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MYSEA - Mediterranean Youth, NEETs and women advancing Skills, Employment and Awareness in the blue and green economy

MYSEA

"IT Skills for the Agri-food sector"

Module 2

IT Skills for the Agri-food Sector

Become familiar with the different **digital tools** and how these can benefit the **agri-food sector**

Understand the key concepts around the **digital agriculture revolution**

Know how to **utilize the different digital technologies** to achieve the desired objectives

INTRODUCTION

This teaching module is focused on the digital revolution in agriculture, including key concepts such as digital agriculture, agriculture 4.0, and smart farming.

- ✔ Unit 1 provides an overview of the impact of digital agriculture and covers the main areas of digital agriculture, trends, and key concepts such as Agriculture 4.0 and digital and smart farming.
- ✔ Unit 2 delves into innovation and agri-preneurship, including what it is, its forms and importance, how it is connected to digital transformation, and steps to develop an innovation culture.
- ✔ Unit 3 covers precision agriculture, including technologies and techniques, benefits, and examples.

INTRODUCTION

- Unit 4 explores the internet of things (IoT) in agriculture, including its technologies and applications in agri-food, benefits, and examples.
- Unit 5 focuses on big data analysis in agriculture, including its applications in agri-food, benefits, and examples.
- Unit 6 provides additional examples of digital agriculture, including robotic systems, temperature and moisture sensors, GPS technology, smart farming and food security, and challenges.

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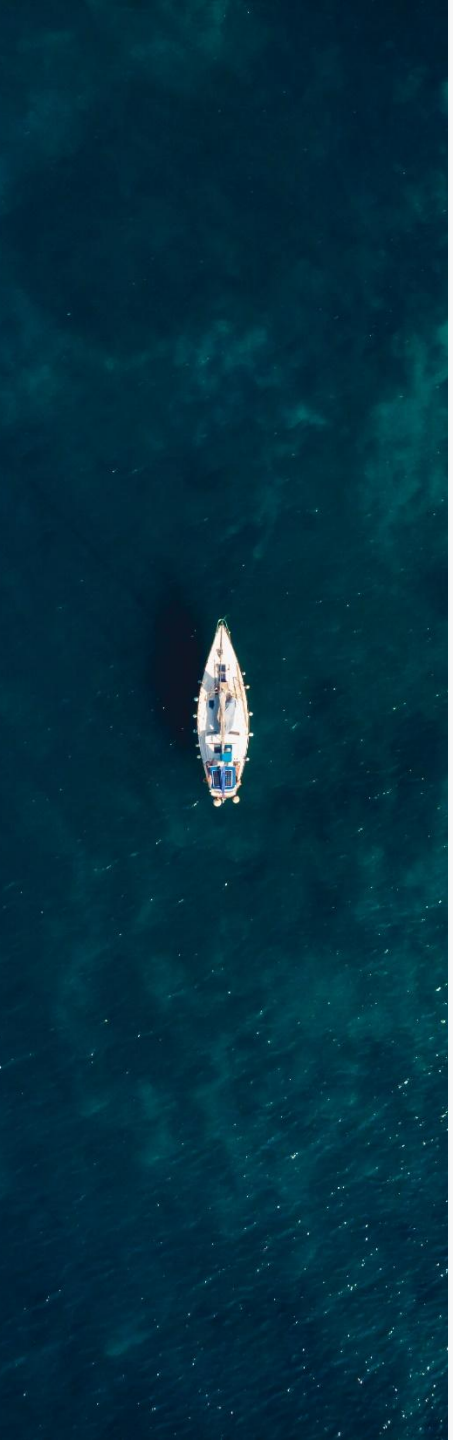
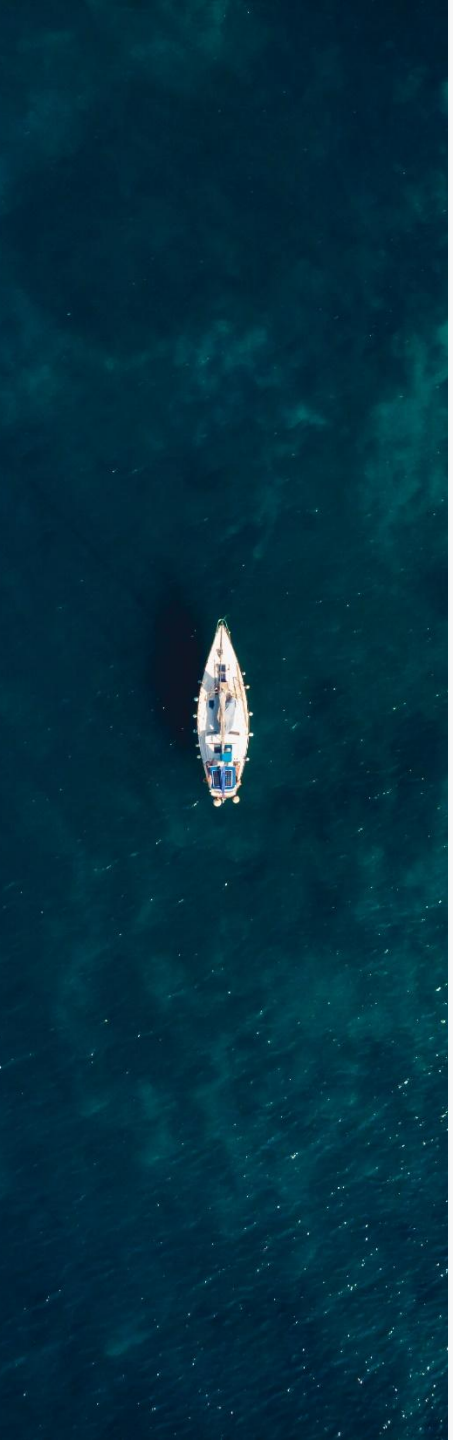


Overview and impact

The digital agriculture revolution refers to the use of technology and data in farming and agriculture. This includes precision farming techniques, use of drones and sensors to collect data, and use of artificial intelligence to analyze and make decisions about crop growth and management



Overview and impact

Precision farming techniques
more precisely use of fertilizers and pesticides reducing waste and improving crop yields

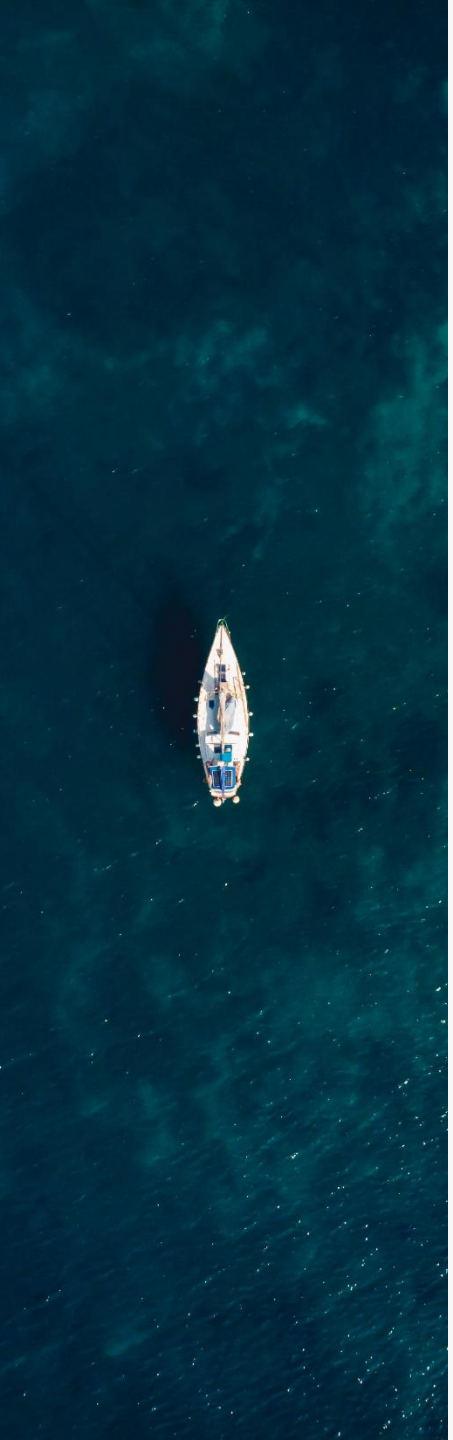
Drones and sensors
collect data on crop health and growth

Artificial intelligence
analyze the data and make predictions about weather, pests, and other factors that can impact crop growth

Digital agriculture
better understand their land and resources

Increase the productivity and efficiency of the agricultural sector

Improve the efficiency, yield, and sustainability of agriculture

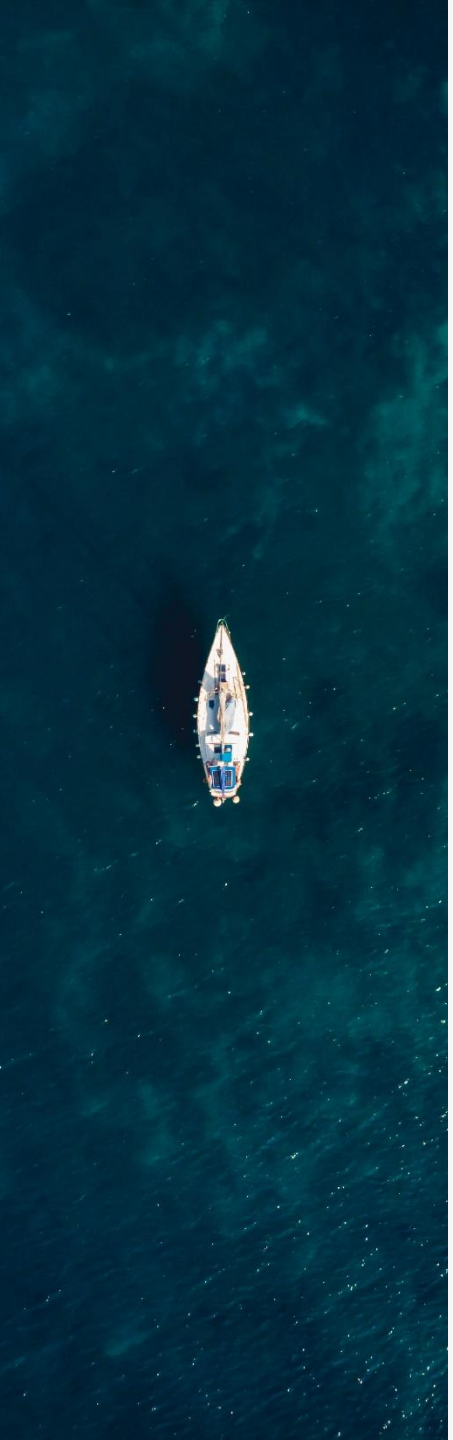


What is digital agriculture?

