Agricultural Machines in 2045: tractors of the future or futures of the tractor? A Future Studies approach

Mosé Tosin, Davide Rizzo

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Who are we?

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Summary

1. Future Studies: an introduction
2. Strategic Interviews: “7 Questions” technique
3. Interview analysis: key topics
4. Summary and conclusions

01

Future Studies: an introduction

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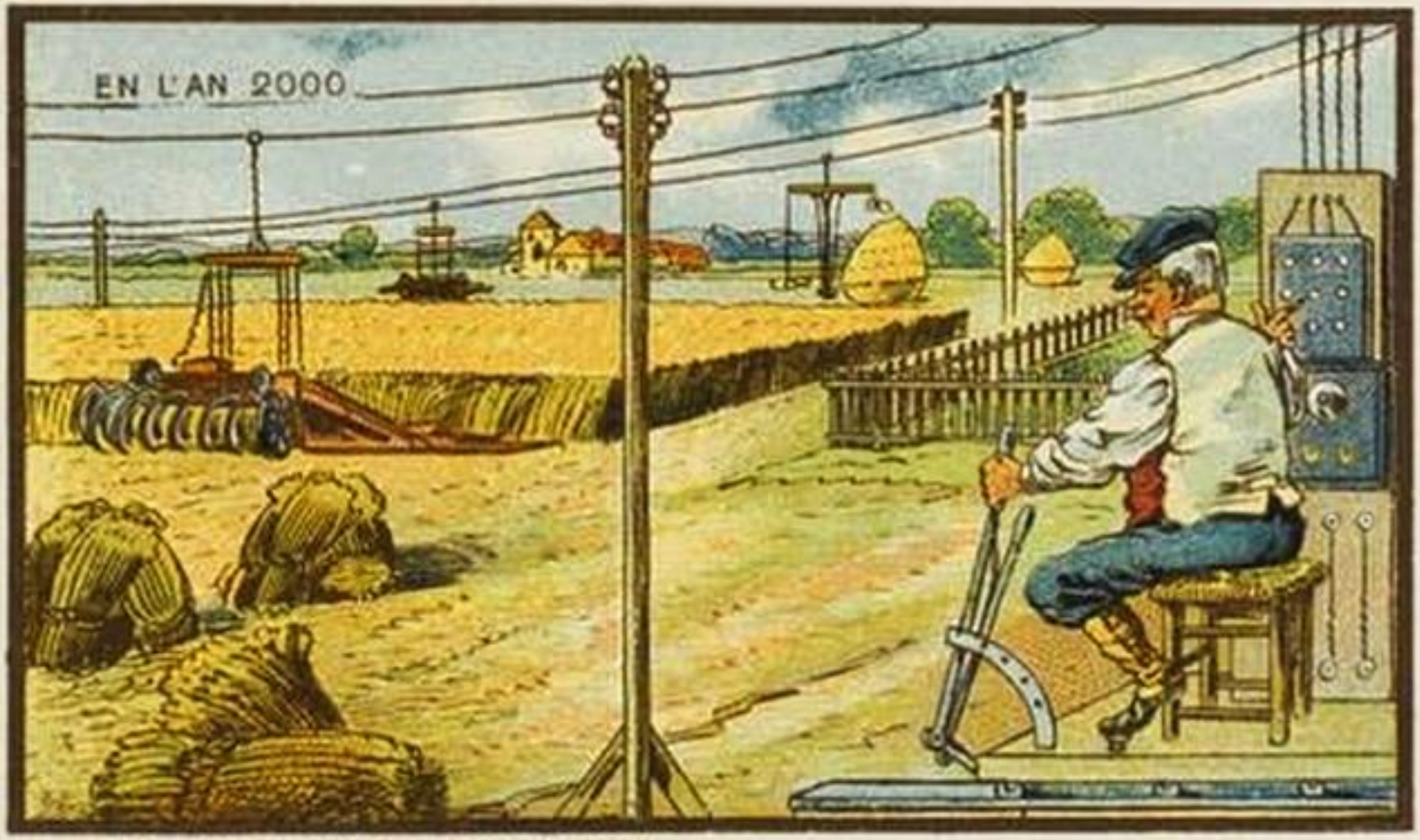


