IARIA

Panel #3

VALENCIA
FALL 2024

TechWorld 2024 & DigitalSustainability 2024

PANEL #3

AI Tools and Sensing Systems

Panel #3

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FALL 2024

Moderator

Assist. Prof. Dr. Lorena Parra, Universidad Politécnica de Madrid, Spain

Panelists

Prof. Dr. Pedro Gonçalves, Escola Superior de Tecnologia e Gestão de Águeda and Instituto de Telecomunicações, Portugal

Ph. D. Candidate Alberto Mino Calero, NTNU, Norway

Dr. Mahmood Ahmad, RIZQ/YUNUS WEFnex Hub AIT, Thailand

Prof. Dr. Petre Dini, IARIA, USA/EU

Moderator Position

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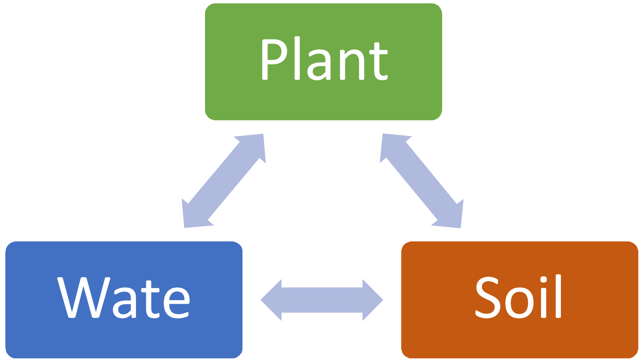
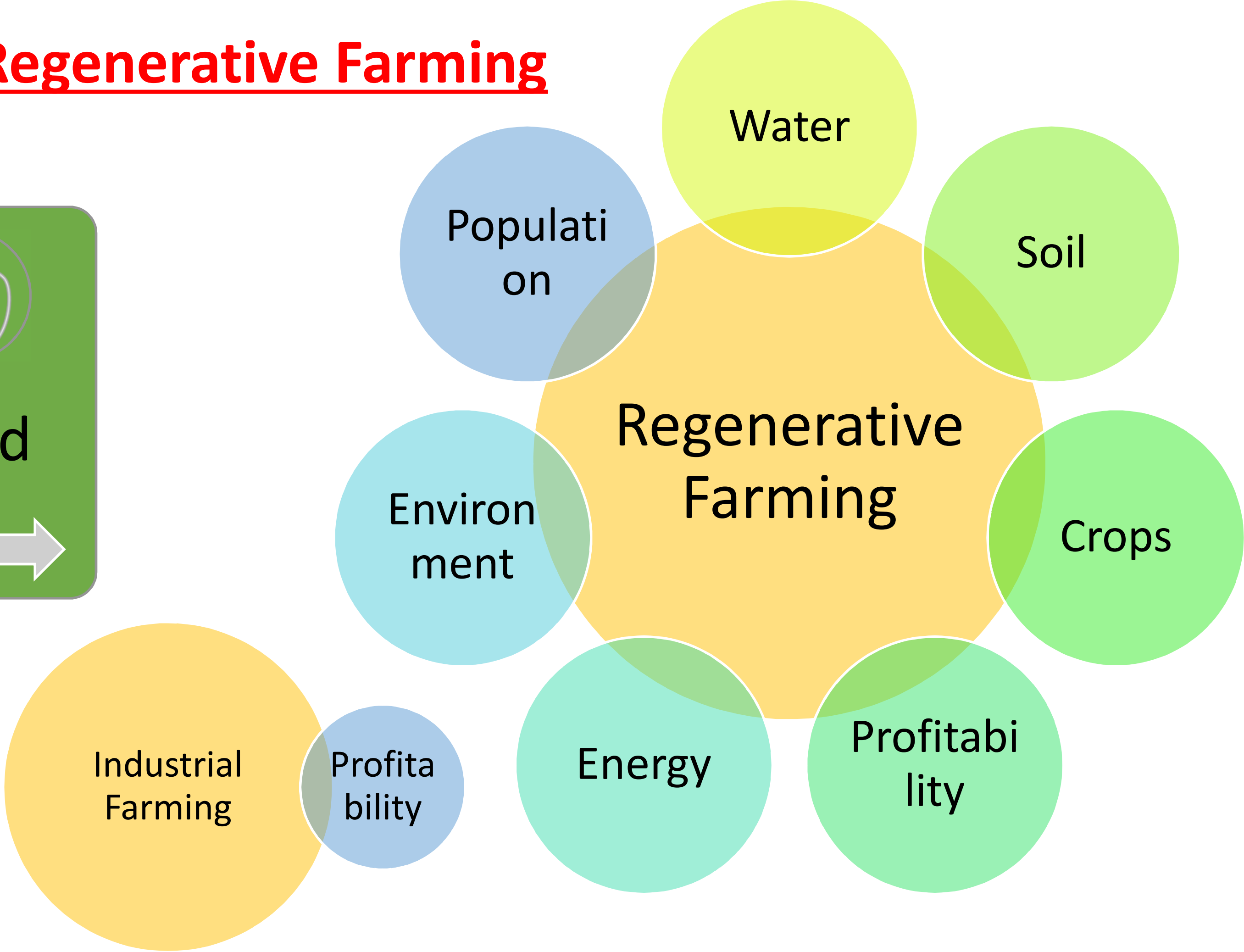
- **AI Tools and Sensing in Regenerative Farming**
  - **Regenerative Farming**