The digital agriculture revolution refers to the **use of digital technologies**, including precision agriculture, IoT, big data analytics, and artificial intelligence, **to improve the efficiency, productivity, and sustainability of agricultural practices.** The digital agriculture revolution seeks to transform traditional farming methods by leveraging technology to optimize crop yields, reduce costs, and improve the efficiency of resource use.

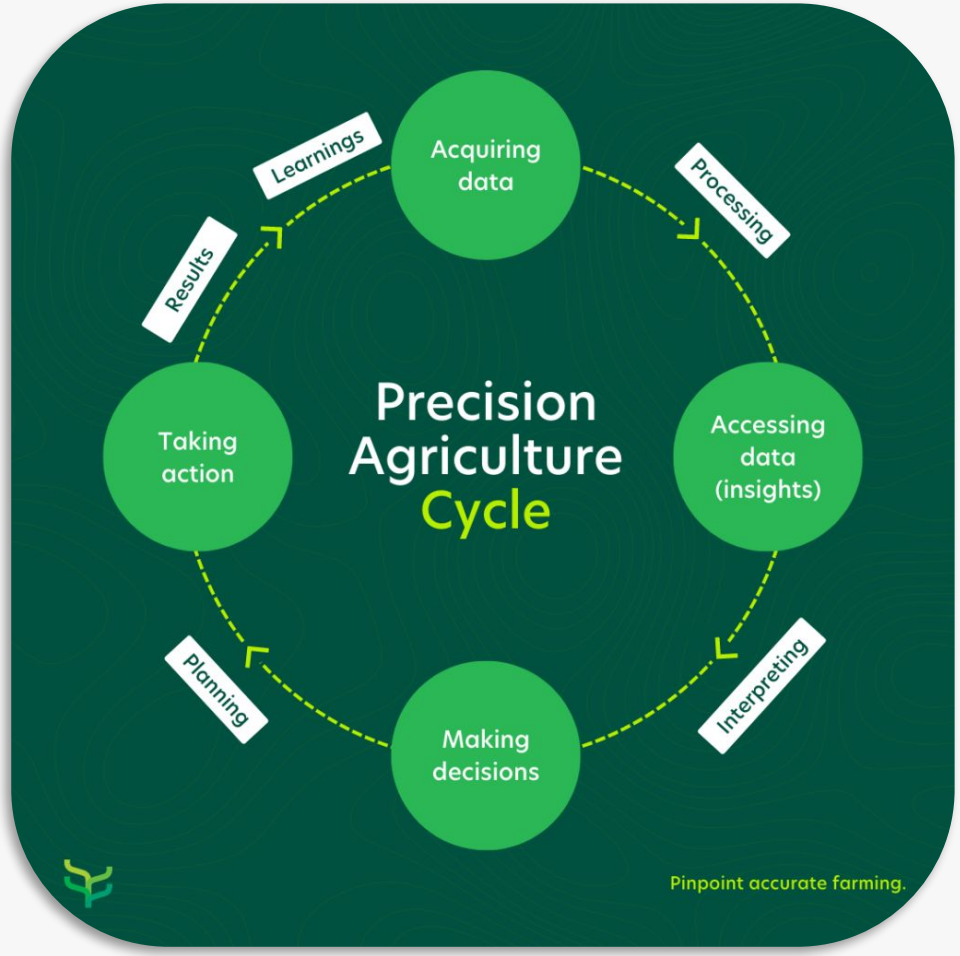
"The best way to predict the future of agriculture is to create it…"

What are the main areas of digital agriculture?

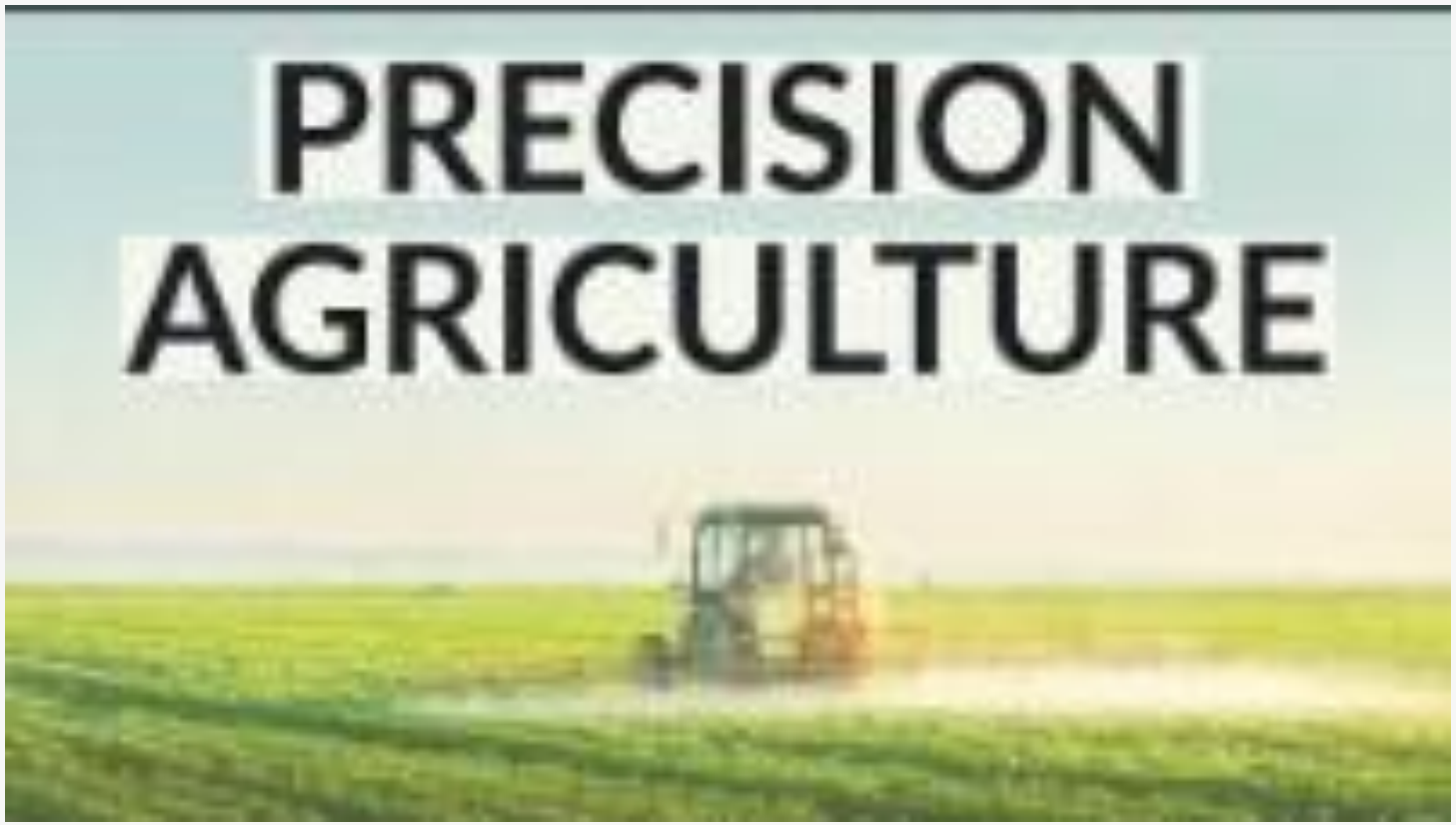


PRECISION AGRICULTURE

It uses sensor technology and precision mapping to collect data on crop growth, weather, and soil conditions. This data is then analyzed to make more informed decisions about planting, fertilizing, and harvesting crops, which can lead to more efficient and sustainable farming practices

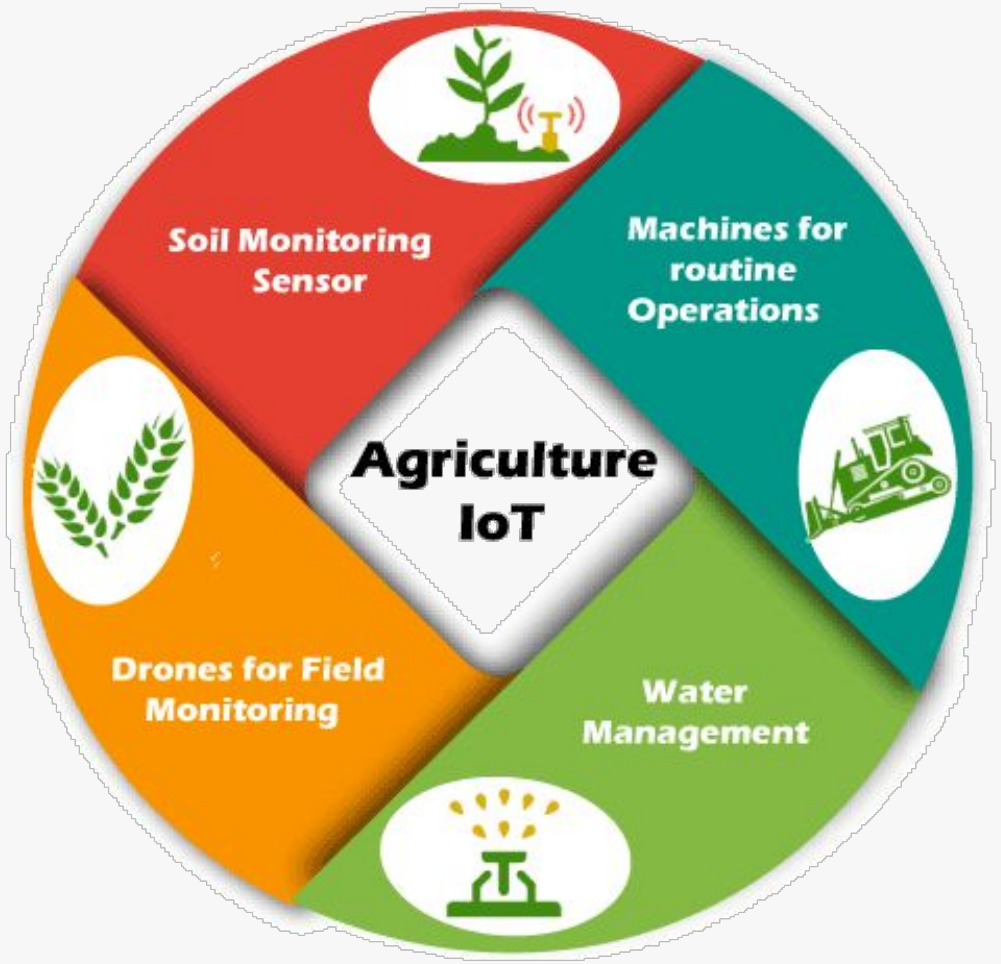


What are the main areas of digital agriculture?



https://www.youtube.com/watch?v=WhAfZhFxHTs

What are the main areas of digital agriculture?



