Artificial intelligence in the agri-food sector: applications, risks and impacts

Josse De Baerdemaeker,

with the support of co-authors: S. Hemming, G. Polder, A. Chauhan, A. Petropoulou (Wageningen University and Research), F. Rovira-Más (UP Valencia), D. Moshou (Aristotle University), G. Wyseure, T. Norton, B. Nicolai, (KU Leuven), F. Hennig-Possenti and I. Hostens (CEMA).

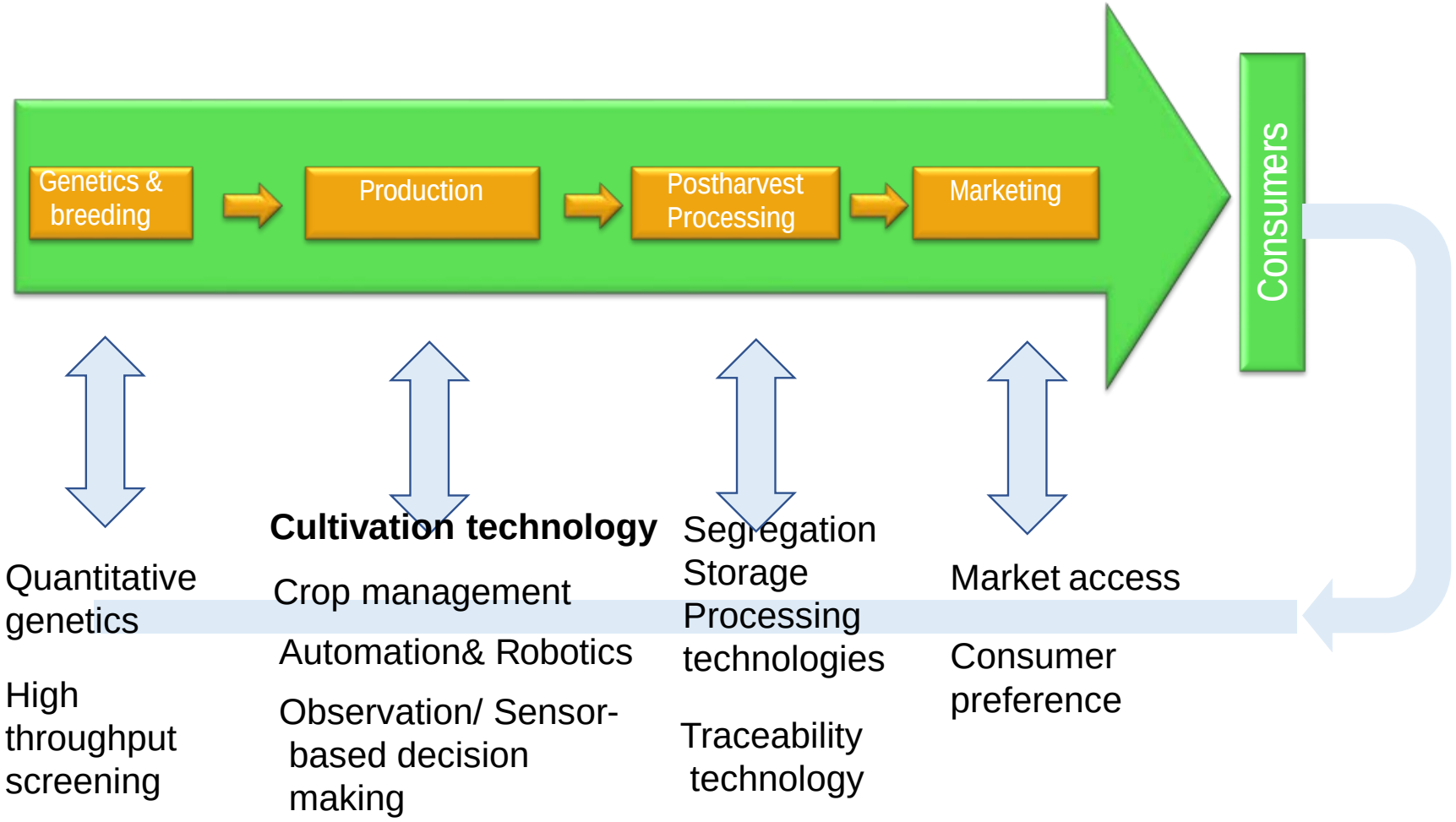
A study at the request of
EPRS | European Parliamentary Research Service Scientific Foresight Unit (STOA)
PE 734.711 – March 2023
https://www.europarl.europa.eu/RegData/etudes/STUD/2023/734711/EPRS_STU(2023)734711_EN.pdf

