



# **Science, Knowledge on Sensors to Build Food Security, Sustainability, and Wealth**

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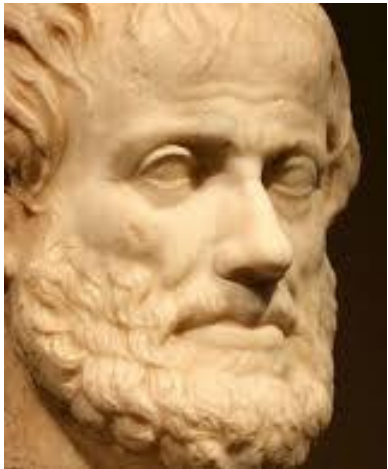
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## A collage of six portraits of scientists. The top row features Galileo Galilei (left, with a long beard and dark clothing), William Brouncker (middle, wearing a large ruff and a hat), Robert Boyle (right, with long dark hair and a white collar), and Isaac Newton (far right, with long curly hair). The bottom row features Benjamin Franklin (left, in a dark coat) and John Dalton (right, with long white hair and a dark coat). The text '7 Works' is visible in the bottom right corner of the John Dalton portrait.



## Historical and epistemological framework



**Aristotle not only inspired the enlightenment, but also helped to understand the movement, since his thought acts as an important part of the hermeneutics of knowledge.**

# The Enlightenment

- ✓ It was a philosophical and intellectual movement.
- ✓ It was with great political, social and economic implications, which occurred in Europe (Modern Age), peak happened in the 18<sup>th</sup> century.

# **“Discourse on the Method”**

*Sermo in modum* by René Descartes,  
published in 1637, where it is recommended  
to systematically disbelieve in everything,  
unless one has a well-founded and well-  
established reason.

**“I think, therefore I am”**

*Cogito ergo sum*

# **“Mathematical Principles of Natural Philosophy”**

**Philosophiae naturalis Principia Mathematica  
by Isaac Newton, published in editions of  
1687, 1713 and 1726, as essential in  
contextualizing the scientific revolution that  
occurred during the Enlightenment period.**

*Social Transformations and the  
Age of Reason*



# Science

**Defined as the observation, identification, description, experimental investigation, and theoretical explanation of natural phenomena.**



# Knowledge

**Decisive factor in establishing perspectives to face the challenges and uncertainties of the macro environment.**







## **First Wave (1760-1840)**

**Faster means of communication, minimizing problems like social unrest and repetitive work.**

**Main inventions: the cotton gin, the electromagnet, photography, gas street lighting, the steam engine, the mechanical loom, the telegraph...**

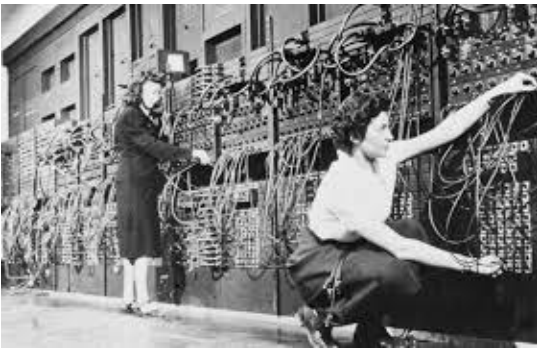


## Second Wave (1870-1914)

The Enlightenment's moral values of reason, liberty, equality, and fraternity did not find full resonance in their understandings and practices, guiding needs for public policy.

**Main inventions:** automobile, advances in the use of nuclear energy, electric dynamo, fertilizers, incandescent lamp, the combustion and electric engines, steel ships, plastics, lubricants, synthetic products and petroleum derivatives, telephone, television, steam trains (railways) and the electronic tube...

## - Electronic Numerical Integrator and Computer - Transistor



Source: ENIAC's first programmers. U.S. National Archives Education Update



Source: John Bardeen, William Shockley and Walter Brattain in 1948, Bell Telephone Laboratories

- ENIAC was created by scientists John Eckert and John Mauchly (1943-46), being capable for processing 5,000 operations/s.
- Transistor was invented by physicists John Bardeen, Walter Brattain and William Shockley (1947).