Un Agriculteur très occupé | **A very busy farmer** *Jean-Marc Côté, 1900*

1900

- Electrification
- Wired devices
- Innovative machines

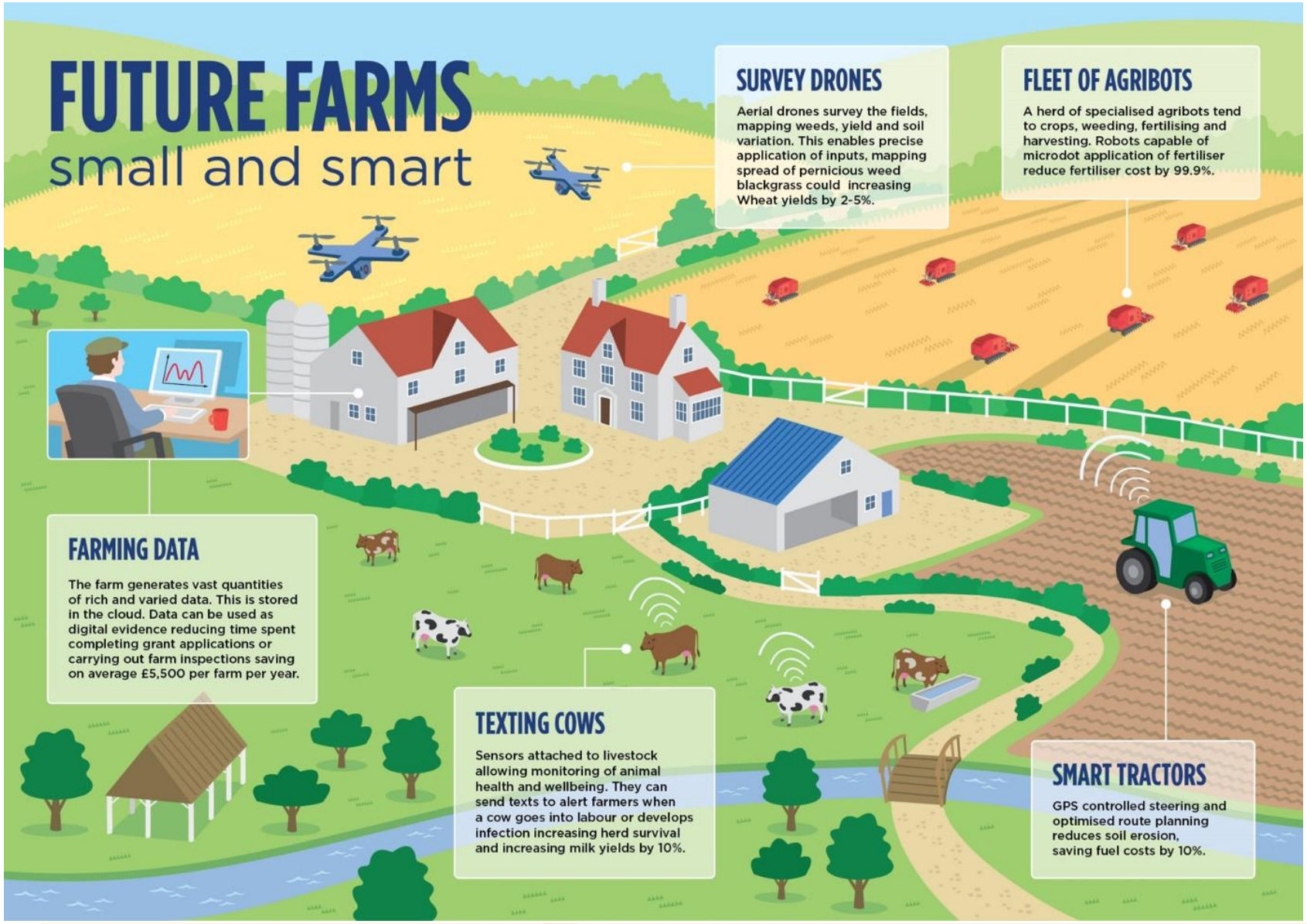
- Monocropping

- Remote control

…and a farmer with a hat out in the field

1900's postcard from a series of futuristic pictures by Jean-Marc Côté came to light after Isaac Asimov (1986) in "Futuredays: A Nineteenth Century Vision of the Year 2000".

https://publicdomainreview.org/collections/france-in-the-year-2000-1899-1910/



2015

- Smart tractors
- Survey drones