Artificial intelligence in the agri-food

- Value chain and digital data
- A definition of AI
- Some applications of AI in agri-food
- Risks and concerns
- Policy options towards AI in agri-food

Value chain in agri-food

Product flows and data flows for information -based decisions



Modified from Ian Ferguson, ACPA 2017, Hamilton, New Zealand

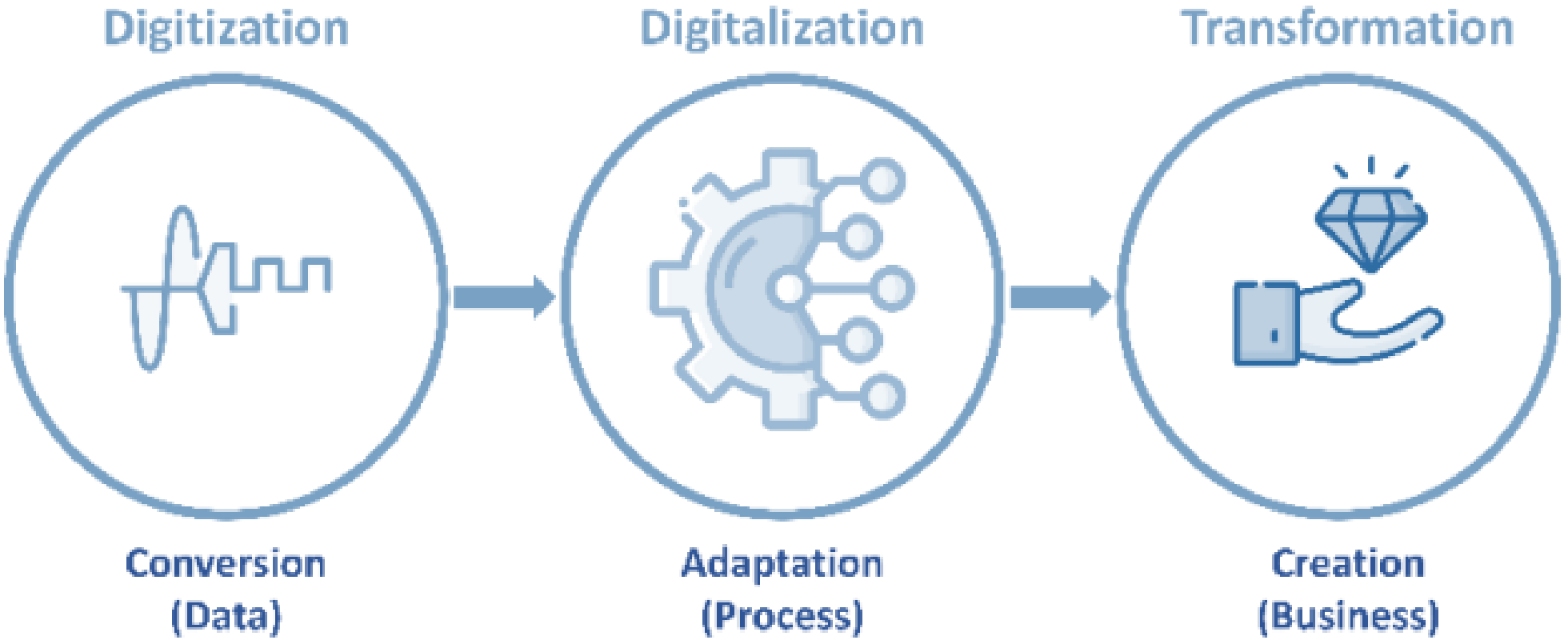
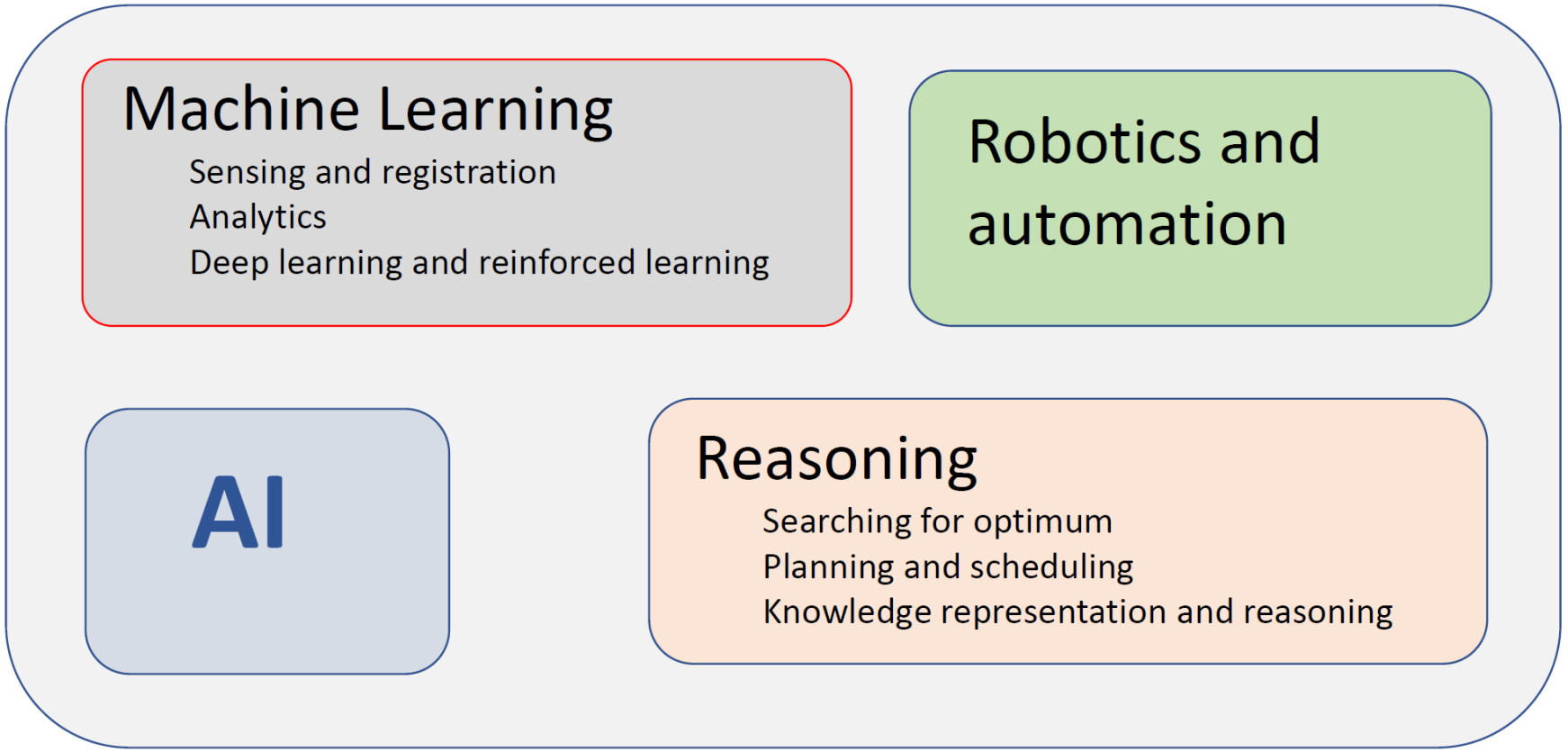


Figure 2. Digitization, Digitalization, and Digital transformation according to (Maltaverne, 2017).