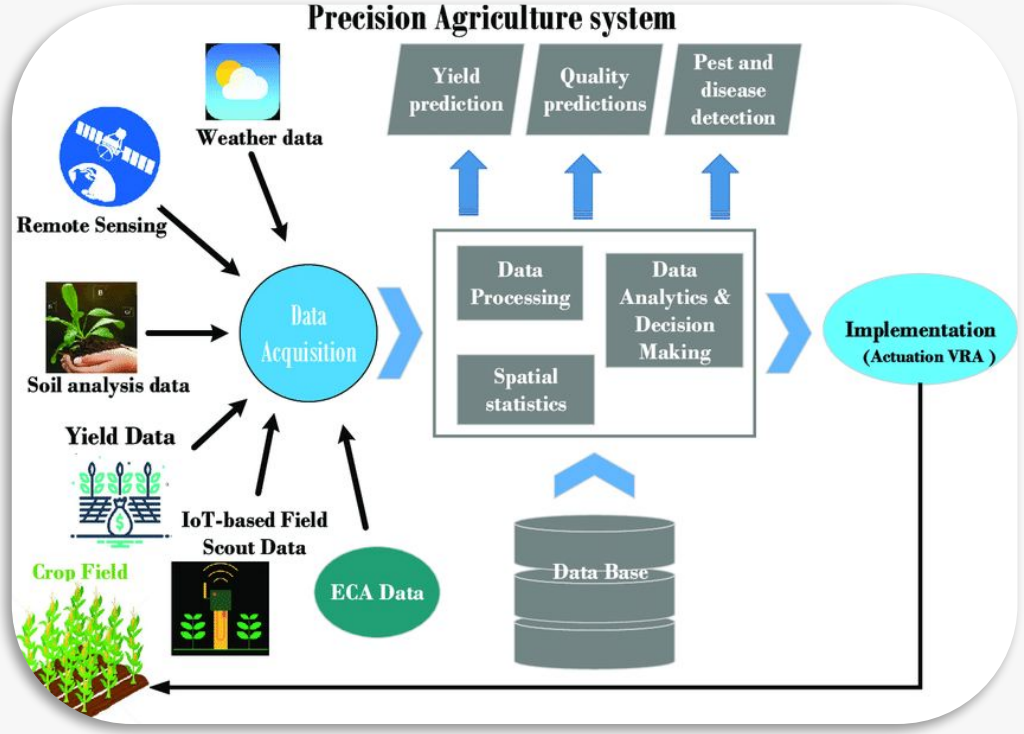
IOT DEVICES

It is used to collect real-time data on crop growth, soil conditions, and weather patterns. This data can be used to improve crop yields, reduce costs, and increase efficiency

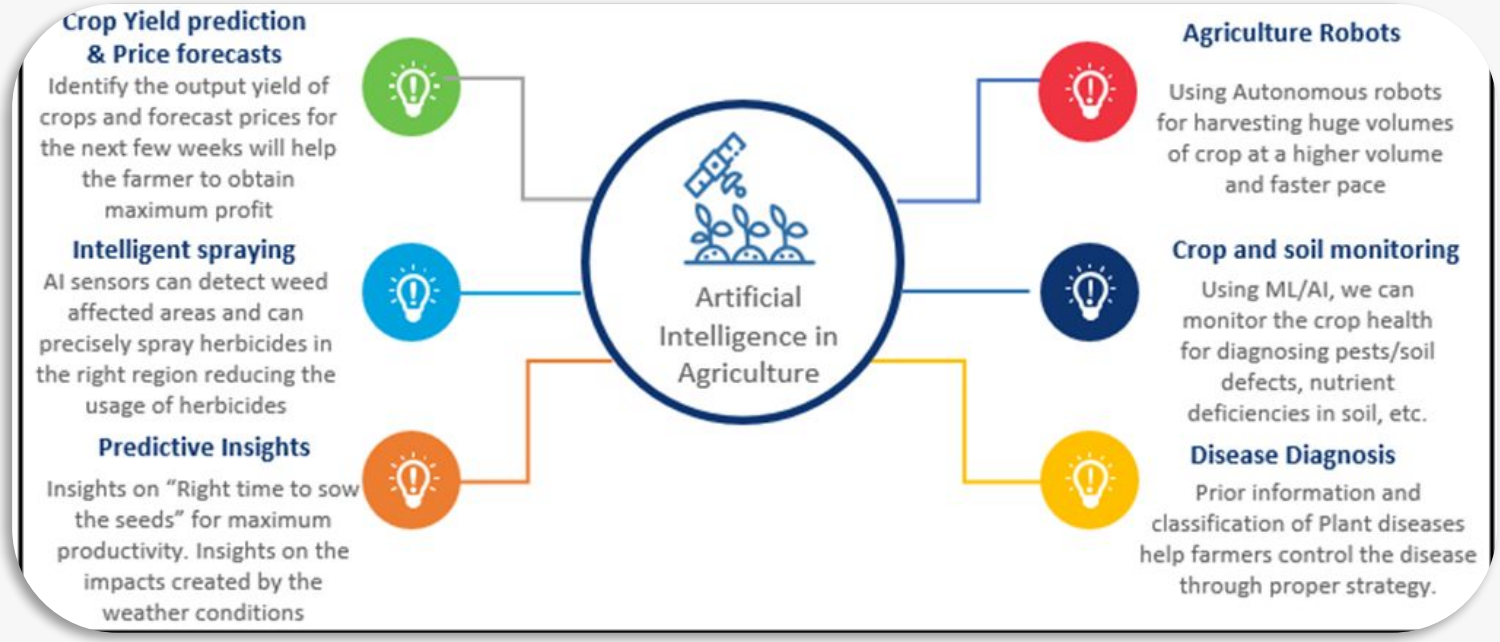
What are the main areas of digital agriculture?

BIG DATA ANALYTICS

It allows farmers to analyze large amounts of data from various sources, such as weather forecasts, soil and crop sensors, and social media, to make more informed decisions about planting, fertilizing, and harvesting crops

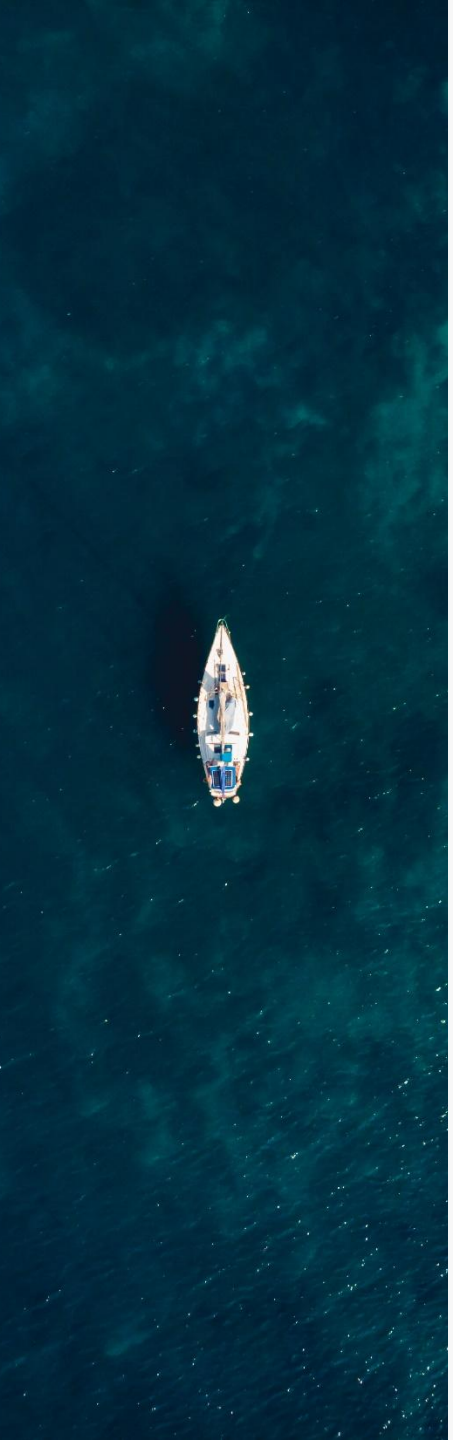


What are the main areas of digital agriculture?



AI and ML

AI and ML can be used to analyze data from various sources, such as weather, soil and crop sensors, to help farmers make informed decisions about planting, fertilizing and harvesting



Trends

Digital Twins

The use of digital twins, virtual replicas of physical assets, to simulate and optimize the performance of different farming scenarios in order to improve crop yields and reduce costs

Autonomous vehicles and robots

The use of autonomous vehicles and robots to perform tasks such as planting, harvesting, and monitoring crops

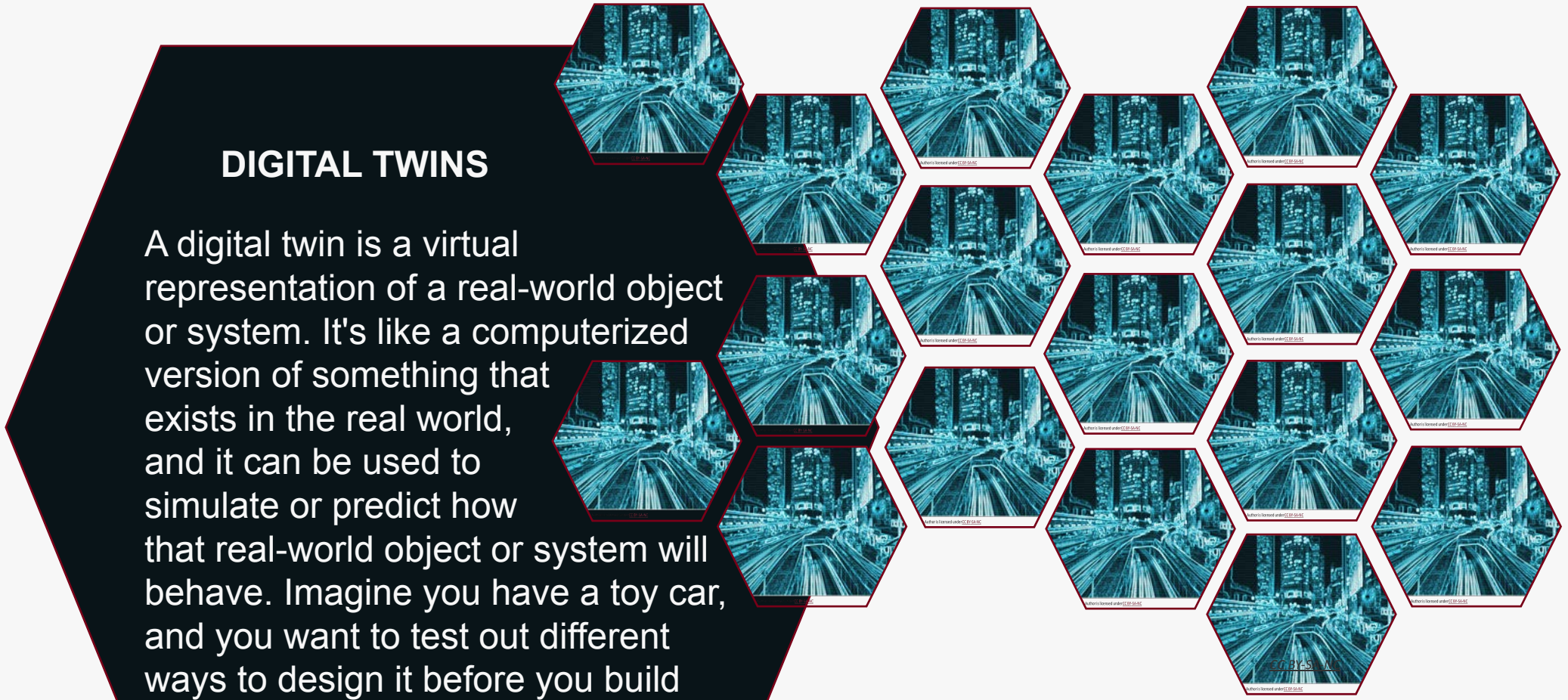
Blockchain technology

The use of blockchain technology to enhance transparency, security, and traceability in supply chain management, and to improve quality and safety of produce