## Third Wave (1950- 2011)

Improvements and new advances in the technological field began to encompass the field of advanced sciences, integrating them into the production system on a larger scale.

**Main inventions:** personal computer, Internet, electronic decision-making systems and devices, laser, virtual reality, robotics, cellphone, genetics, biotechnology, energy matrices, telecommunications, customized softwares, information in real time...

# Fourth Wave (2011–2017)

**Main advances:** methods for productivity gains in crops focused on food, fibers and biomass energy production, technologies for the adaptation and mitigation of climate change, ecological vision, ethics and law.

**Main inventions:** use of biomimetics, green chemistry, renewable energies, nanosciences, Internet of Things (IoT), artificial intelligence, advanced cybernetics and new materials.



## **Fifth Wave (2017...)**

- ✓ **Linked to the concept of Industry 5.0, which originated with the aim of filling gaps observed in the fourth wave.**
- ✓ **Seeks to recognize the centrality of humans in organizations and is related to resilience and prosperity.**

## Recognizing:

**bioeconomy, intelligent creative action,  
automation with human beings in the  
environment and manufacturing area.**

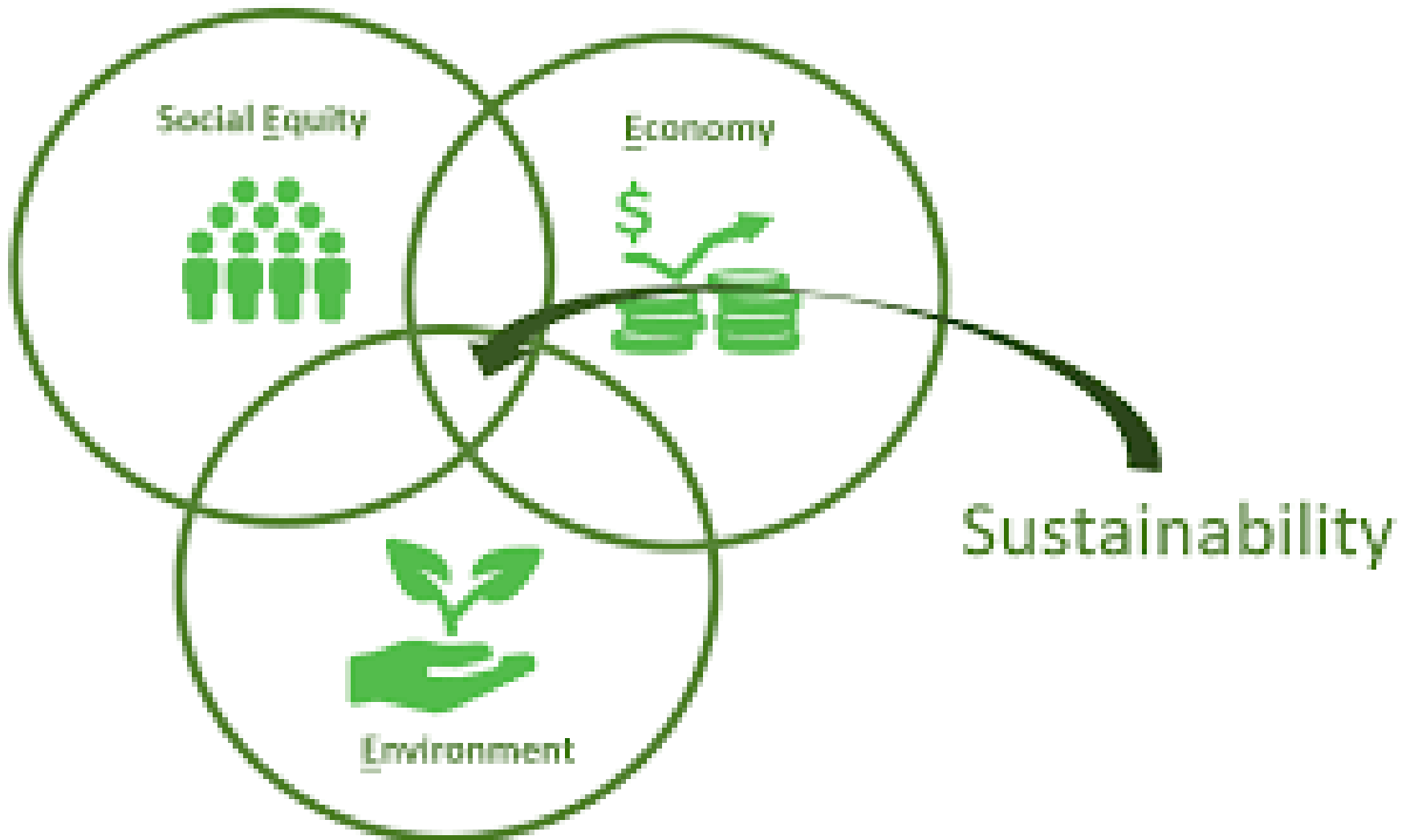






**Main inventions:** cobots, augmented reality coupled with virtual reality, Big Data, smart 3D and 4D printing, general AI and integration, unsupervised decision systems, autonomous systems, use of cyber-physical systems integrated via IoT...

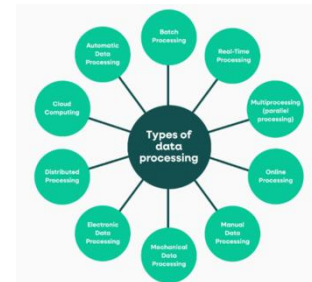
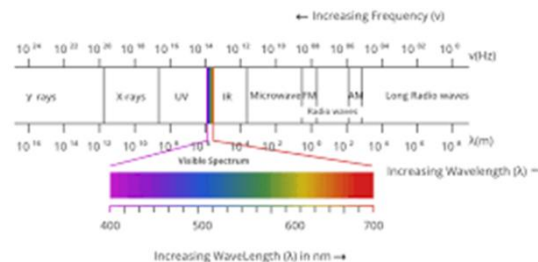
# Resilience and ESG model



# **Demands and opportunities**

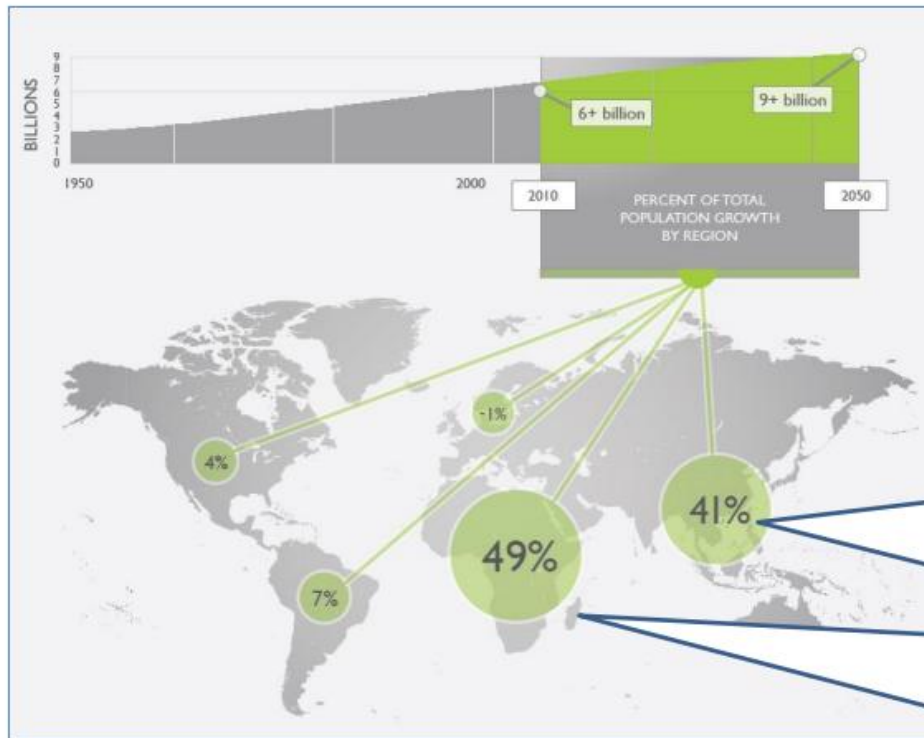
## **- Sensors -**

**“Without sensors, there would be no true data, no information retrieval, no oriented knowledge, as well as no interaction with nature by machines, and, of course, no automation at all.”**