AI's sub-disciplines and their relationship (modified from (AI HLEG, 2018))



Autonomous greenhouse production

News: Successful first try-out with autonomous lettuce growing

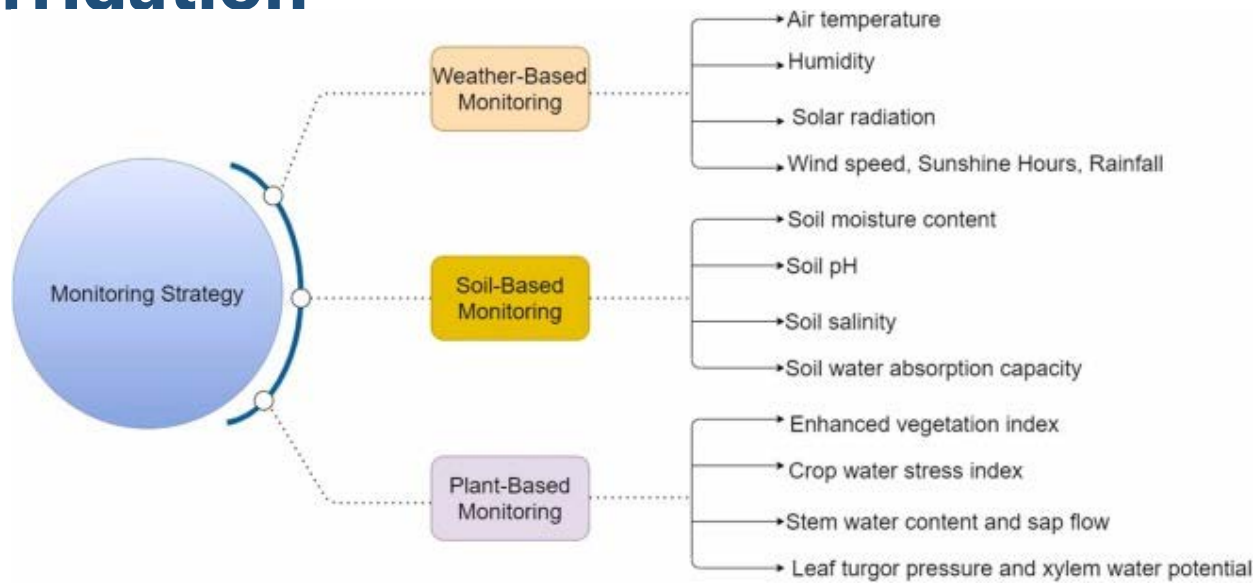
Familiar face leads ‘Team Koala’ to win the Autonomous Greenhouse Challenge for a second time - WUR