Trends

DIGITAL TWINS

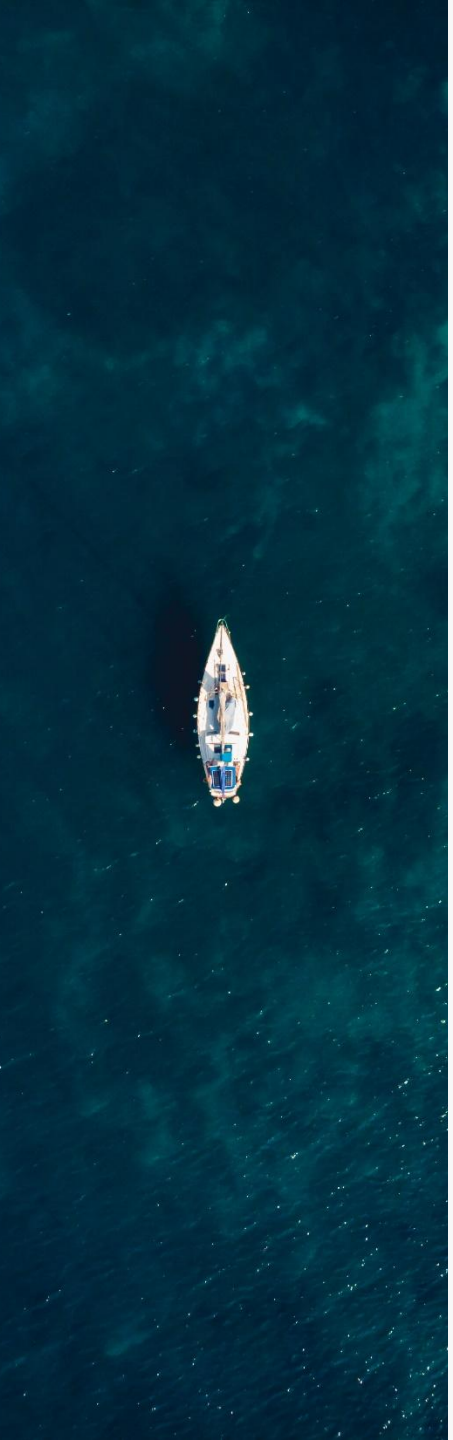
A digital twin is a virtual representation of a real-world object or system. It's like a computerized version of something that exists in the real world, and it can be used to simulate or predict how that real-world object or system will behave. Imagine you have a toy car, and you want to test out different ways to design it before you build the real thing.



Trends

AUTONOMOUS VEHICLES AND ROBOTS

Autonomous vehicles in agriculture are vehicles such as tractors, harvesters, and sprayers that can operate without a human operator. They use sensors and GPS technology to navigate and perform tasks like planting, harvesting, and spraying crops. Robots in agriculture are similar, but they are smaller machines that can perform specific tasks such as picking fruits and vegetables.



Trends

5G and edge computing

Use of 5G networks and edge computing to enable faster, more reliable communication between smart devices and to enable real-time data processing and decision-making

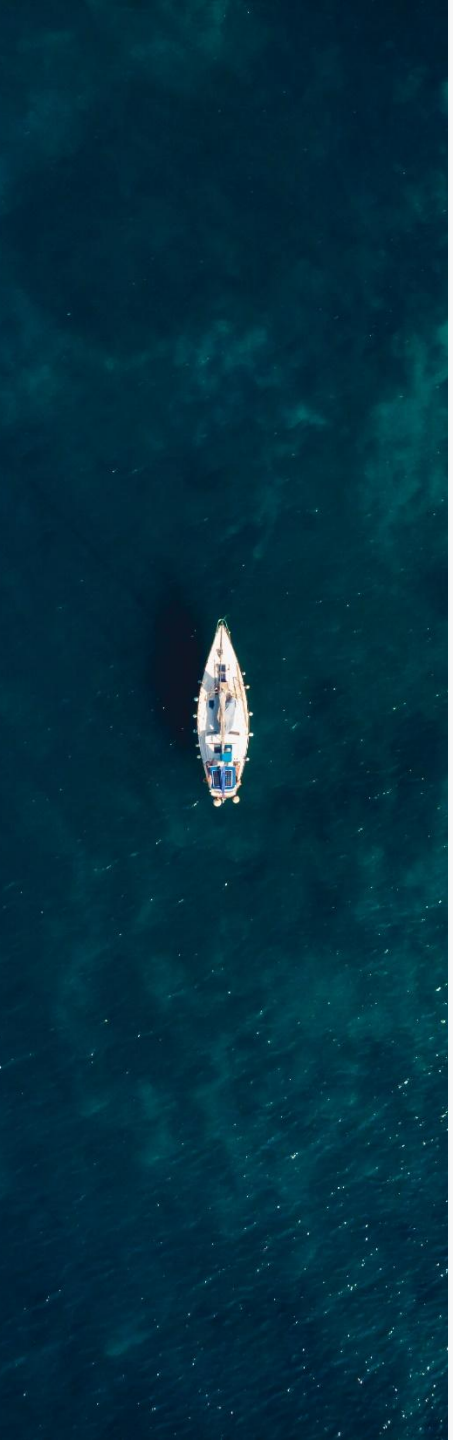
Digital extension services

The use of digital platforms to provide farmers with access to information, training and digital extension services, such as weather forecasting, crop management, and market information

Virtual and augmented reality

The use of virtual and augmented reality to provide farmers with immersive training and visualization of different farming scenarios, to help improve crop yields and reduce costs

Trends

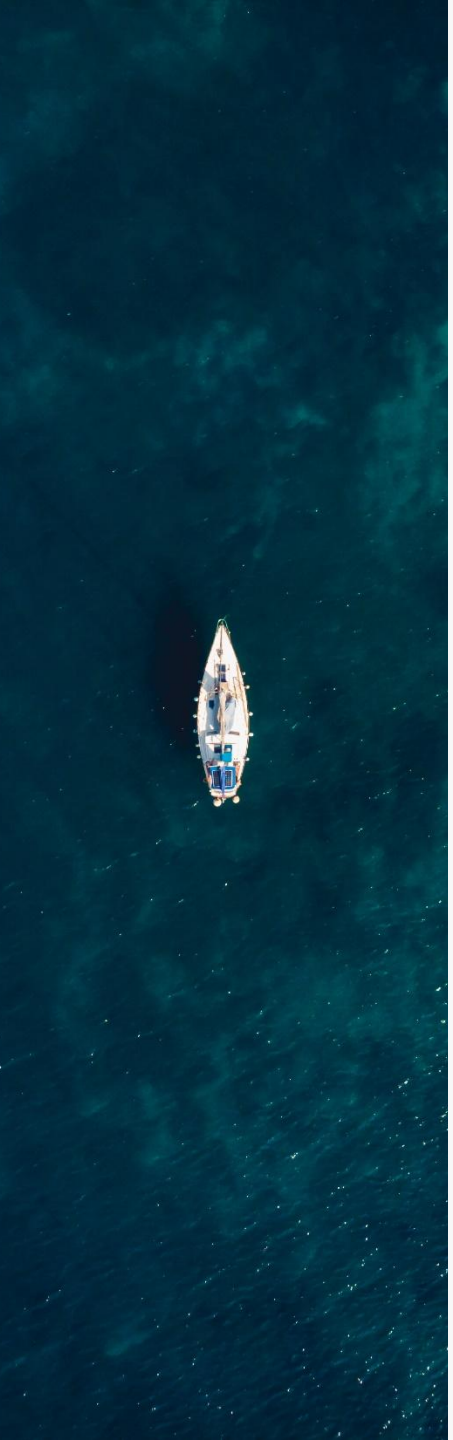


DIGITAL EXTENSION SERVICES

Digital extension services are ways that farmers and other people in the agriculture industry can access information and resources online, rather than having to go to a physical location. This could include things like online tutorials, videos, and forums where people can ask questions and get advice from experts.

Agriculture 4.0

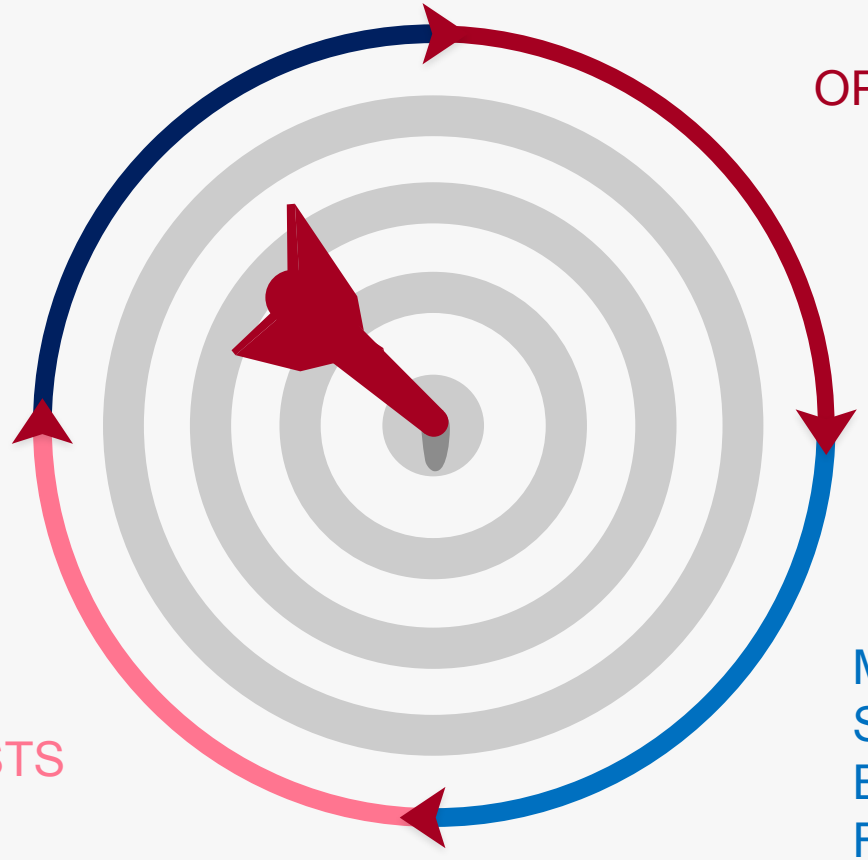
Agriculture 4.0 is a term used to describe the fourth industrial revolution in agriculture, characterized by the **integration of digital technologies such as IoT, big data analytics, artificial intelligence, and robotics** into traditional farming practices.



