The use of remote sensing: complex regulation and economic feasibility

François Christiaens

Drivers

Need	Causes	Benefits from remote sensing	1-2 y	3-4 y
Increasing yields	• Increasing global population + improving living standard → higher food demand • Decreasing cultivated area / person + yields levelling off	Use cases feedbacks: +5 to 10%, up to +15% yield increase	+++	+++
Crop scouting	Decline (workforce, average age) + larger average farm sizes	Time and cost (energy) savings Objective, shared information	+++	+++
Inputs delivered as precision ag	Increasing input prices Risks for farmers	Prescription maps + VRA = cost savings Spraying by drones, a 3D task	+++	+++
Services	Limited capacity to invest (most farmers)	OPEX vs. CAPEX Equipment coops	+++	+++

Drivers (continued)

Need	Causes	Benefits from remote sensing	1-2 y	3-4 y
Regulation	Risks due to flying objects	Lower qualifications required for drone pilots	++	++
Environment preservation	Soil erosion and overfertilisation (e.g. Nitrate Directive)	Optimizing inputs intake and waste	++	++
Water resources: extended areas and longer hydric stress periods; Pests monitoring	Climate change	Long time series	+	++
Food traceability + food safety + *reputation* (territories)	Consumers use transparency as a proxy for confidence	Certification by an independent authority (incl. blockchain)	+	++

Drivers (continued)

Need	Solutions	Benefits from remote sensing	1-2 y	3-4 y
Low prices, high-tech techniques	Satellites and drones = spill-over market	• Sensors and first-level analysis already written off and optimized (size, energy consumption) • Agri: Low equipment rate → open ground	++	++
Quick financial compensations	Parametric insurance	Enable automatic triggering	++	+++
Implementation of agro-ecological practices	Public policy for agro-ecology transition	Measured results required by CAP part 3	+	++
Resolve the bottleneck	High-throughput phenology	Operational tools for seed producers	++	++

