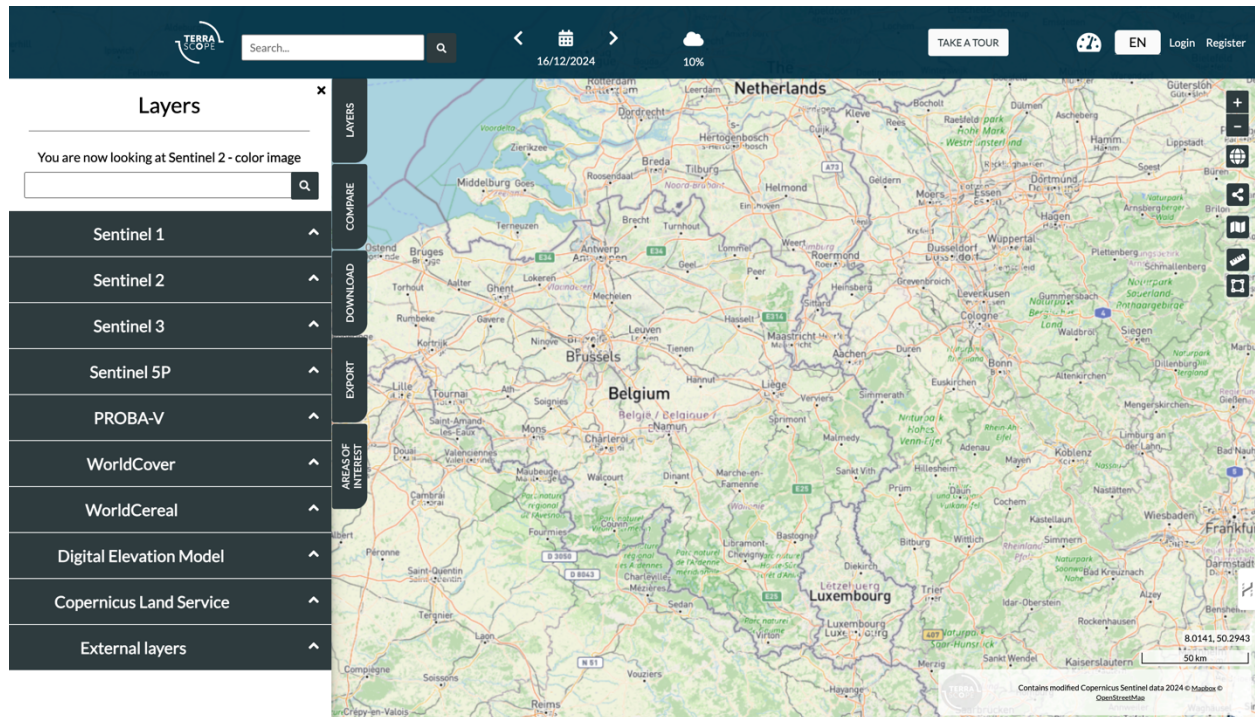
2018

WatchITgrow was launched to support farmers and agribusinesses.

2020

MAPEO was introduced as a platform for crop phenotyping.

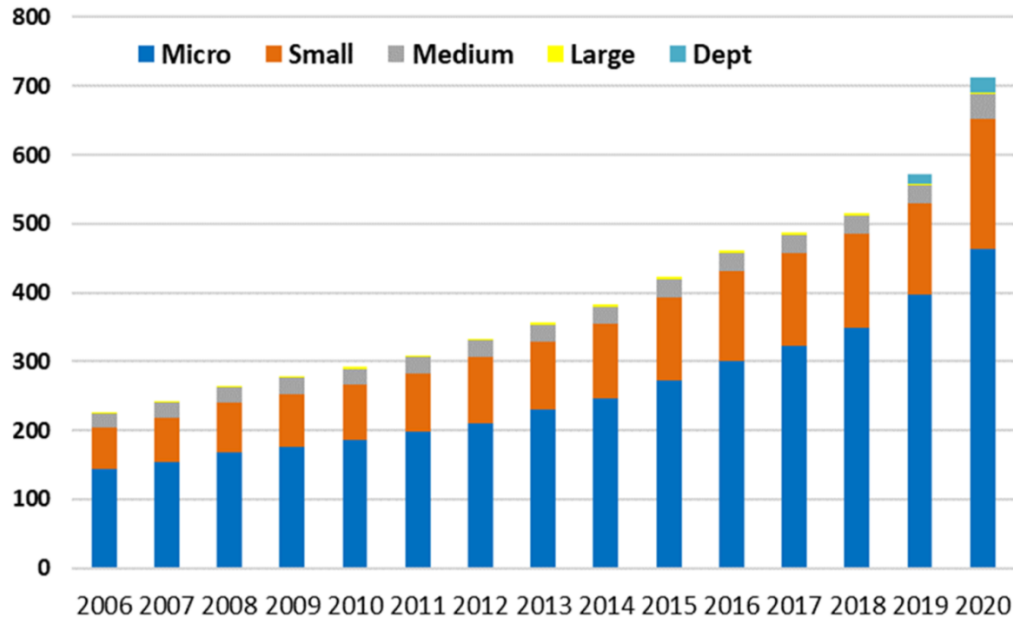
Appendix 3: User Interface of Terrascope



Source: VITO, Terrascope: Unlock the Potential of Satellite Data n.d.

Appendix 4: Evolution of the Number of Earth Observation Companies in Europe

According to Company Class



Source: Oligschläger 2022

Dept refers to businesses selling earth observation services as part of a larger offering.

Appendix 5: Competitors Of Vito Remote Sensing and their Key Offerings and Gaps

Company	Offerings	Gaps
Airbus intelligence	Its Farmstar platform provides high resolution satellite imagery along with geospatial data analytics for precision farming. It can be integrated with farming equipment which enables variable rate application of fertilizers and crop protection products.	There could be restricted adoption for farmers that are financially constrained due to its reliance on high-tech farming equipment.
e- Geos	The platform provides personalized agricultural solutions by combining geo- spatial information with big data analytics and AI.	There could be concerns regarding data privacy and security because of cloud processing and automation.

	It is able to handle vast amounts of data because of automation and cloud processing.	
DigiFarm	DigiFarm utilizes neural network models and high resolution satellite imagery to deliver accurate field boundary detection and acreage assessments. It can integrate with existing farm management systems and offer tools for crop health monitoring, input management and yield forecasting.	The availability of high quality data is quintessential to using neural network models and without it, the model could prove to have a larger field of error.
EOS Data Analytics	Its crop monitoring platform integrates data from satellite images, soil data and weather patterns into a comprehensive farm management solution. Its main claim is that it is easy its interface accessible and easy to use for both smallholder farmers and enterprises alike.	Lack of advanced customization for large-scale enterprise farmers.

Appendix 6: List of Main User Communities for EO Products and Services for Agriculture and their Demands

Customer Segment	Uses
Governments, National and Regional Agricultural Government Agencies, Environmental Agencies	Use EO for monitoring and managing agricultural activity, enforcing regulations and for support of certain policy decisions.
International Agencies and Organizations Advocating for Environmental Protection	Use EO for monitoring land use changes and for advocating sustainable farming practices.

Farmers, Cooperatives	Use EO for crop monitoring and data driven decision making for yield forecasting and resource optimization.
Crop Traders	Use EO to assess the financial feasibility of agricultural projects and this lending and investment decisions easier for them.
Insurance Companies	Use EO to monitor crop health, yield predictions as well as damage assessments for insurance claims which helps effectively manage risks for farmers and insurers.

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