Agriculture 4.0

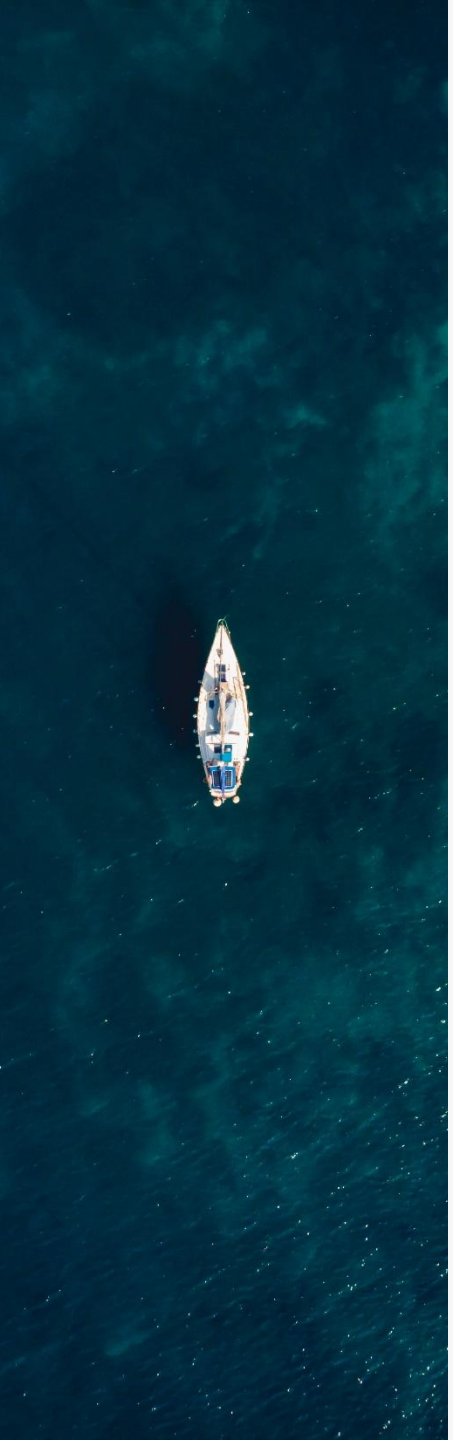
IMPROVE THE EFFICIENCY OF RESOURCE USE

OPTIMIZE CROP YIELDS



REDUCE COSTS

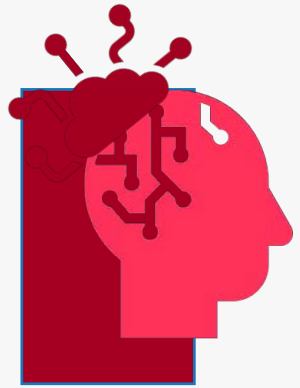
MAKE FARMING MORE SUSTAINABLE AND ENVIRONMENTALLY FRIENDLY



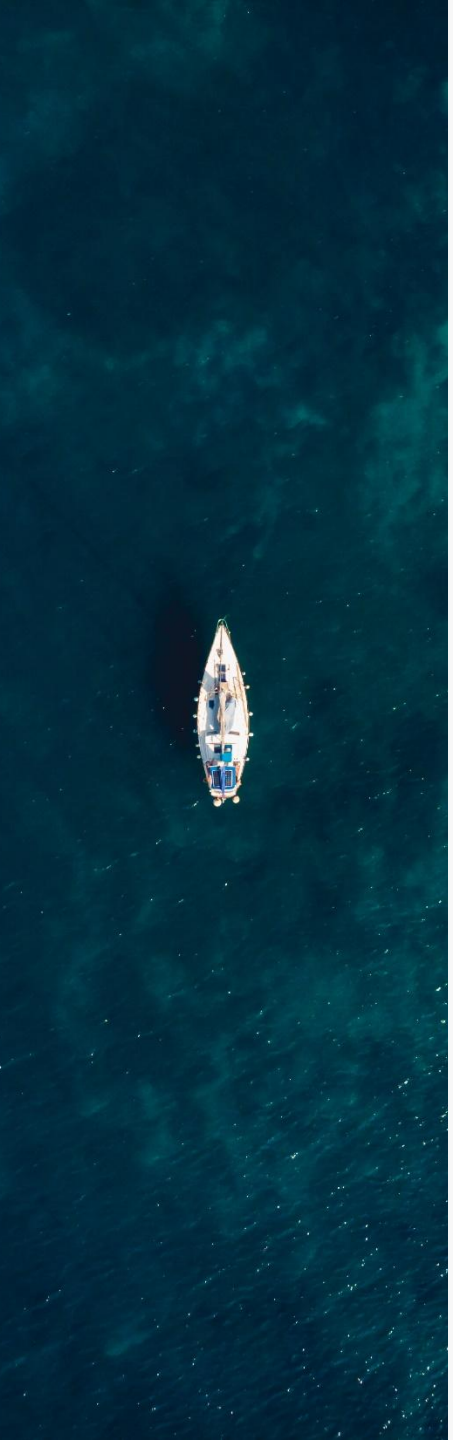
Digital and smart farming

"In this topic you will understand what digital and smart farming is"

Digital and smart farming are closely related concepts that refer to the **use of technology and data in agriculture** to improve efficiency, yield, and sustainability



Digital farming refers to the **use of technology and data in agriculture**, while **smart farming** refers to the use of technology to create a **more sustainable and efficient food production system**.



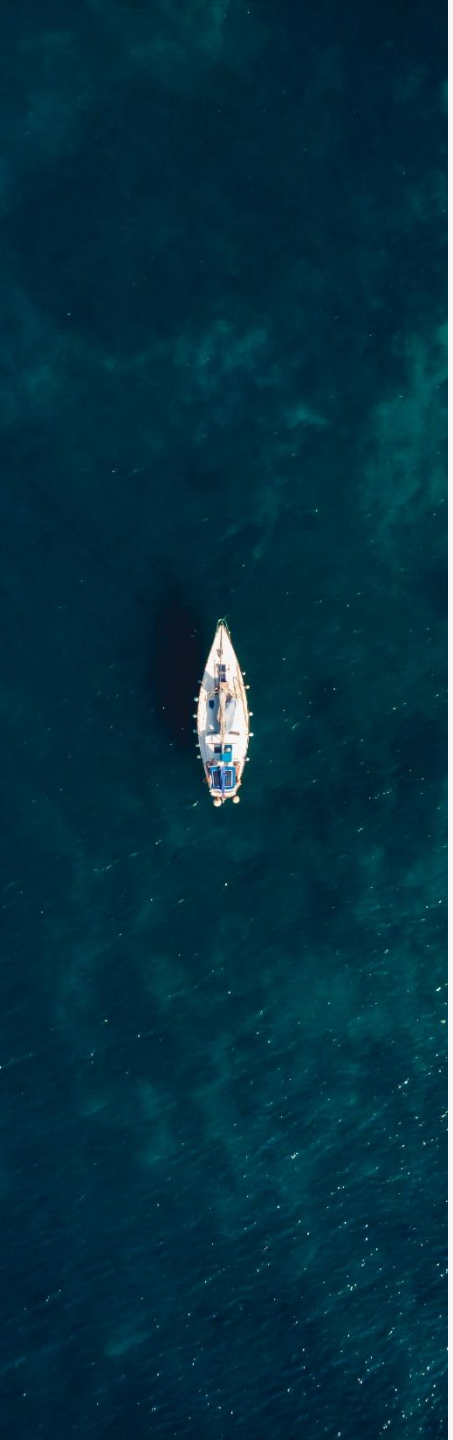
Digital and smart farming

DIGITAL FARMING

…use of technology in agriculture, such as precision farming techniques, drones, and sensors to collect data, and the use of artificial intelligence to analyze the data...

SMART FARMING

…use of technology in agriculture to improve efficiency, yield, and sustainability. Smart farming involves the integration of digital technologies such as IoT, big data, and AI to create a more sustainable and efficient food production system…



Digital and smart farming

DIGITAL FARMING

Precision agriculture - *improve the use of fertilizers and pesticides, reducing waste and improving crop yields*

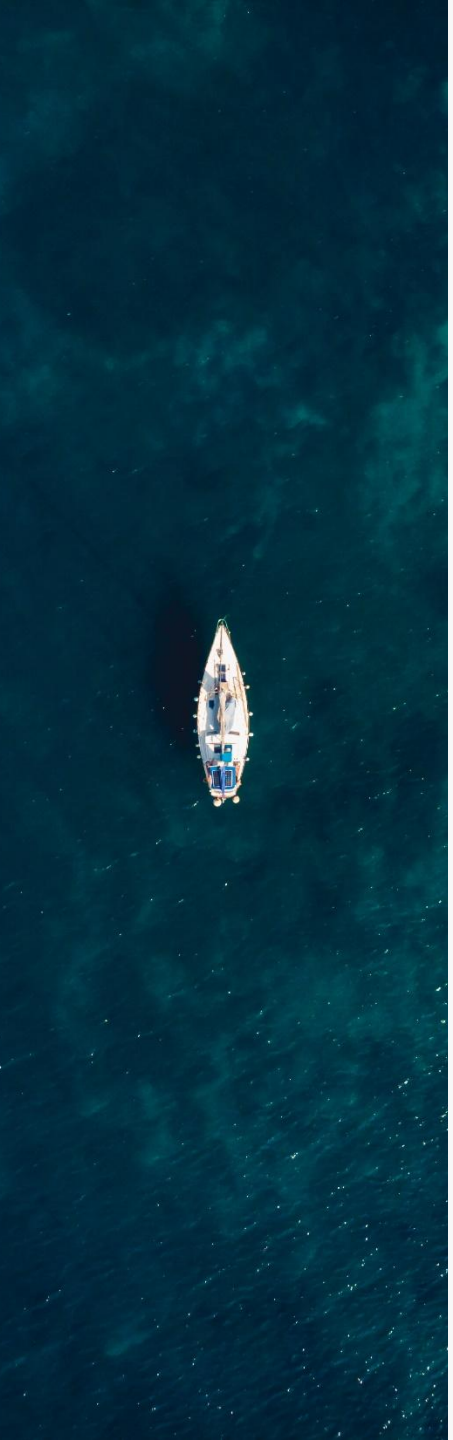
Drones and sensors - *collect data on crop health and growth*