Water

Energy

Food





Lorena Parra

Panelist Position

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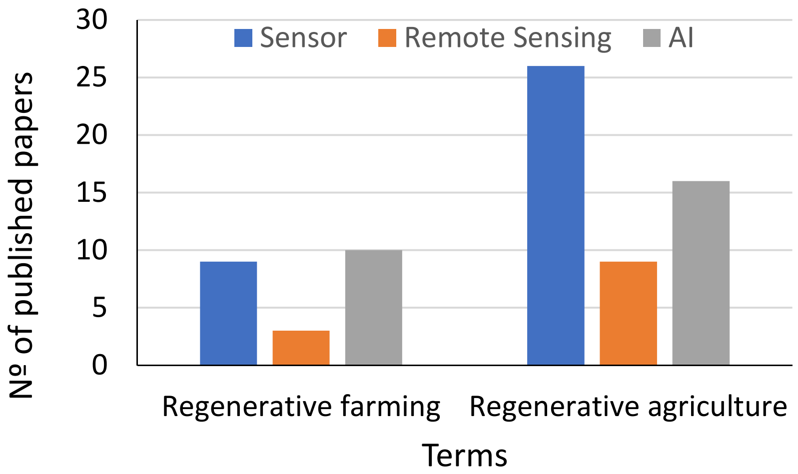
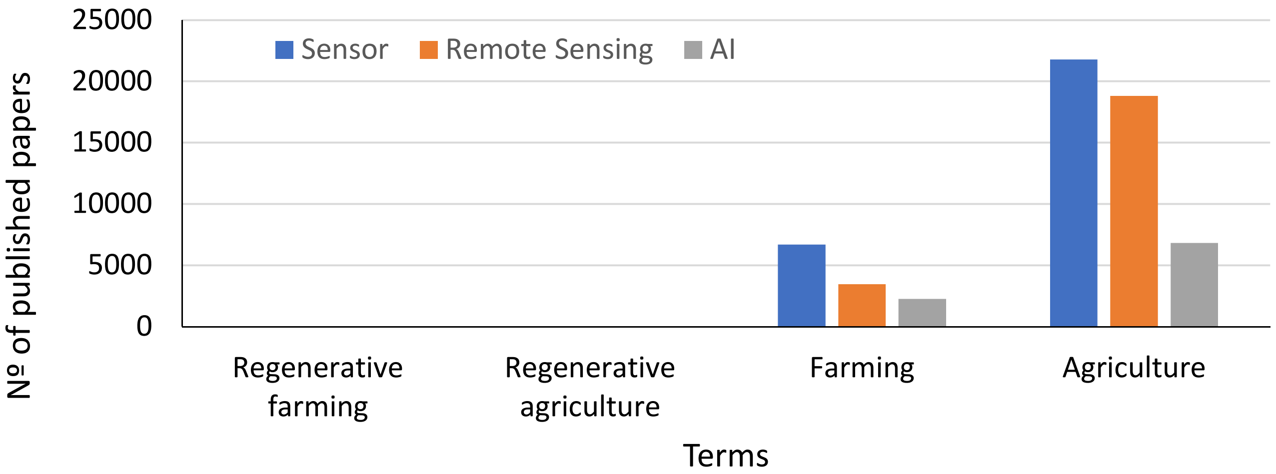
AI Tools and Sensing in Regenerative Farming:

- Regenerative Farming (RF) and/or Regenerative Agriculture (RA)

Lorena Parra

- AI and Sensors use in RF/RA





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- **AI Tools and Sensing in Regenerative Farming:**
  - **Uses and Benefits:**

- Identify trends
- Determine best management strategies
- Allocate resources
- Fair and technical based decisions

Lorena Parra

UNIVERSIDAD
POLITÉCNICA
DE MADRID

  - **Needs:**

- Homogenization in nomenclature (farming/agriculture, remote sensing/proximal sensing, UAV/drone…)
- Standardization the results to allow a reuse data and allow comparing the performance.
  - Fairly use of metrics and use well-known datasets or publish the datasets