- Fleet of agribots
- Connected livestock

- Mixed cropping

- Remote control

…and a farmer with a hat inside an office

Nesta. ‘Precision Agriculture’. Futurescoping. Nesta, 2015. https://www.nesta.org.uk/feature/precision-agriculture/

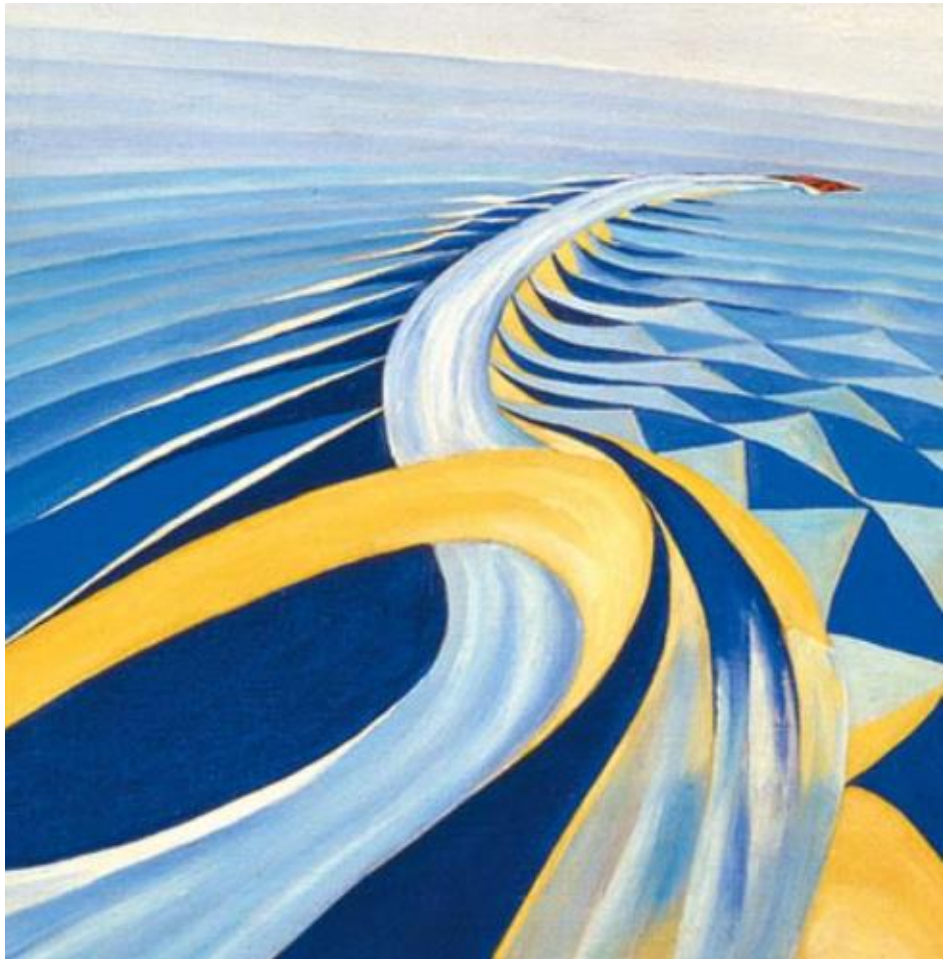
Future Studies

“An interdisciplinary field that aggregates and analyzes trends, with both lay and professional methods, to compose possible futures. It includes analyzing the sources, patterns, and causes of change and stability in an attempt to develop foresight.”