# The Multiple Agri-Food Challenges

Asymmetries of population growth and food production



Expected Population Growth  
by Region

2010 - 2050

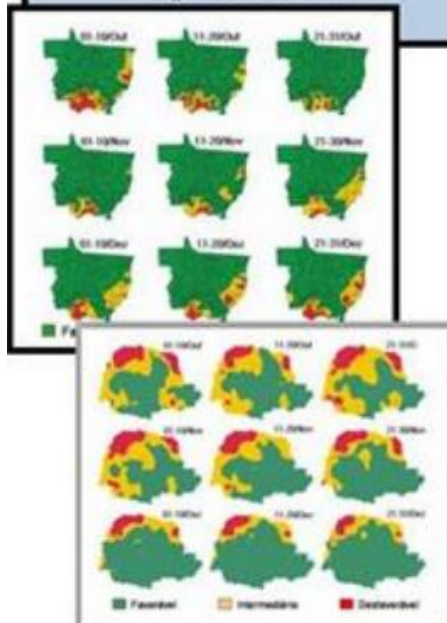
Most population growth is expected in sub-Saharan Africa and Asia. Low-income areas with relatively low levels of agricultural productivity.

Source: UN data from Global Harvest Initiative GAP Report (2011).

## geospatial/sensing knowledge to support Public Policies

### Zoning of Climatic Risks

Regionalization of climatic claims to minimize losses in agricultural production, risks reducing from the rainfall regimes  
regime de chuva.



### Agroecological Zoning of Sugarcane

It defines suitable areas and exclusion zones for the cultivation of sugar cane in Brazil. Directs the policy of expansion and bioethanol production



### Low Carbon Agriculture ABC Plan

Decarbonization of the agriculture processes by the incorporation of practices of low emission of greenhouse gases