Artificial intelligence - *analyze the data and make predictions about weather, pests, and other factors that can impact crop growth*

SMART FARMING

Sensors and other digital tools - *monitor and analyze crop growth, weather patterns, soil conditions, and other factors to optimize crop yields and reduce waste*

Automated systems - *control irrigation, fertilization, and other critical farming activities*



Group work

Groups

- Divide into groups of 10

Examples

- Read the examples and identify if they are referring to digital farming or smart farming

Brainstorm

- Choose 3 examples and brainstorm on how the agri-food sector could benefit from this technology

Share

- Share your thoughts and discuss

Group work

1. A farmer uses a precision farming technique, such as precision planting, where seed planting is done with high accuracy using GPS-controlled equipment
2. A farmer uses an IoT-enabled sensor system to monitor soil moisture levels in real-time
3. A farmer uses a drone to collect aerial images of the farm
4. A farmer uses AI algorithms to predict weather patterns and make decisions about planting, harvesting, and crop management
5. A farmer uses a GPS-enabled tractor to map the farm and create a digital record of the farm's layout and topography
6. A farmer uses machine learning algorithms to optimize crop yields and improve the efficiency of farming operations

Module 2: IT Skills for the Agri-food Sector

Unit 1: Digital Agriculture Revolution

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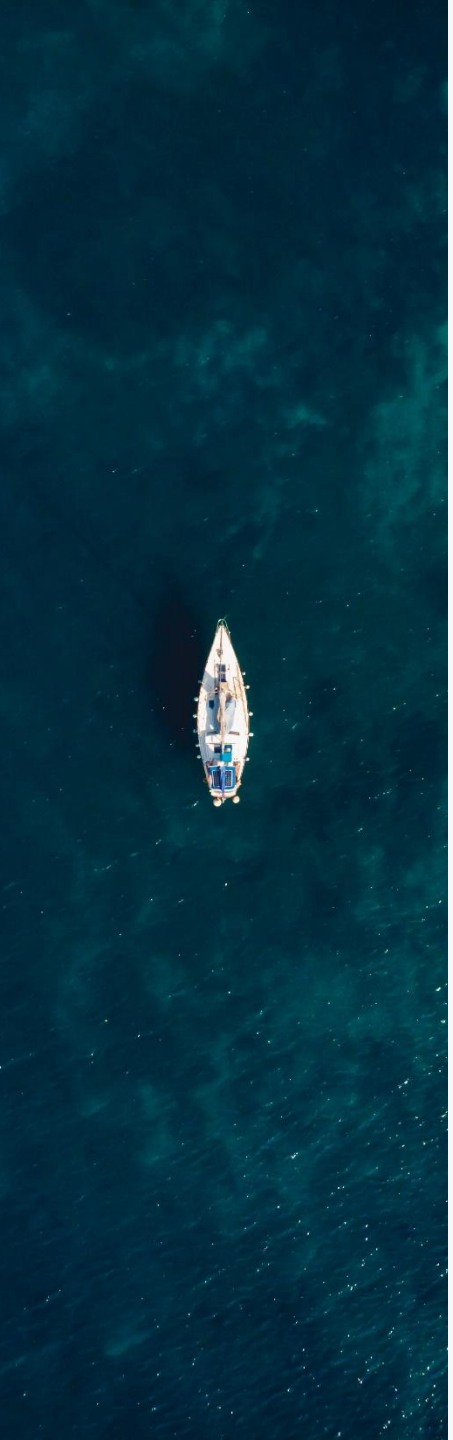
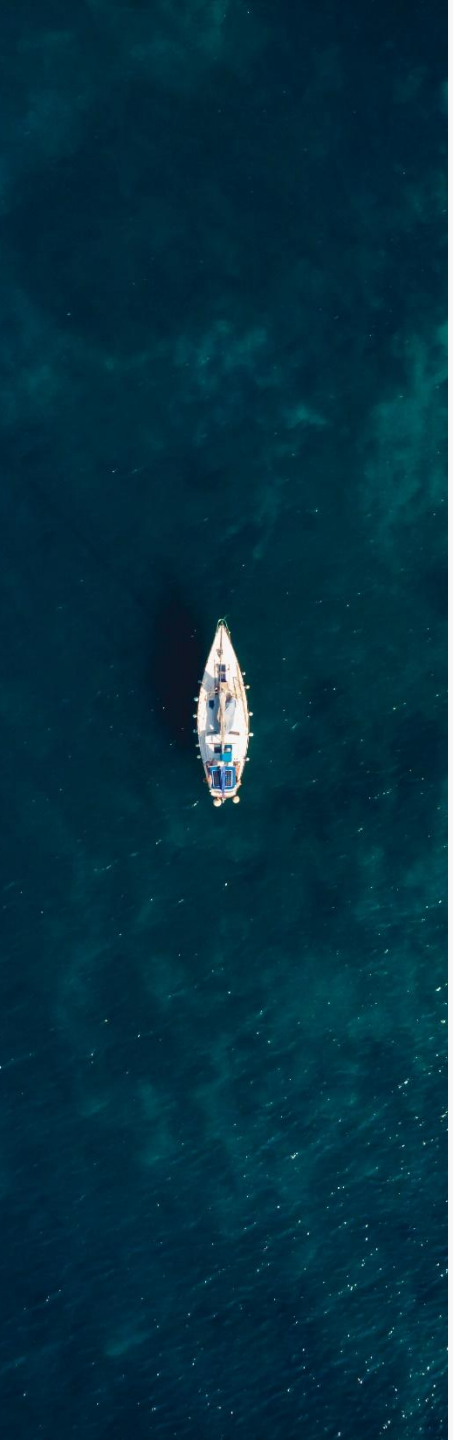


What is agri-preneurship?

Digital agri-preneurship is the **application of digital technologies and business models to the agriculture industry**. It includes using technology such as precision farming, data analytics, and e-commerce to improve efficiency, increase yields, and connect farmers with markets

The first step is to establish that something is possible: then probability will occur
-Elon Musk



Importance

ECONOMIC DEVELOPMENT

…by creating jobs and increasing productivity…

FOOD SECURITY

…by increasing yields, reducing waste, and connecting small farmers with markets…

ENVIRONMENTAL SUSTAINABILITY

…by reducing the use of water, chemicals and other resources, and by promoting sustainable agriculture practices…

IMPROVED LIVELIHOODS FOR FARMERS

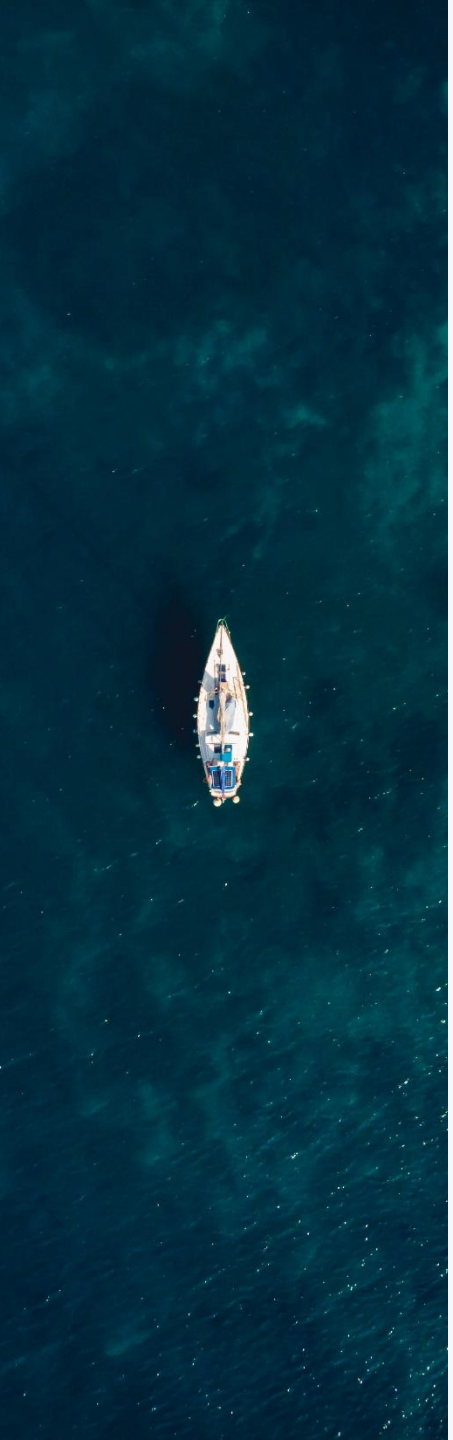
…by increasing their incomes and reducing their costs, which can lead to better living standards and more stable communities…

INNOVATION IN AGRICULTURE

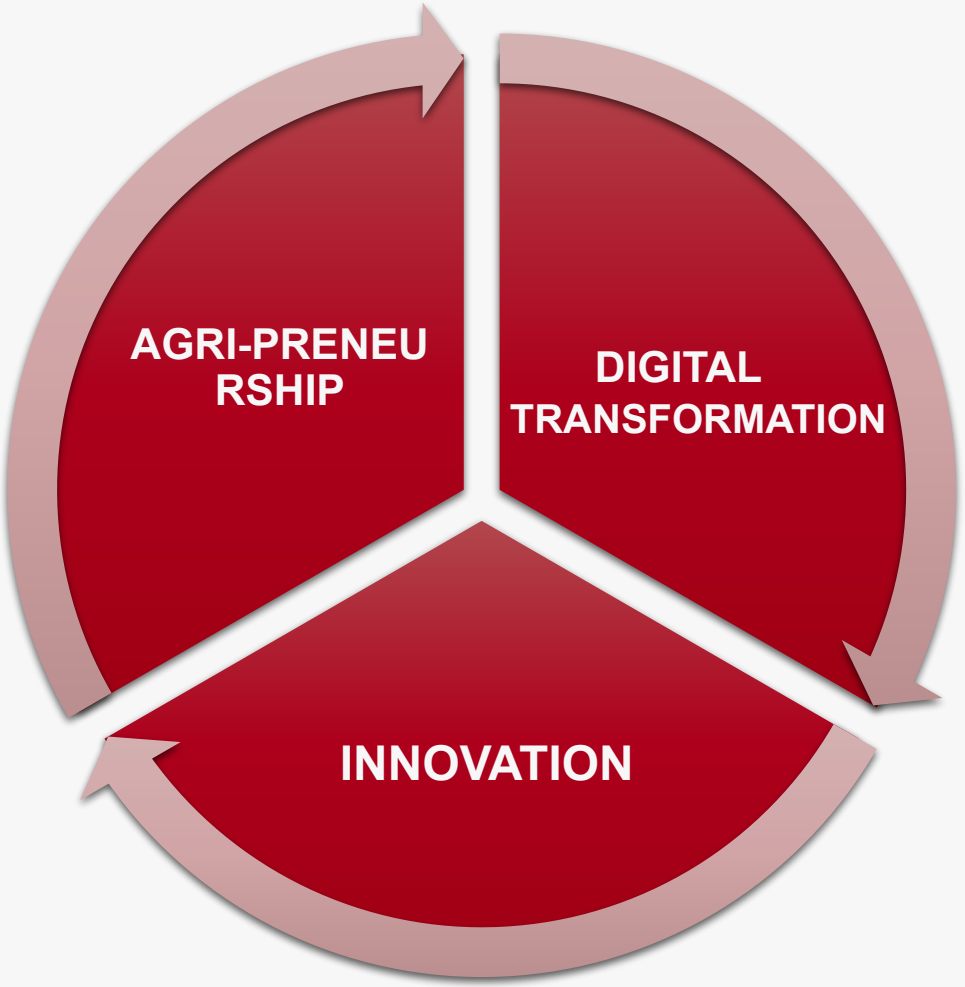
…more efficient and productive ways of farming which can be beneficial for the whole agricultural ecosystem…