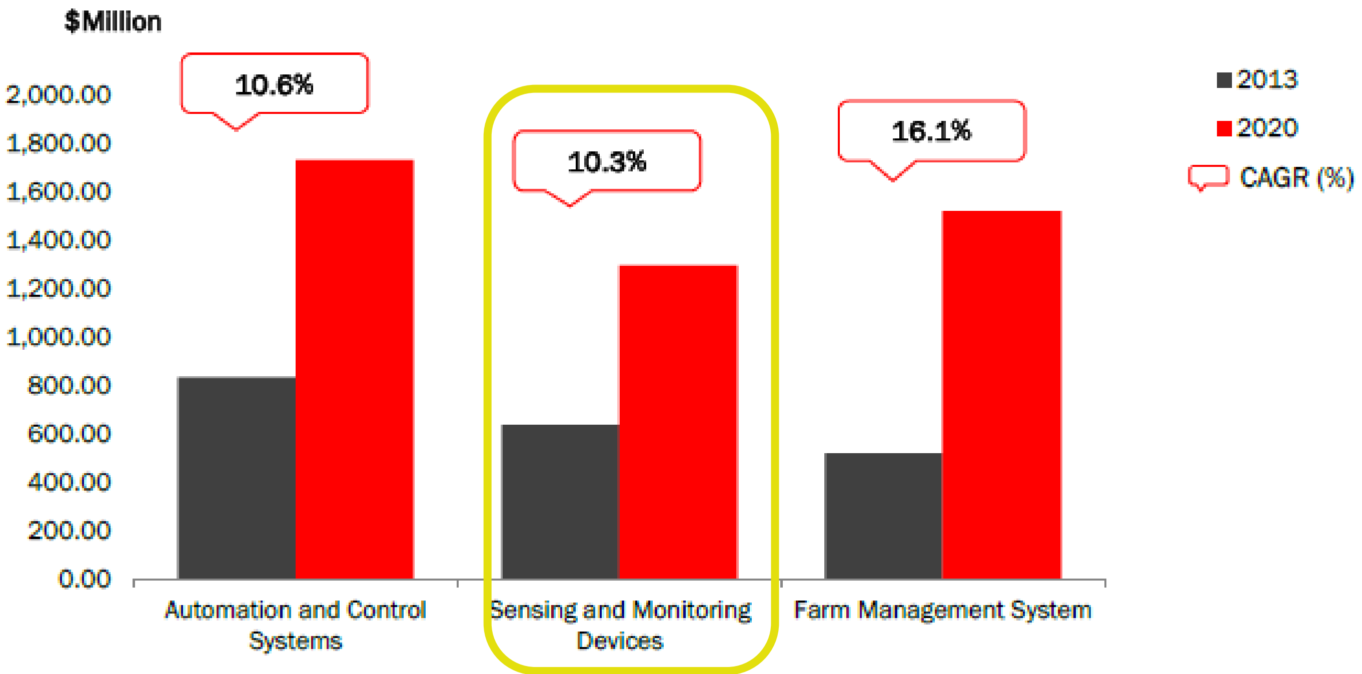
Restraints

Need	Causes	Problems for remote sensing	1-2 y	3-4 y
ROI	• Farmers' low income • Lessons learned from studying high-resolution imagery of one crop are not necessarily transferrable to other crops	Difficult to calculate New business models required	+++	+++
Monitor large areas + low cost flight	Regulation: Beyond Visual Line of Sight + low altitude	→ Pilot → €	+++	+++
Crop information	Competing technologies: IoT (sensors, robots, tractors)	All-weather, constant collect	++	+

Restraints (continued)

Need	Causes	Problems for remote sensing	1-2 y	3-4 y
Actionable information	New skills required	Translate aerial imagery Interoperability	+++	++
Understand the technology	Farmers: Change reluctance	Data are non-material deliverable	++	+
Variable rate application	• Variable rate application equipment availability • How-to use • Regulations	Prescription maps are almost useless without VRA	+++	++
Data value: fair share		Data property: debate	+	++