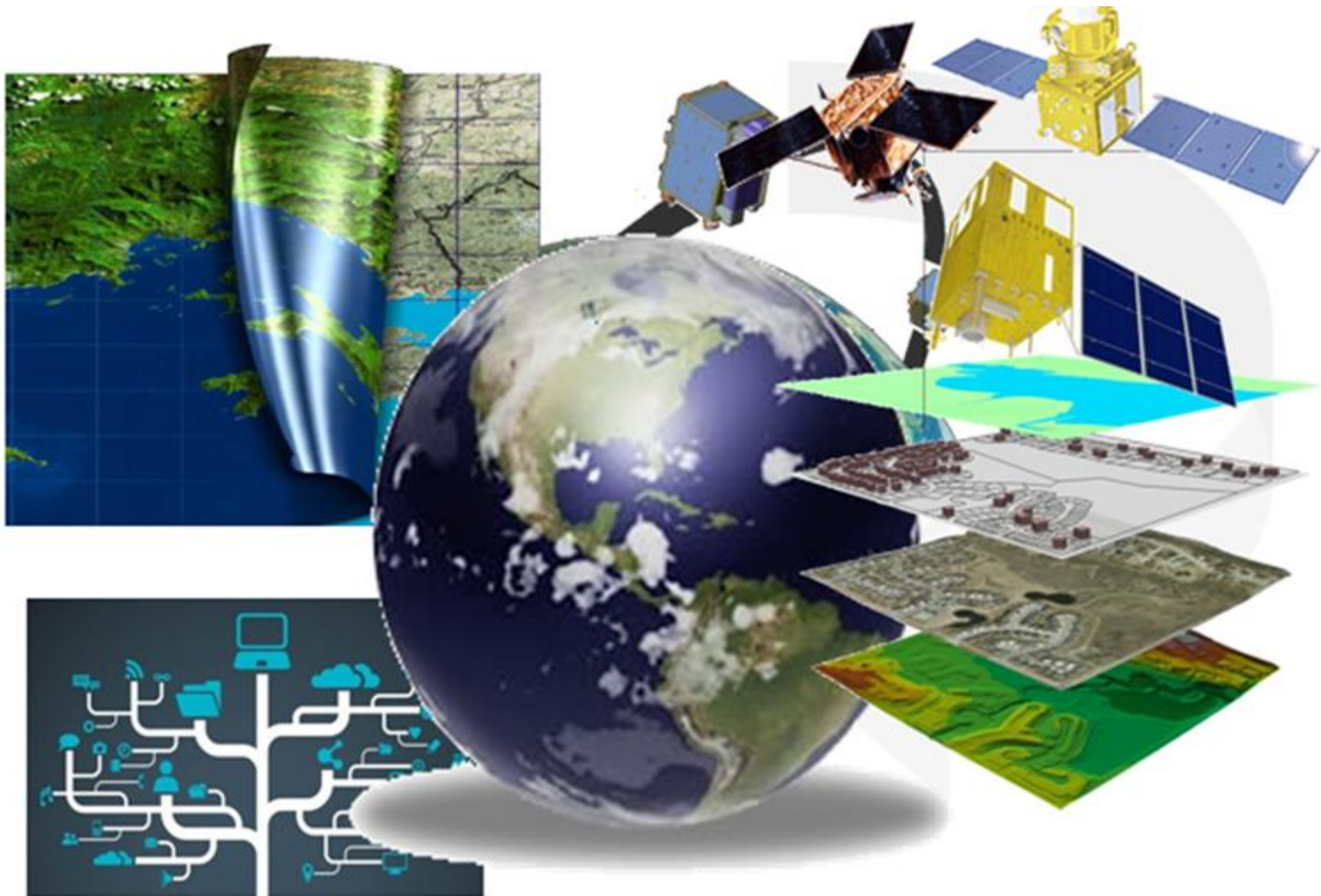
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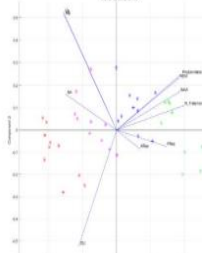
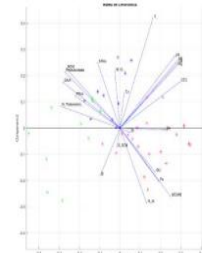