Autonomous machines in the field or orchard

Smart irrigation

Rain gun attached to a reel machine

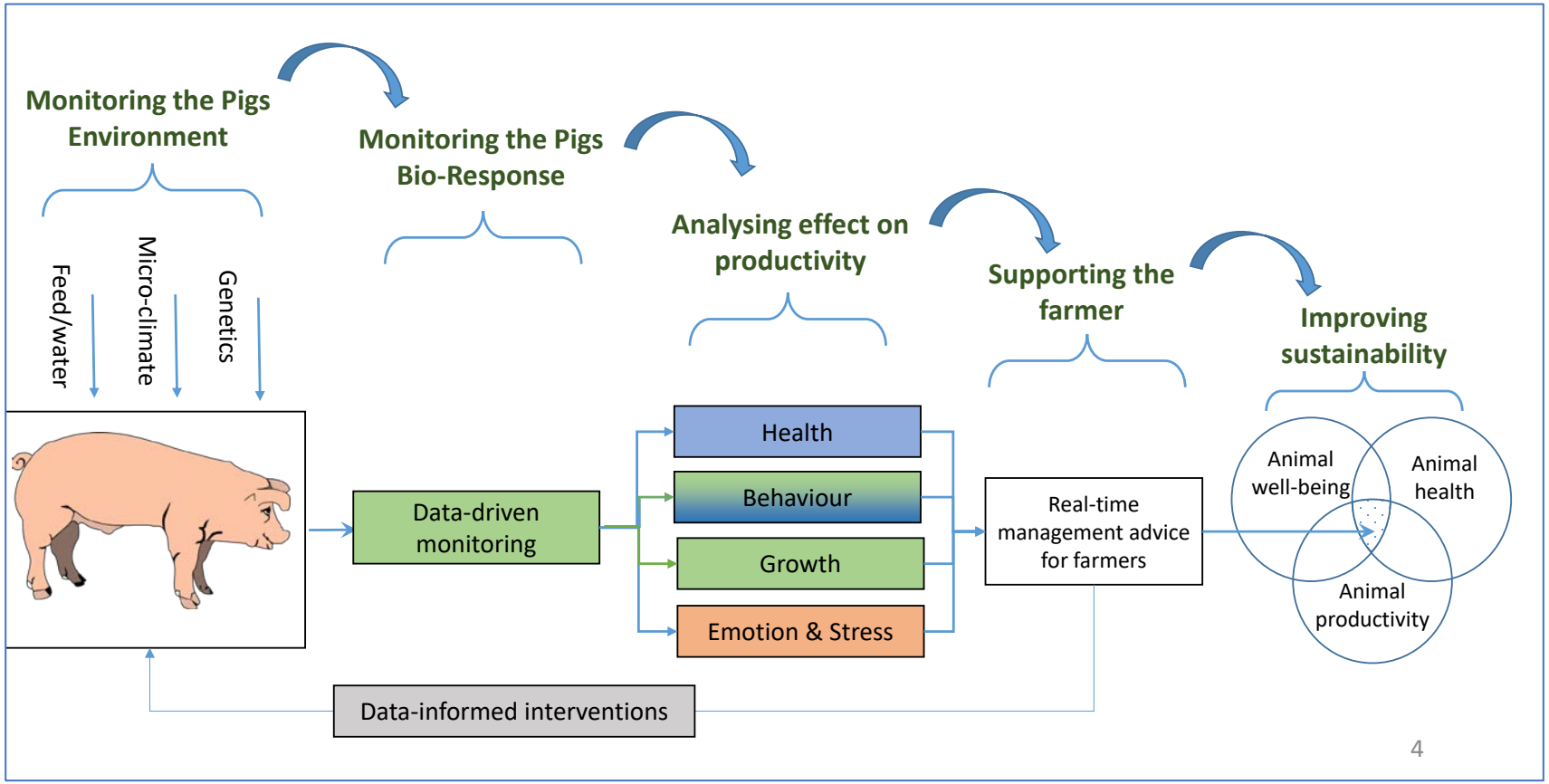
Spray boom attached to a reel machine



Monitoring methods in smart irrigation (Bwambale et al., 2022)

- To deal with potential water shortages, how the water priorities are established.
- The depletion of ground water and damage to the environment

Data-driven animal management



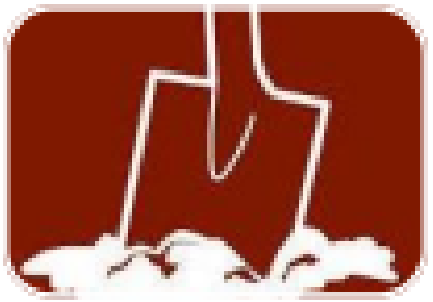
Data-driven technology and the official animal welfare standards –

Promised areas of improvement of agriculture in the data age

(Mark, 2019)