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Pedro Gonçalves
Universidade de Aveiro

Precision grazing provides a relevant societal service

- Territories with temperate climates have regular problems with wildfires
  - 139,819 hectares Portugal; 504,000 hectares EU were burne in 2024
  - wildfire carbon emissions during the 2023-2024 fire season were approximately 2.4 gigatons of carbon, at global scale
    - 24 billion km of a EURO6 car
- abandonment of agricultural land leaves combustible material near villages
  - herbs and bushes grow during spring season, and get dry during the summer
- Ruminants are a very efficient and ecological mean to remove fuel material
  - herd grows and animals produce by-products
  - animals fertilize land
- But herding is an extremely hard and time-consuming activity
- And animal handling requires knowledge

Moderator Position

Pedro Gonçalves
Universidade de Aveiro

- **AI and sensing tools allow/ease**
  - Tracking/locate animals
    - and geofencing the flock:
  - Monitor animal behavior
    - walking, eating, standing, ruminating
  - Monitor animal wellbeing
    - detect / forecast diseases, forecast parturition
  - Efficiently manage animal feeding and supplementation
    - monitoring daily activity, and ingestion

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Alberto Miño Calero
Norwegian University of Science and Technology

- **The more complex AI tools become, the more assurances should be required that they work as intended**
  - AI tools increase in complexity daily.
    - Traditional methods for deciding which models are best are becoming less reliable. There is awareness of some issues, such as adversarial attacks, data leakage, uncertainty, etc., and mitigating solutions. Performance is oblivious to these issues.
  - The behavior of many models already deployed in apps and systems is not actually explainable.
    - In many cases, impactful decisions are not made based on their feedback.
    - On the other hand, there are people already using LLMs to solve work-related tasks without verifying results.
  - When the results of a model cannot be explained, making decisions based on their outputs becomes risky, especially for critical applications.
    - Need to encourage use of AI tools as decision support systems, a cooperative use of AI.
    - Current AI tools have gone far, but are still distant from AGI.
  - Is there an overuse of cumbersome models just to follow the trend?

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Dr. Mahmood Ahmad, RIZQ/YUNUS WEFnex Hub AIT, Thailand

AL Benefits:

- Reduce water and fertilizer use; improves soil health
- Enhance water productivity
- Increased crop yields (20 %) and Livestock productivity (15)
- Health benefits
- Reduced Costs:_ reduce costs by up to 10%, leading to increased profitability for farmers.
- Create new job opportunities in agriculture, leading to increased employment and economic growth.
- Carbon Offset or Credits

AL Opportunities

- Can make farming profitable, competitive, sustainable (biodiversity) and inclusive
- Meet global climate changes target
- New business model – services, data analytics , RA consulting

AL Challenges

- High Initial Investment
- Small farmer left out, bridge financing
- Collective actions
- Change in mindset and awareness at all levels
- Capacity build at all levels

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Major Achievements in Agriculture through AI Tools

- **Predictive Analytics:** AI tools have enabled predictive analytics for crop and soil health, helping predict crop yields, identify potential diseases, and suggest optimal planting and harvesting times
- **Automated Pest Control:** AI-driven systems can detect and classify pests and diseases through image recognition technologies. These systems can autonomously initiate targeted treatments, minimizing crop damage and reducing chemical usage.
- **Precision Farming:** AI enhances precision agriculture by processing data from various sources (satellites, drones, sensors) to make precise recommendations for water, fertilizer, and pesticide application.
- **Robotic Harvesting:** AI-powered robots are being used for harvesting crops at peak ripeness, reducing waste and labor costs. These robots can operate around the clock, optimizing productivity and handling delicate tasks like picking fruits without damaging them.
- **Supply Chain Optimization:** AI tools analyze market demand, weather conditions, and logistical variables to optimize the agricultural supply chain; reducing spoilage, lowering transportation costs, and ensuring that products reach the market in optimal condition.
- **Climate Adaptation Models:** AI models simulate various climate scenarios to help farmers adapt their practices to changing environmental conditions; selecting crop varieties more suited to future climates and modifying farming techniques accordingly.

Petre Dini
IARIA
USA/EU

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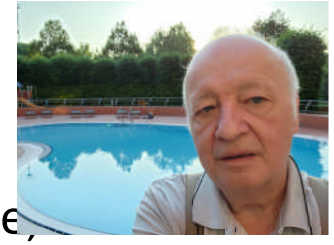
Major Achievements in Agriculture through Sensing Systems



Petre Dini
IARIA
USA/EU

Soil Health Monitoring: Sensors monitor soil conditions, including moisture, pH levels, temperature, and nutrient content; real-time data helps farmers apply precise amounts of water and fertilizers.