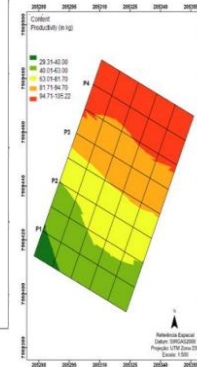
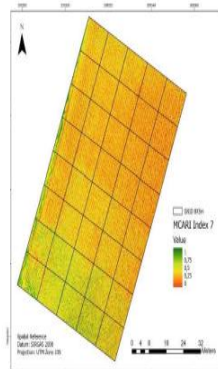
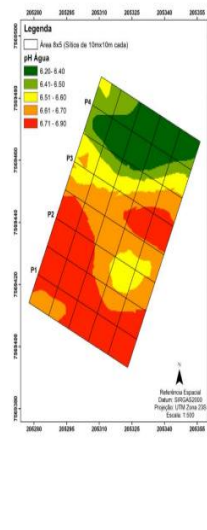
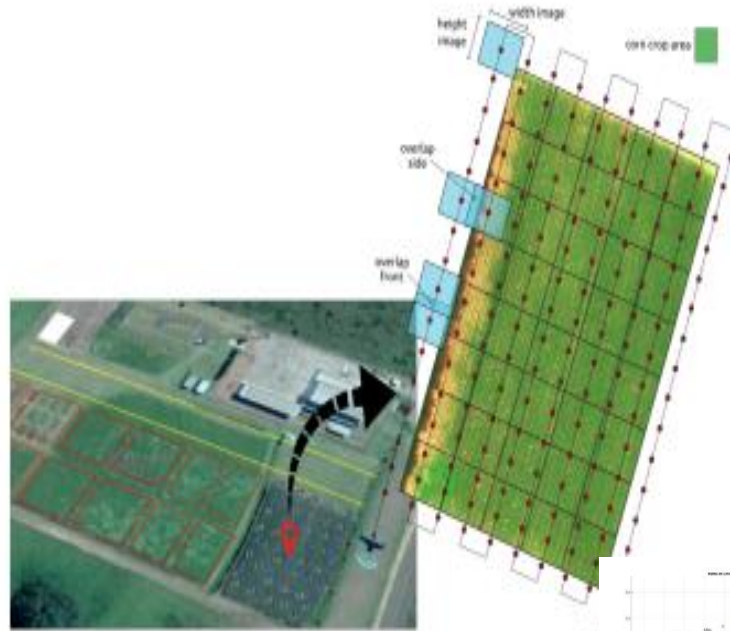
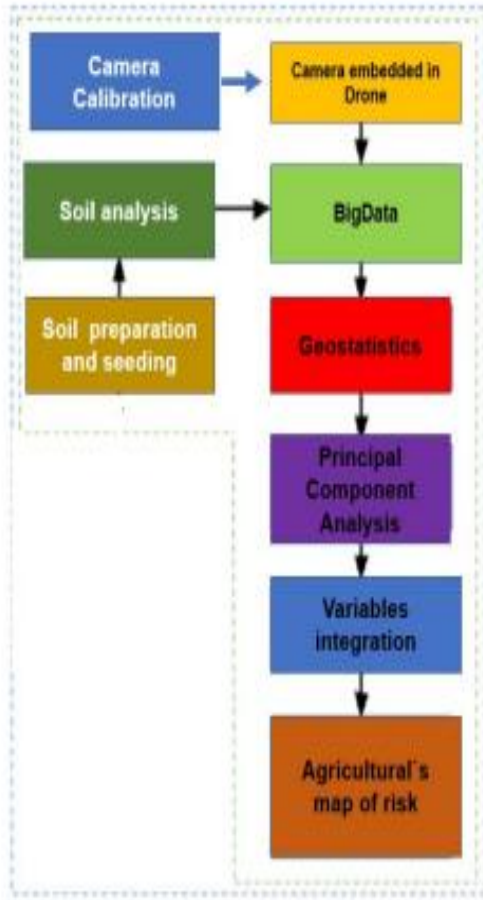