Water quality

Air quality



Soil health

Food quality

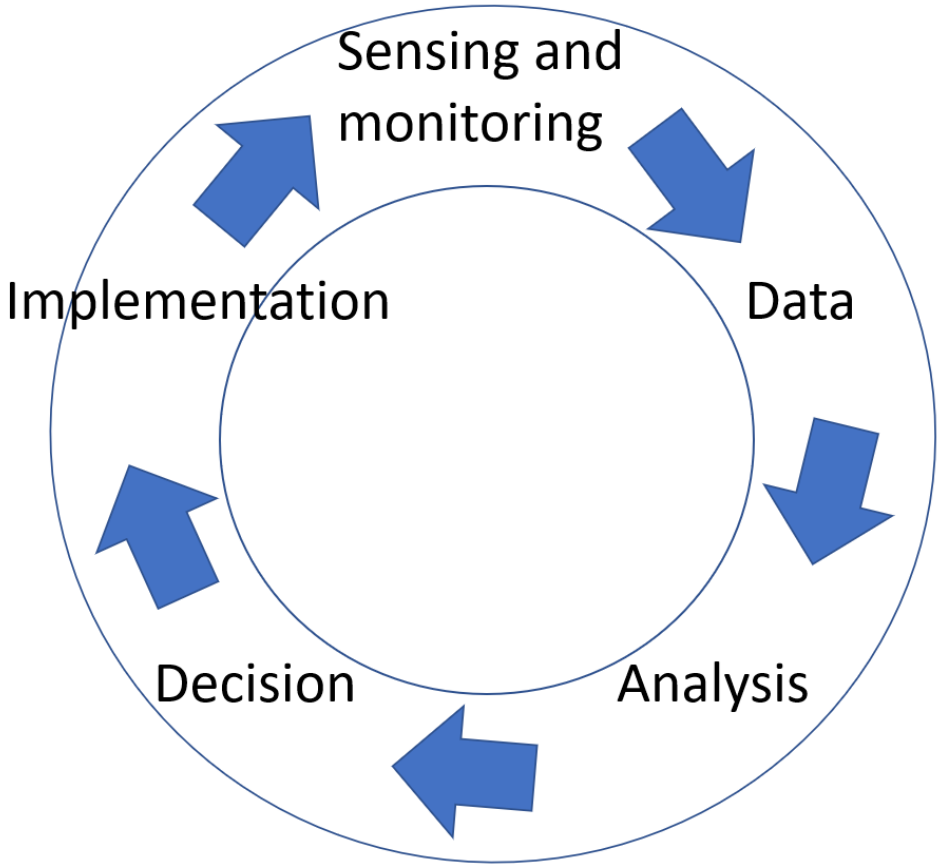
Food security

Biodiversity

Quality of life

Output

AI and agricultural production cycles



Yearly or seasonal activities/decisions:

- Soil sampling, soil preparation
- Crop and variety selection
- Planting,
- Harvesting

Within season activities/decisions

- Weed and disease/pest control
- Nutrient management
- Irrigation
- Measure and predict