Precision agriculture markets: poised to a steady growth



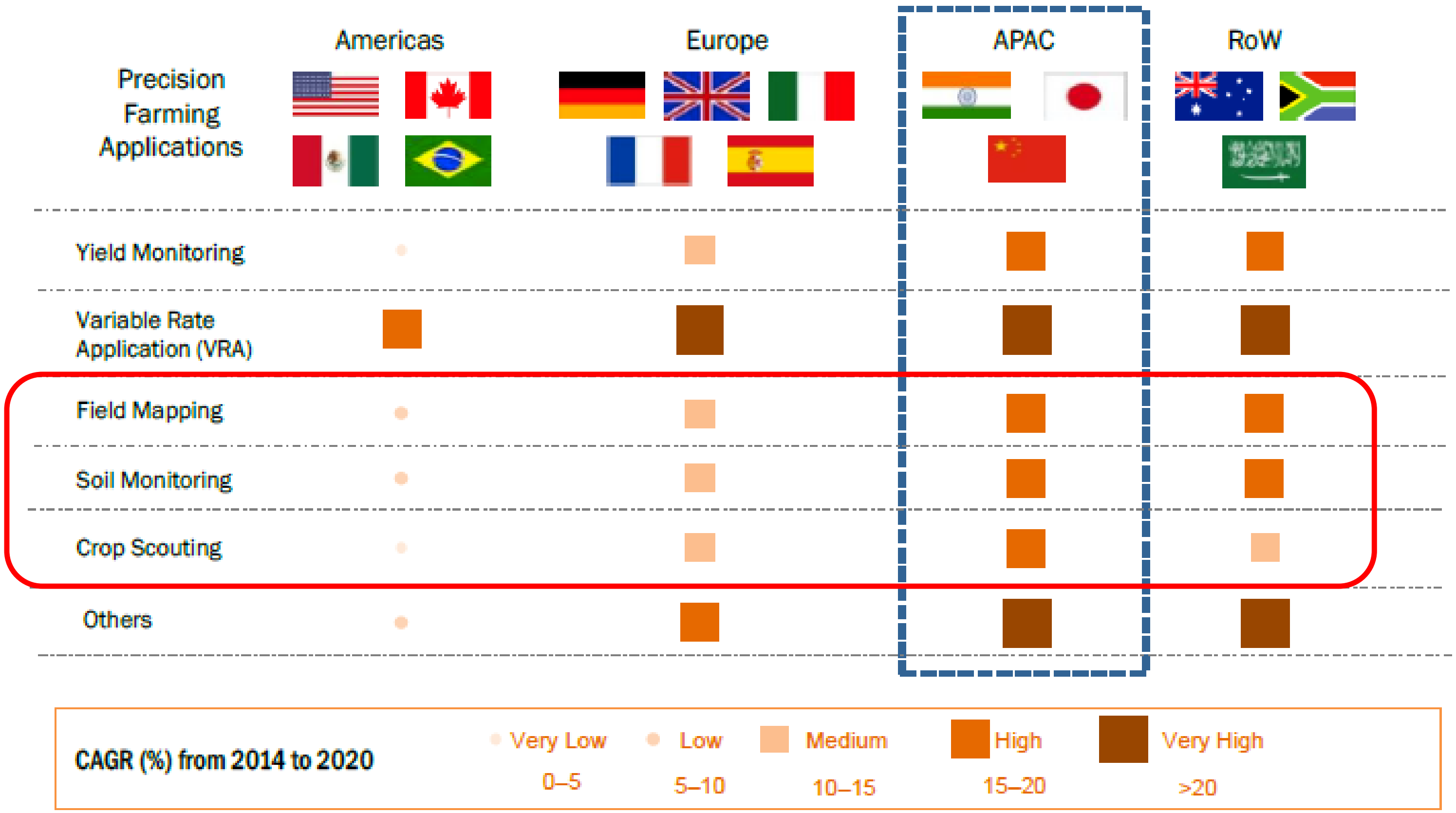
Precision Farming Market – Global Forecasts to 2020. MarketsandMarkets, 2014

Remote sensing is one of the key enabling technology.

The European market is estimated at 317 M$ in 2020.

Agricultural drones:
294 - 434 M$ (2016)
1400-5000 M$ (2025) – CAGR between 20% and 38%!

Variable rate application market to grow, then remote sensing applications



Source: International Society for Precision Agriculture (ISPA) (U.S.), Precision Agriculture Research Association (PARA) (U.S.), Precision Ag Institute (U.S.), SPAA Precision Agriculture (Australia), Press Releases, Magazines, Investor Presentations, Expert Interviews, and MarketsandMarkets Analysis

Smart Agriculture-enabling Technologies—Decision Support Matrix

- The below set of smart agriculture-enabling technologies has been identified by Frost & Sullivan's Visionary Innovation Research team as disruptive technologies in the agricultural sector for the future.
- The Decision Support Matrix is based on ranking opportunities on level of attractiveness across different applications/criteria.

Smart Agriculture Technology Market: Food & Agriculture Bioeconomy and Generalized Value Chain, Global, 2015