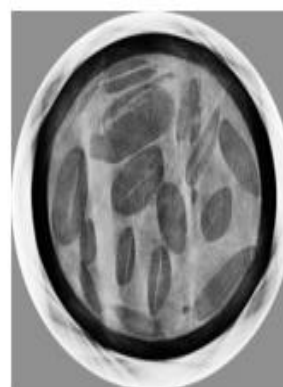
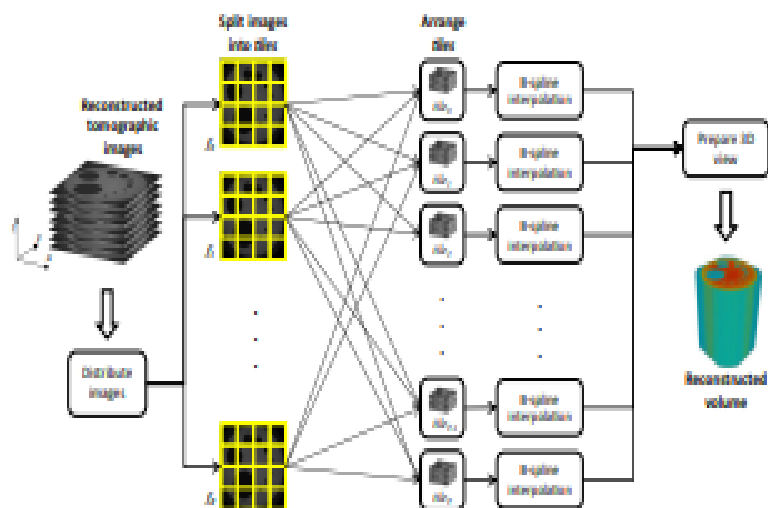
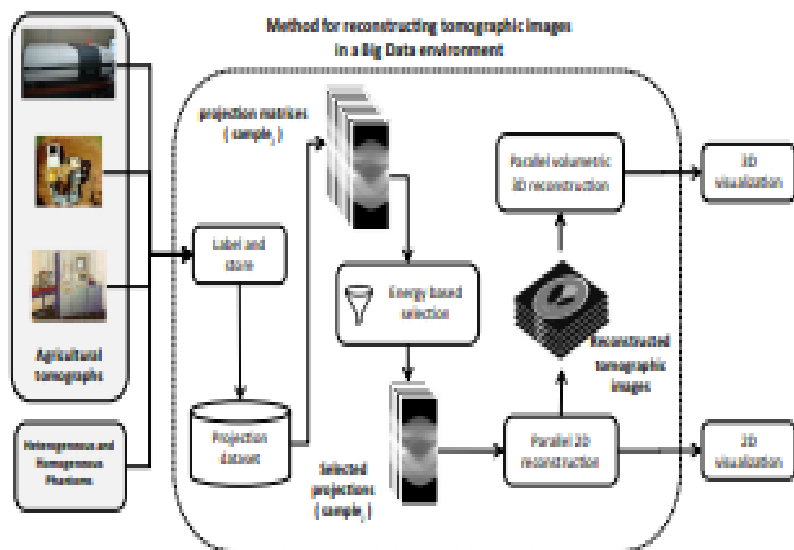
# ALLSENSORS 2025 - The Tenth International Conference on Advances in Sensors, Actuators, Metering and Sensing