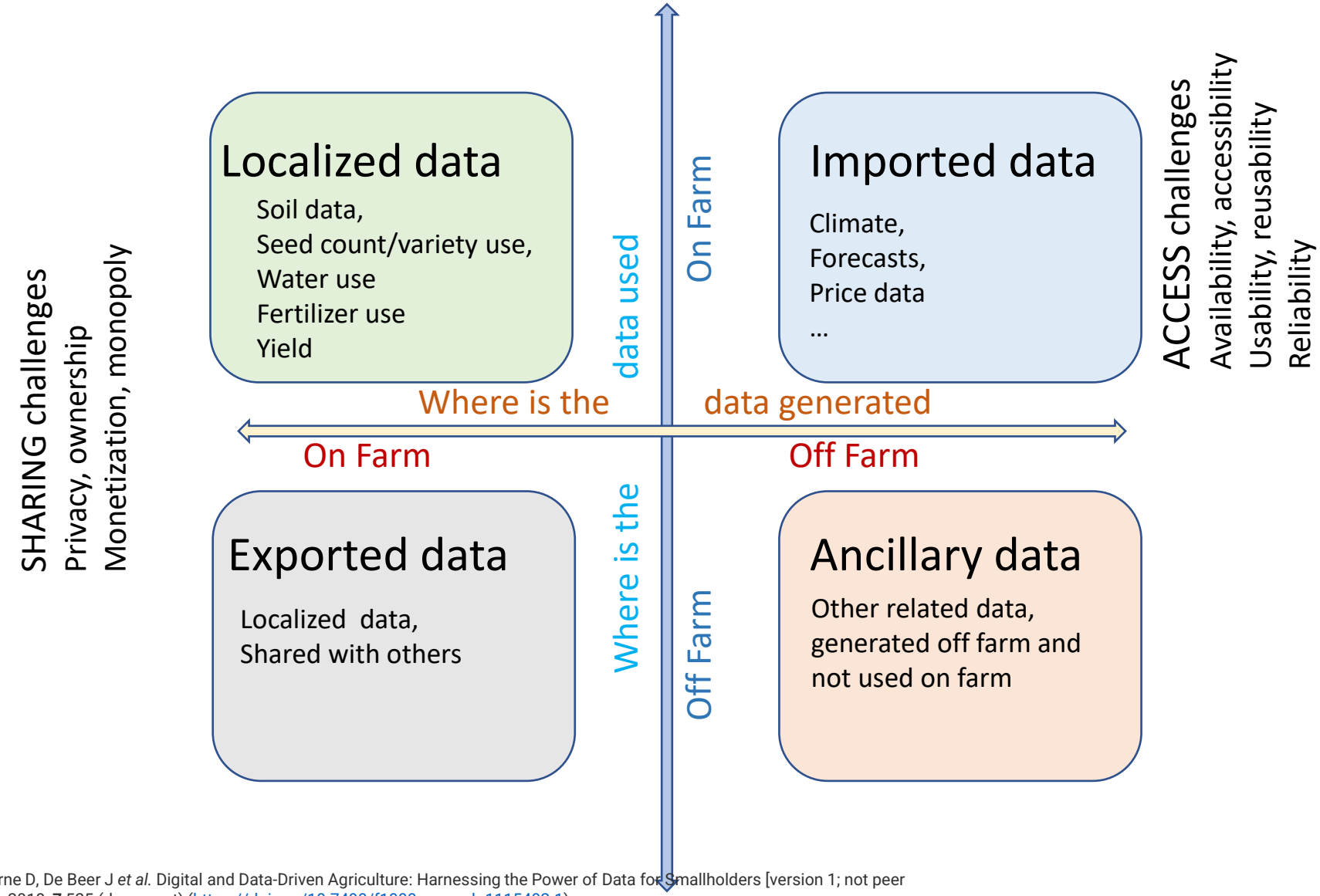
Data collection in each cycle

- Spatial
- Temporal
- Weather conditions (forecast)

Market and economic information

Many years of data for better models

Challenges in sharing and accessing data



Adaped from: Maru A, Berne D, De Beer J *et al.* Digital and Data-Driven Agriculture: Harnessing the Power of Data for Smallholders [version 1; not peer reviewed]. *F1000Research* 2018, **7**:525 (document) (https://doi.org/10.7490/f1000research.1115402.1)

Concerns on data sharing and artificial intrelligence

- Where and how are the data generated (local on farm, imported?)
- Who owns the data? Who has access?
- Where are the data used (on farm, off farm ?)
- Quality of the data is important, Verified by …?
- Portability of the data platforms
- Findable, accessible, inter-operable, and re-usable (FAIR) data?
- Multi-year data and information

Concerns on implementing artificial intelligence in agri-food

- User acceptance and training
- Trust and equal opportunities, explainability and robustness
- Who monetizes the data
- Proven results of the AI-models?
- How to select a service provider
- Affordability to avoid the digital divide
- Risks and liabilities are defined?, also when ‘things go wrong’?
- Are there regulations? Who sets the rules? Biodiversity?

Regulatory policy options

- *Regulations on the rights and expectations for farmers, technology providers and the public*
  - The farmer that collects or enters the data is the owner of the data
  - Farmers can transport these data to third parties in a readable format and units
  - Make a data retention regulation feasible
- *A risk and liability regulation*
  - Demand that AI users/farmers be informed of the potential risks to their farm or business. Role of technology providers.
  - An obligation for the preservation of discoverable information that may be relevant evidence or useful for adversaries in incidents
  - Role of insurance companies with respect to users and technology providers
- *Automation and the protection of farm workers*
  - Farmers and farm workers need the skills for the digital aspects of farming.
  - Mandatory training to operate machines/installations with built-in AI, including emergency situations
  - Set up demonstration and training sites, including the use of digital twins.