https://en.wikipedia.org/wiki/Futures_studies

“In our complex world, the global challenges we face require more inclusive and agile approaches to policy design and decision-making. Rooted in the discipline of anticipation, Futures Literacy can improve our capacity to shape policies and systems that withstand shocks and create long-term resilience.”

https://www.unesco.org/en/futures-literacy



Benedetta Cappa Marinetti, Speeding Motorboat (*Velocità di motoscafo*), 1923-24 (detail)

See also: Rohrbeck, R., Battistella , C., & Huizingh, E. (2015). Corporate foresight: An emerging field with a rich tradition. TFSC, 101(12), 1-9. https://doi.org/10.1016/j.techfore.2015.11.002

02

Strategic Interviews: “7 Questions” technique

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Strategic Interviews – “7 Questions” technique

What it is:

- Approach developed by Shell as part of its Scenario Planning exercises
- Structured interview approach to get strategic insights from different stakeholders
- By design, questions are not requesting to think chronologically
- Ideally, interviewees are familiar with the topic, however with diverse background and expectations

What it delivers:

- Suggests critical topics to be further explored in the foresight exercise
- Highlight conflicting views and positions
- Raise awareness of possible solutions
- No ranking nor statistical analysis
- Provide input for other exercises (e.g. Scenario Planning or Anticipatory Risk Management)

Government Office for Science (2024). The Futures Toolkit. GO-Science Futures resources. London UK. https://www.gov.uk/government/publications/futures-toolkit-for-policy-makers-and-analysts

Strategic Interviews – “7 Questions” technique

Focus area of each question:

1) **Critical issues**
   If you could know the future of this topic in X years, what would you like to know first?
2) **Favourable outcome**
   If everything goes well, how do you see the future related to this topic?
3) **Unfavourable outcome**
   What could happen if things were not going as desired?
4) **Key changes**
   What should be changed to achieve the desirable future described?
5) **Lessons from the past**
   Looking back in the past X years, what positive or negative factors impacted this topic as we know it today?
6) **Priorities**
   What is the priority to be done now, in order to achieve the desirable future?
7) **Limitations**
   Free from all constraints, what would you do differently or more?

Government Office for Science (2024). The Futures Toolkit. GO-Science Futures resources. London UK. https://www.gov.uk/government/publications/futures-toolkit-for-policy-makers-and-analysts

Strategic Interviews – “7 Questions” technique

Our panel: 18 interviews

- **6 European nationalities**

- **4 machinery manufacturers** groups and interviewees representing **7 brands**

- **4 employment sectors**:
  - Academy
  - Machinery manufacturers
  - Farmers
  - Start-up / IT

- **4 Profiles** within machinery manufacturers:
  - Brand general manager
  - Marketing and product management
  - Research & Development
  - Sales

Strategic Interviews – “7 Questions” technique

Answers and comments have been reviewed and classified in five groups, in accordance with the process defined by the “Strategic Interviews” methodology:

Worries Map

Fundamental areas of concern, which are perceived as drivers for future states, however not sufficiently taken into account in current proposed solutions

Pole of risk

Limitations or threats emerging from anticipated future states, alternative options without clear direction

Uncertainties map

Explorations or wild cards with disrupting potential

Perimeter of priorities

What is perceived as most urgent and relevant

Futures poles

Ideal: how interviewees describe ideal states
Dystopic: how interviewees describe worst expected outcomes