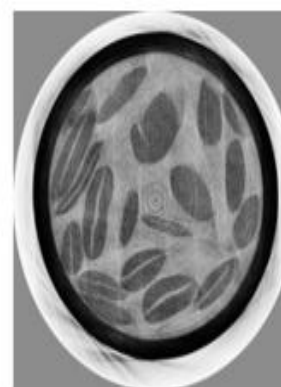




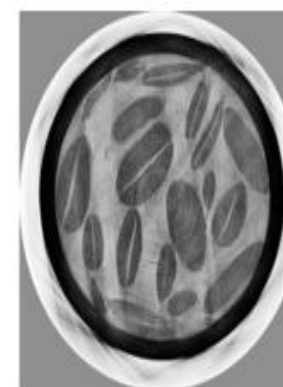




(a) Minimum



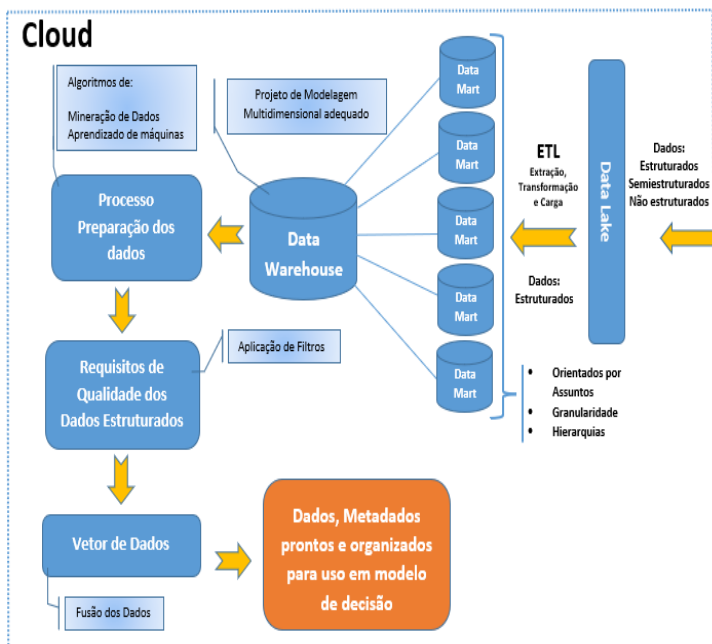
(b) Median



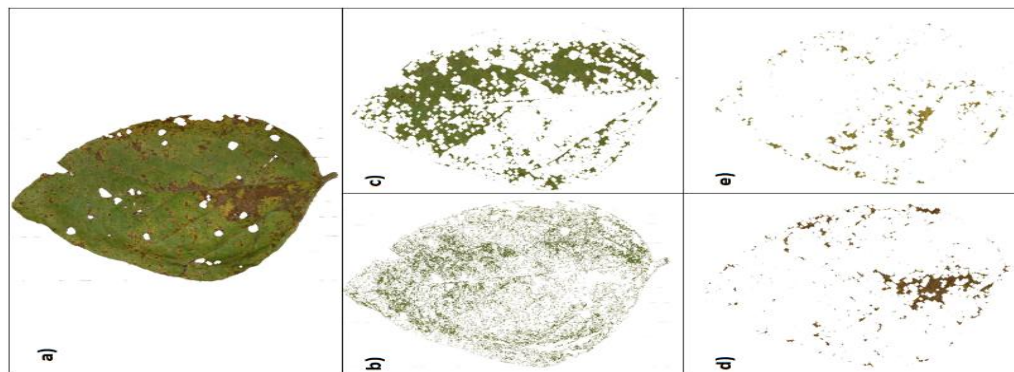
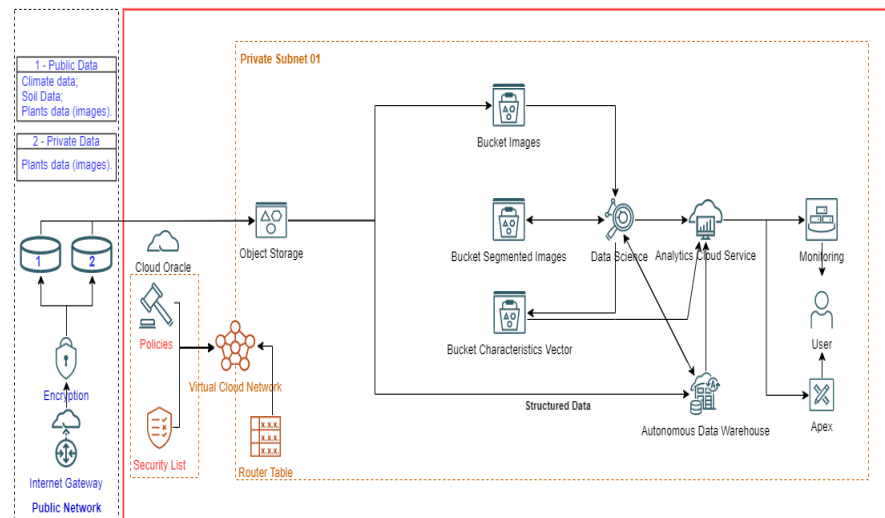
(c) Maximum



## Cloud



## Oracle Cloud Architecture



# **Trends for ST&I and Opportunities**

- ✓ **Systematization of intelligent decision support and risk management processes with semantics specific to agriculture, robotized for operation in the air, on the ground and in water sources (continental, maritime and underground);**
- ✓ **Structuring of 5G(+) communications, protocols such as LoRa, satellite networks, cloud computing, enabling mobile systems and integral, high-speed rural-urban connections;**

# **Trends for ST&I and Opportunities**

- ✓ **Methodization of advanced computational modeling, 3D/4D, Augmented Reality and Bio printing, enabling longer unsupervised operation times with lower maintenance costs;**
- ✓ **Organization in logistics and its management through IAG efficiency, aiming at reducing operational costs and optimizing energy;**



## Challenges

- New sensors and networking;
- Interoperability;
- Field truth and customization;
- Proprietary and public data;
- Standards and public policy.



*Thank you all for the audience!*