Plant Health Imaging: Sensors on drones or satellites capture multispectral images to assess plant health by detecting light absorption and reflection; early detection of disease or stress in plants

Water Management Systems: Sensing systems that monitor irrigation and water usage can optimize water resources, especially in arid regions.

Livestock Monitoring: Sensors attached to livestock can monitor health indicators such as heart rate, activity levels, and eating patterns.

Atmospheric Monitoring: Sensors that detect atmospheric conditions like humidity, temperature, and CO2 levels can help in making informed decisions about crop management and protection measures against potential adverse weather conditions.

Yield Estimation: Sensing technologies can estimate crop yields by analyzing plant characteristics and growth patterns. This allows for better market planning and supply chain management, reducing the gap between supply and demand.

Robotic harvesting

➢The most developed areas for robotic harvesting

Petre Dini
IARIA
USA/EU

Fruits

- ***Berries*** **(Strawberries, Blueberries, Raspberries)**: Vision systems and soft grippers to avoid damaging the fruit.
- ***Apples and Oranges***: Detect ripeness and size, then pick the fruit without causing bruising.

Vegetables

Lettuce and Cabbages: Robots equipped with cutting tools and visual recognition systems can harvest these leafy vegetables.

Tomatoes and Peppers: Greenhouse environments provide ideal conditions for robotic systems to navigate and selectively harvest ripe produce.

Grapes: Robotic harvesters can identify ripe clusters and perform precision cuts to minimize damage to vines and fruit.

Cucumbers: Especially in greenhouse settings, robots can effectively identify and harvest cucumbers.

Root Crops: *Potatoes and Carrots*: Some advancements have been made in robotic systems that can uproot these vegetables without causing damage, although challenges remain due to the variability in soil conditions.

Nuts: *Almonds and Walnuts*: Robotic technology is used not just for harvesting these nuts but also for tasks like pruning and monitoring the health of the trees.

Robotic harvesting

Petre Dini
IARIA
USA/EU

➢Technological and Operational Considerations

- **Vision Systems**: Robotic harvesters use advanced cameras and imaging technologies to determine the ripeness and location of fruits and vegetables. These systems must be highly accurate to ensure that only ripe produce is harvested.
- **Gripping Mechanisms:** Different crops require different types of grippers to handle them without causing damage. For example, soft fruits like berries need very delicate handling to prevent bruising.
- **Navigation and Mobility:** Robots must be able to navigate through varying farm environments, which can range from dense orchards to open fields. This involves sophisticated AI and machine learning algorithms to manage obstacles and optimize harvesting paths.
- **Adaptability:** The ability to adapt to different sizes, shapes, and conditions of crops is crucial for the effectiveness of robotic harvesters. This adaptability is a significant focus of ongoing research and development

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Robotic harvesting for Apples and Oranges

Petre Dini
IARIA
USA/EU

- **Complexity in Detection and Picking:**

***Ripeness Assessment*:** Accurately determine the ripeness of each fruit, which can vary greatly within a single tree; advanced vision systems capable of analyzing color and possibly other indicators.

***Obstructed View*:** Fruits like apples and oranges often grow in clusters with leaves and branches obstructing the view and access; must navigate through this foliage without damaging the produce or the plant.

- Delicate Handling:

***Damage Prevention*:** Both apples and oranges are susceptible to bruising if mishandled; grippers must be sophisticated enough to apply just enough force to pick the fruit without squeezing it too hard or dropping it.

- **Variability in Environment:**

***Outdoor Conditions*:** Orchards are subject to variable weather conditions that can affect robotic operation. This includes changes in lighting, wind, and precipitation, which can disrupt sensor accuracy and robot mobility.

***Uneven Terrain*:** Orchards may have uneven or sloped terrain, posing challenges for robot stability and mobility, which are critical for precise operations.

- **Speed and Efficiency:**

***Operational Speed*:** Need to operate at a speed comparable to or better than human pickers. Achieving this efficiency while maintaining accuracy and delicacy in picking is a significant challenge.

Energy Consumption: Efficient power use is crucial, especially given the potentially large areas that robots need to cover in commercial orchards.

- **Cost and ROI:**

High Initial Investment: The cost of developing, purchasing, and maintaining robotic systems can be prohibitive for many growers, particularly when the return on investment (ROI) is uncertain.

***Maintenance and Upkeep*:** Robotic systems require regular maintenance and updates, which can be costly and require technical expertise not always available on farms.

- Integration with Existing Practices:

Adaptability to Different Orchard Designs: Orchard layouts and tree shapes vary widely, and robots may need customization to work effectively in different settings.

Compatibility with Other Farming Operations: Integrating robotic systems with existing farm management practices, including spraying and pruning, is essential for seamless operation.

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