Strategic Interviews – “7 Questions” technique

Answers in each group have been classified in three clusters, based on the stakeholder which would perceive the most significant change/impact:

Farmers, consumers, and society

Machinery and OEM

Agronomy and the Environment

03

Interview analysis: key topics

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Key Topics

- Energy/Fuel transition and autonomous machines
- Farming, labour and future agricultures
- Agriculture: systemic view
- Farmers income, profitability, machines cost
- Pollution, sustainability, rules and society
- Connectivity, AI (Artificial Intelligence) and Big Data
- Value Chain: production, distribution, competitive landscape

Energy/Fuel transition and (autonomous) machines

Energy transition:

- Paradigm shift confirmed; new regulations anticipated.
- No preferred solution; need for a clear roadmap on emissions/energy standards.
- Focus on resiliency: farm-based energy production

Autonomous machines:

- Full autonomy is a future possibility, but not a priority (a "necessary evil" for labor shortages).
- Farmers want machines to remain controllable
- Preference for smaller, versatile machines over complex large tractors
- Soil compaction is a key concern

« If the machines drives in the field autonomously, what will I do? »

« Autonomous machines mean that there will be no more people needed in our villages »

Quotes from the interviews

Farming, labour and future agricultures

Labour and farming:

- Farmers need broader skills (agronomy, management).
- Automation won’t fully replace unskilled labor due to costs and peak demands.
- Attracting skilled workers is hard; focus on safety, comfort, and simple interfaces.

Future agricultures:

- More focus on agronomy and precision farming.
- Need for consolidation to manage costs and access skills.
- Growth of niche emerging systems (e.g., vertical farming, hydroponics) offers diversification.

« Farms were used to be managed by the son with most manual attitude. More educated siblings were leaving the farm… this is already not a successful choice today, it will be even less in the future »

« In the past, agronomic choices were driven by machines availability: larger ones were needed to increase productivity on larger plots »

Quotes from the interviews

Agriculture: systemic view

Participants across sectors (farmers, academia, suppliers) agree on the need for a **systemic approach**.

No single solution is expected; diverse options are needed:

- Smaller machines and plots (e.g., pixel farming, patch cropping).
- Greater diversification and reduced soil compaction.

Digitalization (big Data, AI) and Precision Farming:

- Enhanced transparency in decisions and resource allocation.
- Improved decision-making with data-driven insights.
- New farming methods.

More integration and exchanges needed… most interviewees complained about lack of communication and interaction with other stakeholders

« AI has a huge potential and poses big threat: will agriculture become a black box, just following AI recommandation without knowing what is behind and which bias it includes?»

Quotes from the interviews

Farmers income, profitability, machines cost

Consolidation and collaboration

- Farms need to integrate more processes to avoid commoditization.
- Pooling talents and machines to increase efficiency and improve needs coverage
- Higher utilization may favor specialized machines over multi-purpose tractors
- Individual farms struggle to afford new technologies

Machines becoming more complex:

- Increasing complexity raises costs, self-maintenance, and difficulty for seasonal workers
- Simpler machines preferred; complexity often unecessary

Desirable futures:

- Basic, upgradeable machines and reconditioned models for flexibility

Recurring themes:

- Modularity
- Personalization
- Simplification
- (Self-)Maintenance
- Reliability
- Payback

Pollution, sustainability, rules and society

Sutainability: **here to stay** according to most interviewees

- Wrong understanding of farming by the general public, viewed as polluting
- New techniques, products or certifications perceived as inherently good (e.g. organic)

Regulations:

- Stricter CO2 and phytochemical limits will increase machinery costs.
- Carbon markets may offer new revenue.
- Precision farming and electric solutions are expected to grow.
- Future machines will differ significantly in design.

Autonomous Driving:

- Clear road rules, insurance, and remote control are necessary for autonomy.