Application/Criteria	Potential Addressable Market	Speed of Adoption	Likelihood of Occurring	Impact on Food & Agriculture Value Chain	Maturity of Technology	Impact on Farmers' Earnings	Grid Score
Agriculture Drones	High	High	High	Medium High	High	Medium High	6.3
Sensor Fusion	High	High	Medium	High	High	High	6.0
Farm Management Solutions	Medium	Very High	Medium High	High	Medium High	High	5.5
Cellulosic Conversion Technologies	Very High	Medium	Very High	Low	Medium High	High	5.2
Variable Rate Technology	Very High	Medium	Very High	Low	High	High	5.3
HSI	Medium	High	High	Medium	Low	Medium	4.5
Smart Water Management Solutions	Medium	Medium	Medium	Medium	Medium High	High	4.5
Autonomous Farming	Medium	Medium	Medium	Low	Low	High	3.7
Aeroponics	Low	Very High	Medium	Medium Low	High	Medium	4.3
Hydroponics/ Aquaponics	Medium Low	Very High	Medium	Medium Low	Very High	Medium	4.7
Controlled Traffic Farming	Very Low	Medium	High	Very Low	High	Medium	3.7

Based on a review of the aforementioned attractiveness criteria, the challenges faced by the agricultural sector today will be addressed tomorrow with agricultural drones, sensor fusion, and variable rate technologies, all of which will be managed with state-of-the-art farm management solutions.

Source: Frost & Sullivan

Business models for drones services

« Drones as a Service »	« Data as a Service »	« Process as a Service »

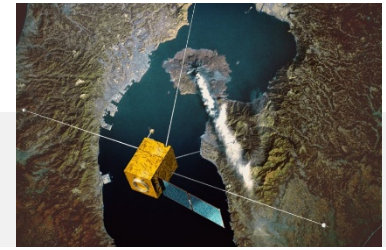
• Drone operators and sensor makers → farmers, cooperatives, seeds producers
• Subscription = equipment + maintenance + upgrades
• Relevant business model:
  • Complex sensor (imager / embarked)
  • Infrequent use
	• Cooperatives, traders in commodities, equipment manufacturers, → farmers, dealers, seeds producers, insurance providers
	• Also sold to suppliers (input makers) or to other partners (equipment manufacturers, agricultural contractors…)
		• Agricultural advisers, decision-making tools developers, sensor makers, equipment manufacturers → farmers, cooperatives, seeds producers…
		• Personalized advice on how to manage crops.
		• CAPEX → OPEX

Key takeaway findings

Drones

- Benefits exceed drawbacks
- Low negotiation power from suppliers
- Regulation "has its foot on the oxygen tube"
- Trends, needing R&D
  - Autonomous flights (cost)
  - Enhanced endurance
  - Spraying + heavy payloads (3D)
  - Swarms