RURAL DEVELOPMENT

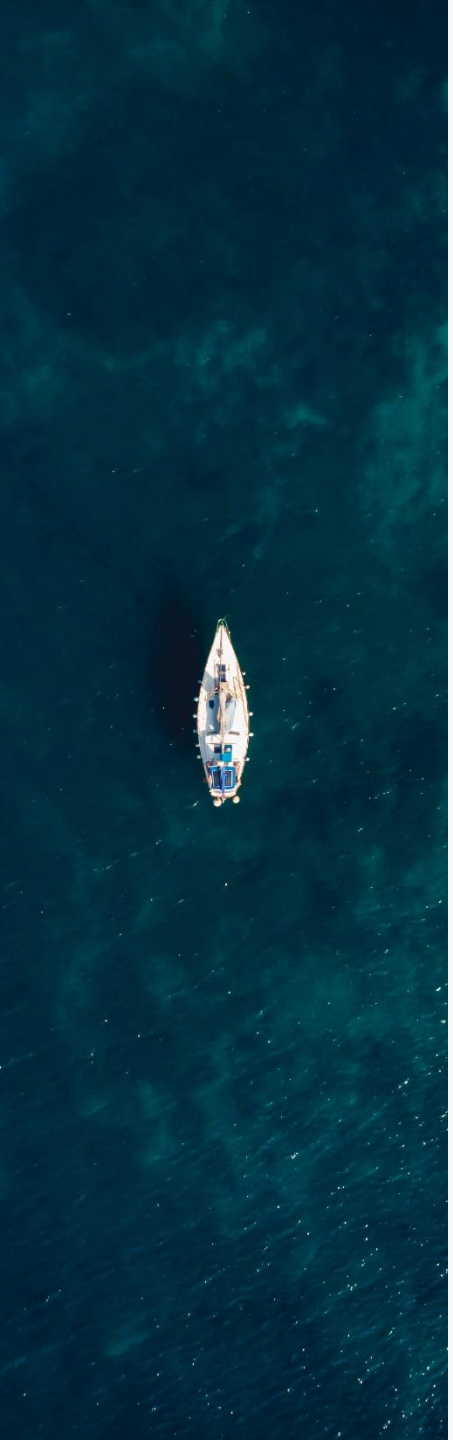
…by providing opportunities for entrepreneurs in rural areas and by encouraging investment in rural communities…



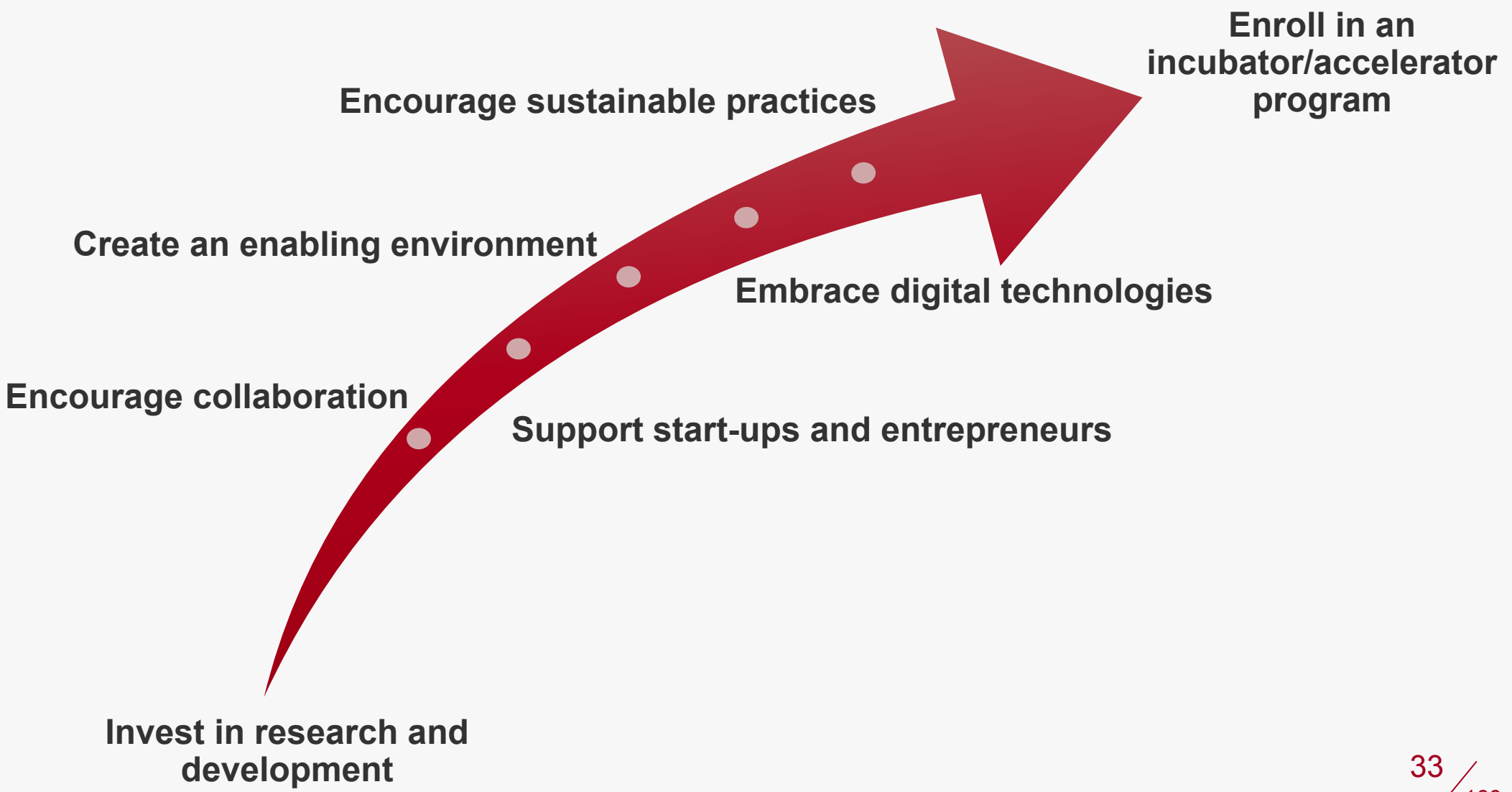
How is it connected to digital transformation?



The adoption of digital technologies and innovative business models by agri-preneurs is driving the digital transformation of the agriculture sector and creating new opportunities for growth and development



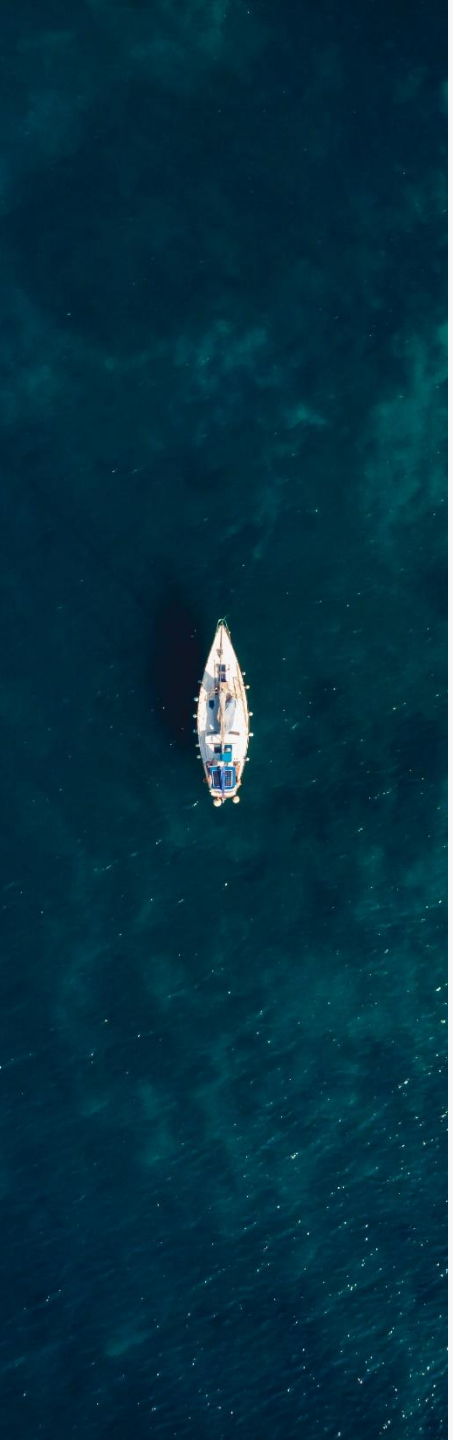
Ways to foster innovation in the agri-food sector



Internet of Food and Farming 2020

The project began in 2016 and ran until 2020. and was co-funded by the European Union's Horizon 2020 research and innovation program.