Quotes from the interviews

« Politicians are taking decisions in the field of energy or chemicals restrictions not based on scientific evidence, onlyt to please the general public, making it more difficult and expensive to produce machines and eventually to farm »

« In Europe machines will have to drive on public roads, without clear regulations on this and insurance contracts, autonomous vehicles cannot be a viable option »

Connectivity, AI (Artificial Intelligence) and Big Data

Connectivity and harmonization: how data is

- collected and transferred: implement ↔ tractor ↔ positioning
- processed by the tractor
- transferred to the management system
- used to improve the next round of planting/harvesting

Multi-machines communication:

- More machines working on the same activity/plot (e.g. tractor, robots, drone) need to exchange data in real time and effectively
- *Standard* required for easy data exchange and elaboration (hardware/signal and data/software)

Traceability:

- Blockchain to certify production methods/techniques
- Proprietary vs open source vs government imposed

Artificial Intelligance:

- Can use of AI change *radically* the way we farm today?
- Will AI only bring *marginal gains*?
- AI requires data sharing to be effective
  - The more *data* is shared, the more it can bring results
  - The more *data* is shared, the more valuable it becomes
  - Who will manage, own and store *data*? Risk of concentration?

Quotes from the interviews

« Producers of implements are typically smaller companies in a more fragmented market compared to tractor producers, there is time-lag between new technologies are made available on a tractor and how these can be exploited by the implement »

« Farmers are already feeling ripped off, data revolution should not be adding on this, rather give the opportunity to be part of this transition and benefit from it »

Value Chain: production, distribution, competitive landscape

Impact of sustainability/social responsibility:

- Machines *durability*, self-repair, *simpler* and *upgrade-ready* machines

Cost of switching to new machines/technologies:

- Consolidation and innovative financing (renting, subcontracting) to mitigate risks.
- Risk-sharing models between producers and farmers

New entrants in the market of agricultural machines (focus on tractors):

- Modular and specialized solutions from new market players (including startups and non-traditional manufacturers).
- Tractors may no longer be central to farm investments, becoming just one part of a broader system.

Quotes from the interviews

« It might happen that managament of the farm is retained, this can be done in parallel with other activities, most operations are externalized to specialized companies »

« Why should tractors continue to be the main investment? We should be looking at the whole process: who can offer the best solution to farmers? »

« New technologies and solutions need to allow for a better income allocation across the chain, farmers will be looking to get a larger share, today it is too small »