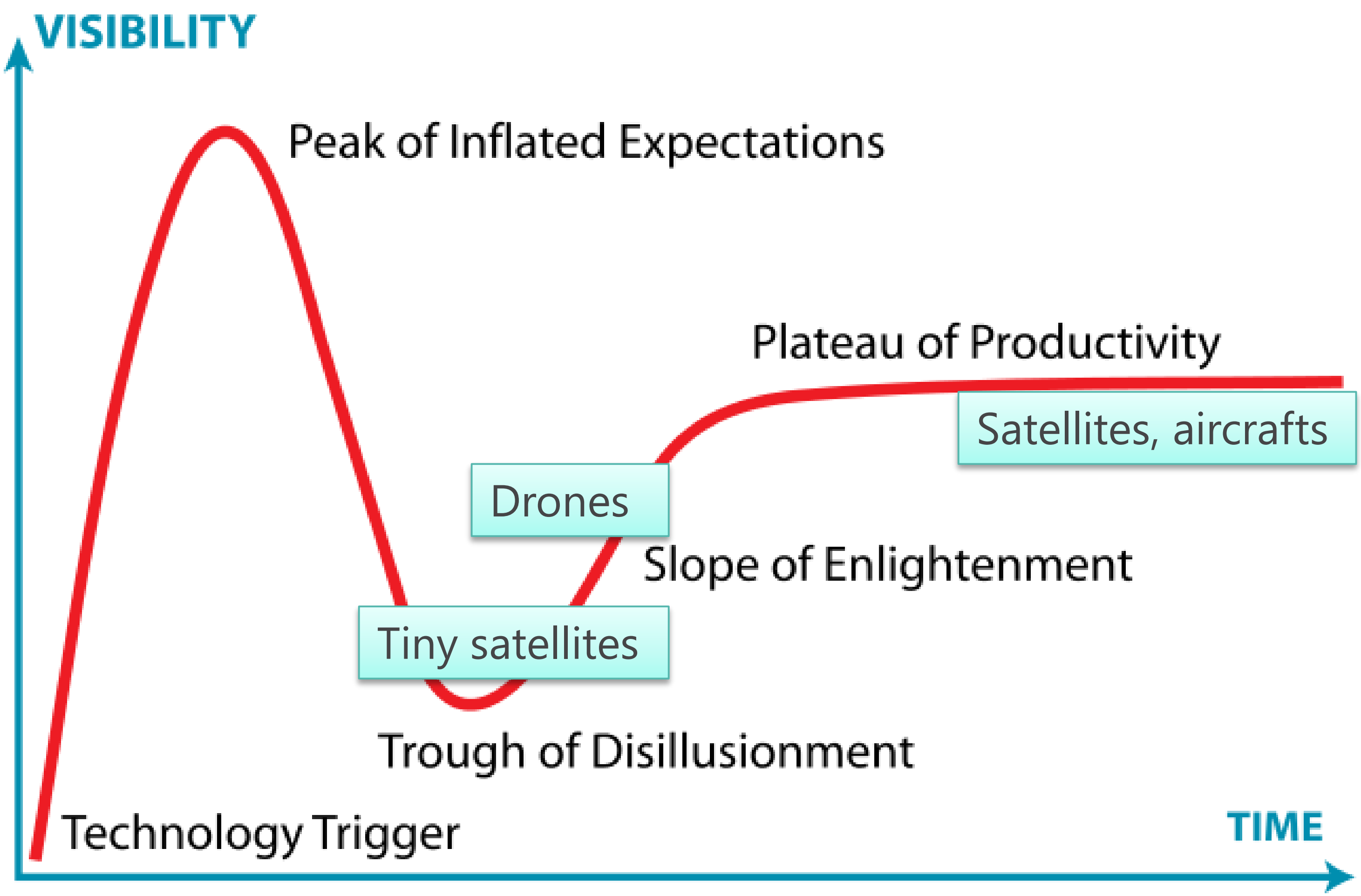
Satellites



- The classic, heavy payloads are here to stay for the 5 years to come (80% turnover).
- Miniature satellites
  - Integration of several links of the value chain + business partnership with existing data reseller networks
  - Much cheaper satellites
  - Much higher revisit rate
  - Lower satellites lifetime
  - More complex data processing
  - PoC: OK; PoP?
- Space data resellers now cope with a free and more abundant offer, thanks to public procurement (see Copernicus)

AI vs. agronomic models…

Remote sensing for agriculture: reaching maturity



Evolution of drone technology for agriculture

Wide-scale use of drones for precision agriculture will progress as research, regulations, and commodity prices improve.

Early 1990s -Now

Introduction

- Research and testing
- Identify/develop use cases
- Uncertain global regulatory environment
- Unique use cases (Japan)

2016+

Growth

- Research and testing
- Ensure collection of science-grade data
- Develop focused agriculture software
- Turnkey solutions
- Improving regulations
- Repeatable operations

2018/2019

Assimilation

- Starting to scale
- BVLOS* testing
- Adoption by co-ops
- Increased focus on integrating drones with other data gathering devices as a network
- Reactive data mainly based on historical, or lagging, indicators
- Commodity prices start to recover

2020–2025

Maturity

- Fully automated
- Full integration with automated farm equipment, manned aircraft, and ground sensors
- BVLOS operations
- Unmanned traffic management system
- Predictive data based on artificial intelligence and other leading indicators
- Continuous improvement
- Increase in agriculture technology investments

*Beyond visual line of sight

Source: Frost & Sullivan

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