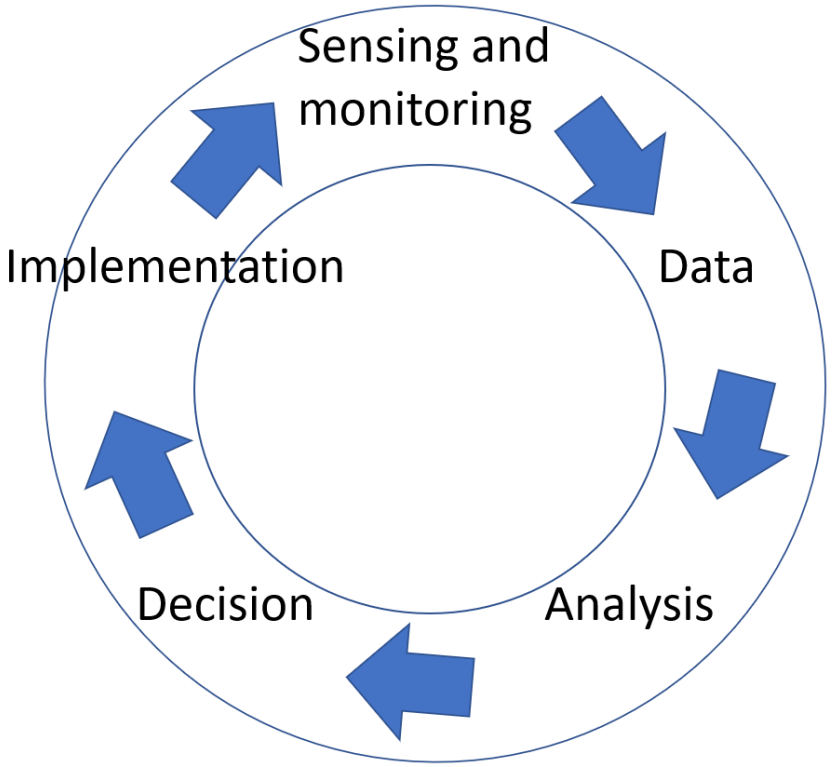
Knowledge creation and management policy options

- *Regulation on the exploitation and governance of the European Data bases*
  - Databases generated using public funding and resources are publicly accessible while respecting privacy
  - Farmers can access their own data, as well as anonymised or aggregated data
  - Access by commercial companies on a fee basis
- *On transparency and quality assurance of AI models*
  - Assure the users of a certain level of quality and trustworthiness
  - Give user information about the underlying model, the data base used and the validation database
  - Evaluation of the quality of the database by a control body as well as
  - In depth evaluation of the AI models
- *Digital literacy and the digital divide*
  - AI users in agri-food should receive training in their own language at an appropriate level
  - Initially part-time (paid?) training, part-time work
  - Demand to clarify the effect of the size of the exploitation on the performance of the model

Options towards AI based agricultural economy

- *Legislation that prevents the lock-in of farmers in corporate digital technology*
  - Encourage the development of non-proprietary technologies and software for open access and open source solutions,
  - Data (collected by machines or manually entered), as well as meta-data, are readable by open-source software
- *Policies towards new market entrants and to limit dominant positions of first movers*
  - Limit intellectual property rights even on the output type and format of the models.
  - A user (farmer, SME) can switch to a new technology provider at a reasonable cost
- *Affordability and accessibility of the data infrastructure and of the IT network*
  - Specify the granularity of the telecommunication infrastructure in Europe even in remote rural areas, at no discriminating cost
- *Policy to support investments by farmers or SMEs to make use of AI potential benefits*
  - Encourage targeted investments, for example by producer organizations
  - Support for complimentary investments and farming strategy changes when using AI

AI and agricultural production cycles



Yearly or seasonal activities/decisions:

- Soil sampling, soil preparation
- Crop and variety selection
- Planting,
- Harvesting

Within season activities/decisions

- Weed and disease/pest control
- Nutrient management
- Irrigation
- Measure and predict

Resilience: dealing with 'unforeseen' disruptions

- Stress slows down (dry spell, heavy rains,…)
  Internet, energy supply, fertilizers, chemical..
- Shocks stop normal actions (floods, …)

Data collection in each cycle

- Spatial
- Temporal
- Weather conditions (forecast)

Market and economic information

Many years of data for better models

AI, technology and sustainable agriculture

P. Ronald and R. Adamchak state in 'Tomorrows Table', Oxford University Press , 2018

In a Sustainable Agriculture the use of a technology or farming practice serves to:

- Produce abundant, safe, and nutritious* food
- Reduce harmful environmental inputs
- Minimize the use of land and water
- Provide safe conditions for farm workers
- Protect the genetic makeup of native species
- Enhance crop genetic diversity
- Foster soil fertility
- Improve the lives of the poor and malnourished
- Maintain the economic viability of farming and rural communities

**As defined by the US Department of Agriculture, Food, and Nutrition Service.*

Thank you very much

Questions?

Josse De Baerdemaeker