04

Summary & Conclusions

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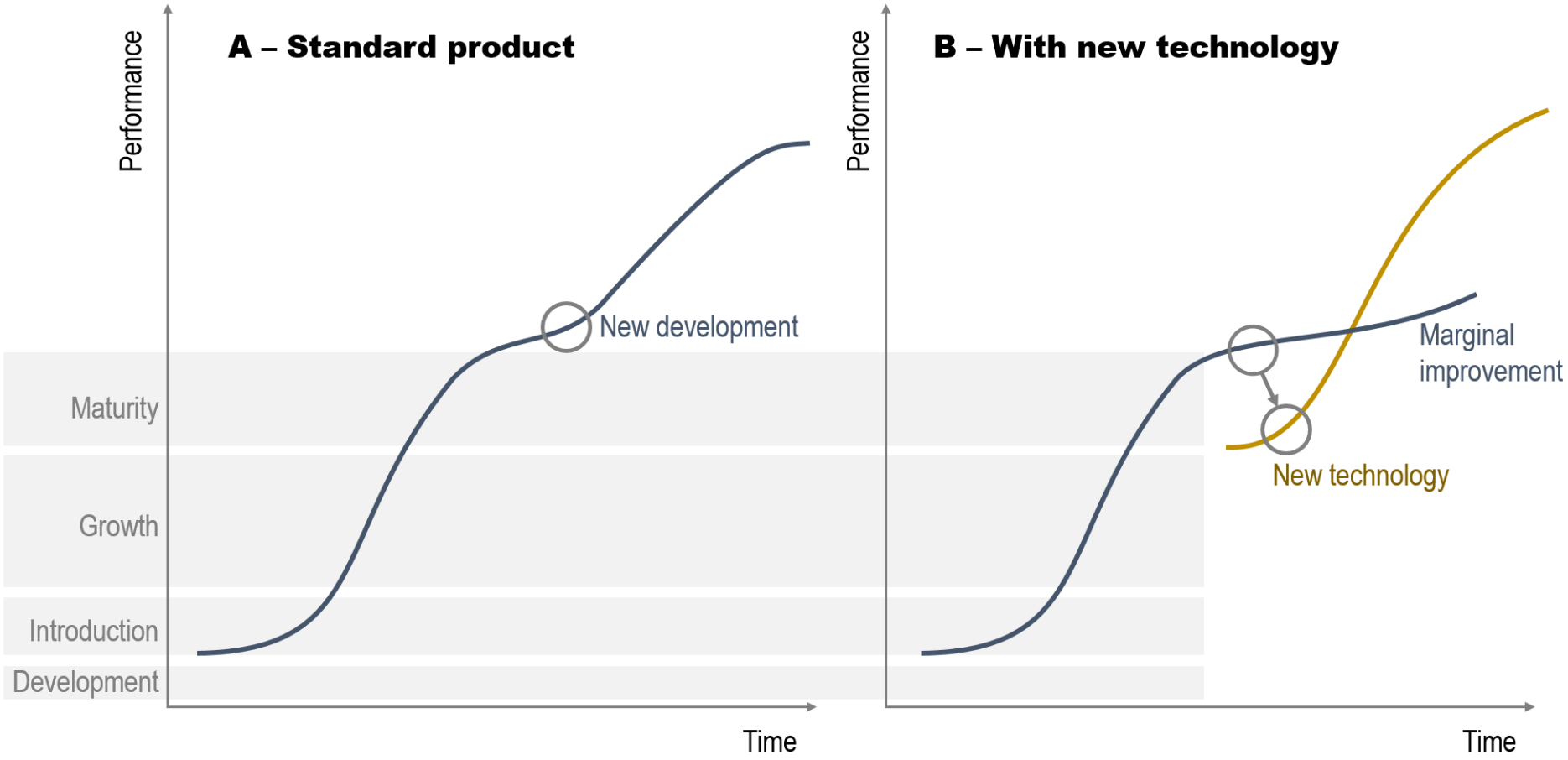
Summary & Conclusions



Status Quo & Market Disruption

- Large investments maintain the status quo.
- Disruptive ideas and new technologies are already emerging.
- Multiple products and solutions expected to coexist.

Debate: Can current leaders retain leadership?

- They must add complex tech.
- New entrants offer simpler, cost-effective solutions.

Summary & Conclusions

Resiliency at the farm:
- self-production of energy
- Self-repair
- Niche productions
- Vertical integration to increase value
- Diversify into energy production

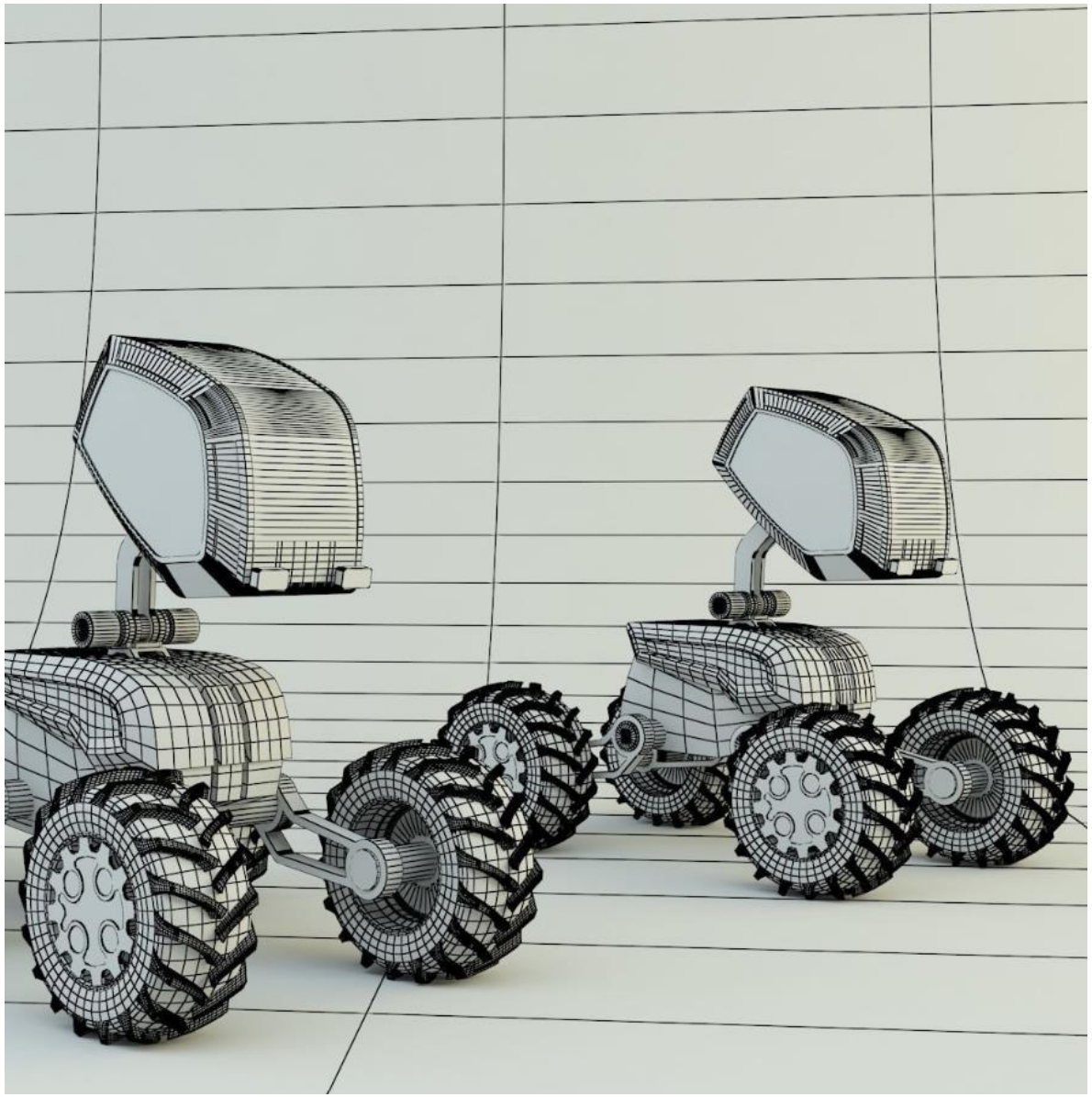
Autonomous machines:
- Current trend, not really a requirement
- Still able to control machines at least when needed
- Need to be cheap and effective to be a breakthrough

Energy sources:
- Agnostic view on preferred option
- Expected to be driven by regulation and economic benefit

Farm grouping:
- Resource sharing
- More investments
- Better outcomes, more efficiency
- Larger farms, smaller plots

Systemic view:
- Agronomy (enhanced by AI) as driver for innovation and new machines type
- In times of change threats for current producers are increasing: new entrants from other markets, industries, radical new solutions
- A single solution to farmers might not be driven by machines (focus on « software », « hardware » as interchangeable)

Machines:
- Smaller rather than bigger
- More simple to operate
- Safer and ergonomic
- Reduced soil compression
- Working in conjunction with other machines, drones, implements…
- Data management and data exchanges
- Multiple solutions and products expected to co-exist
- Modularity (need for simplicity and options)
- Machines that can evolve over time



THANK YOU

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