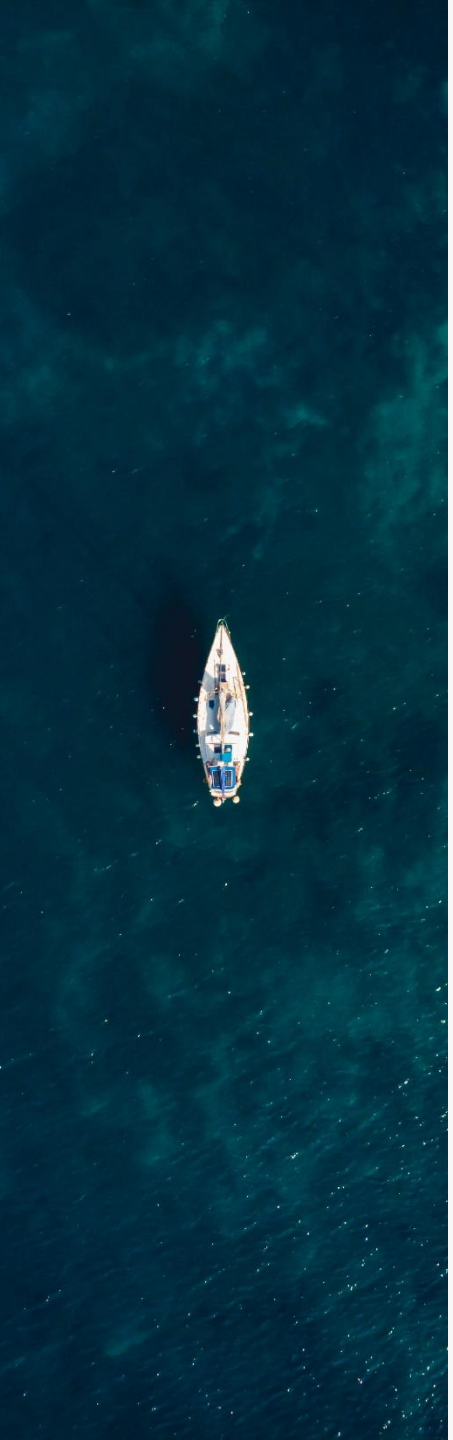
The Internet of Food and Farm 2020 (IoF2020) is an EU-funded research project that aims to develop and demonstrate a new generation of IoT-based solutions for the agri-food sector. The project aims to create an interconnected food and farming ecosystem that will improve efficiency, reduce costs, and increase sustainability throughout the entire food value chain.



Internet of Food and Farming 2020

The project focuses on four main areas of research:

- **IoT-enabled precision farming** *(using sensors, drones, and other technologies to gather data on crop growth and soil conditions)*
- **IoT-enabled food safety and traceability** *(using RFID tags and other technologies to track the movement of food products from farm to consumer)*
- **IoT-enabled livestock management** *(using sensors and cameras to monitor the health and well-being of livestock)*
- **IoT-enabled smart cities and communities** *(using data from IoT sensors to optimize the use of resources and improve the sustainability of cities and communities)*



Match

Examples

- Read the examples and the descriptions

Match

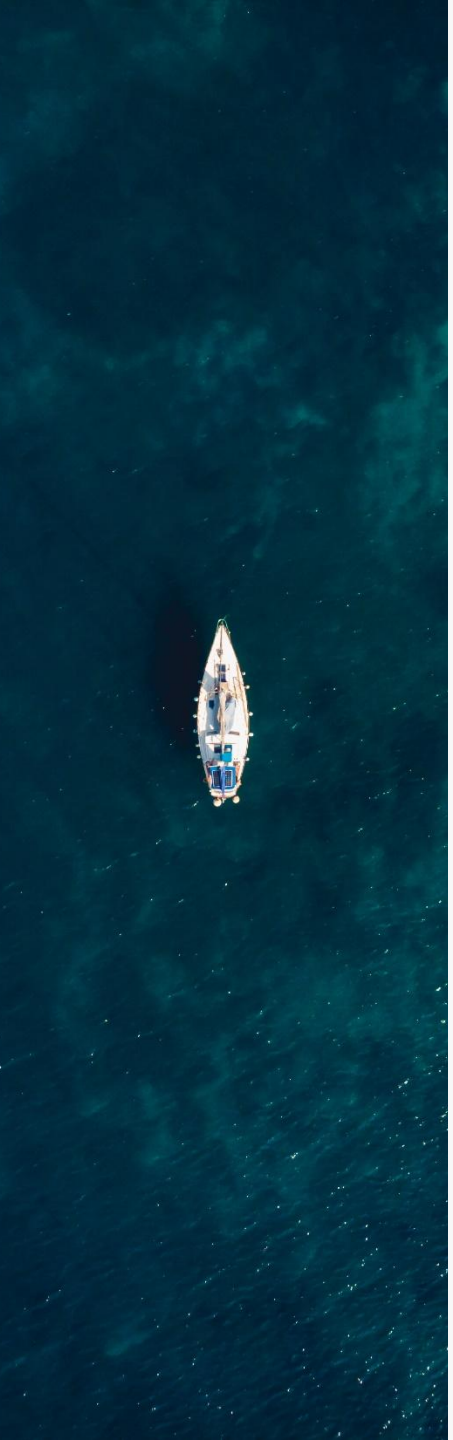
- Match each example with the description that best describes it

Review

- Review the answers

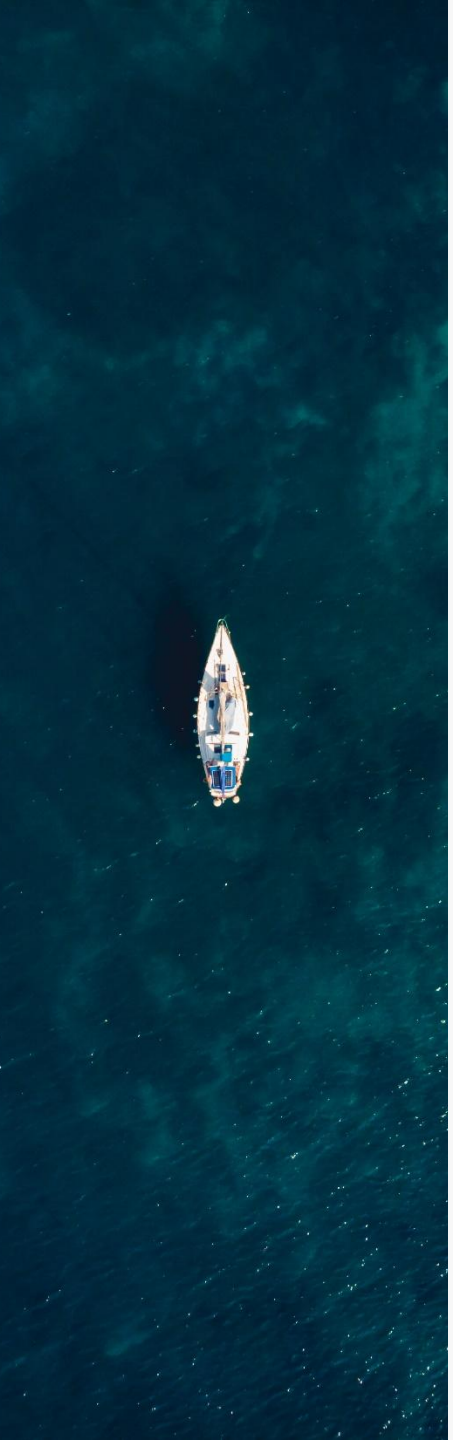
Discuss

- Discuss the answers and any differences with the classroom



Match

1. Precision farming	a. using sensors, cameras, and other technologies to monitor the health and well-being of livestock, which can help farmers detect and respond to diseases more quickly
2. E-commerce platforms for connecting farmers with consumers	b. using real-time data on weather, soil moisture, and crop growth to optimize irrigation systems, which can help farmers save water and reduce costs
3. Livestock monitoring systems	c. using data analytics and machine learning to predict crop yields and weather patterns, which can help farmers make more informed decisions about planting and harvesting
4. Crop and weather forecasting	d. using RFID tags, GPS, and other technologies to track the movement of livestock and ensure compliance with food safety and animal welfare regulations
5. Smart irrigation systems	e. using technology such as drones, sensors, and GPS to gather data on crop growth and soil conditions, which can help farmers make more informed decisions about planting, irrigation, and fertilization
6. Livestock Traceability	f. online marketplaces that allow small farmers to sell their produce directly to consumers, bypassing intermediaries and reducing costs



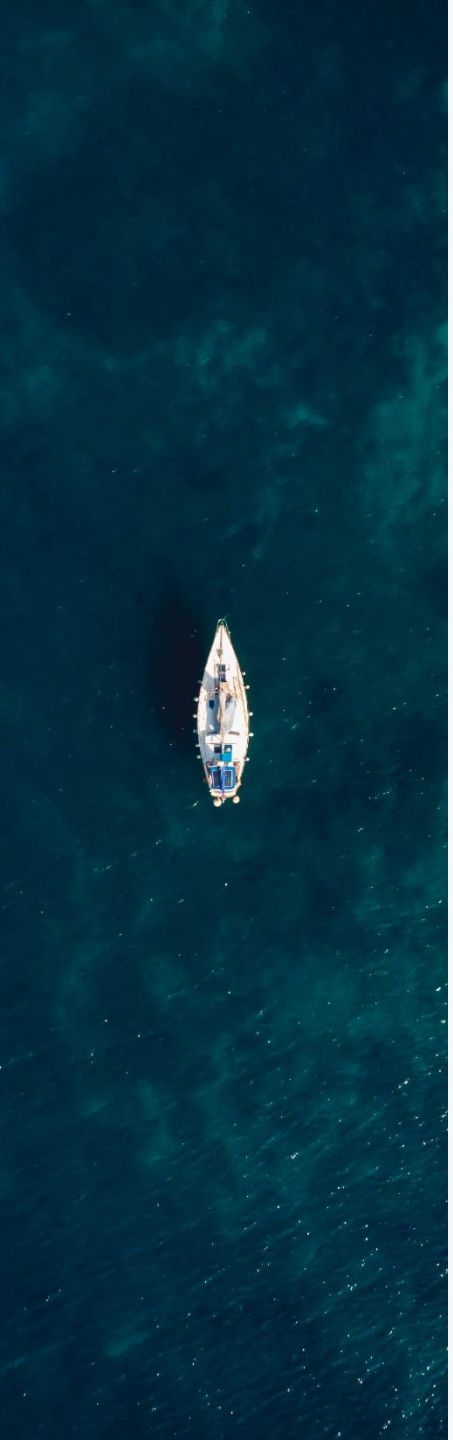
Quiz

1. What is the definition of agri-preneurship?

A. The application of digital technologies and business models to the agriculture industry
B. The use of technology such as precision farming, data analytics, and e-commerce to improve efficiency and increase yields
C. The disruption of traditional agriculture practices by agri-preneurs
D. All of the above

2. What is precision farming?

A. A form of agri-preneurship that uses technology such as drones, sensors, and GPS to gather data on crop growth and soil conditions
B. An online marketplace that allows small farmers to sell their produce directly to consumers
C. A system for monitoring the health and well-being of livestock
D. A technique for predicting crop yields and weather patterns



Quiz

3. What is an example of agri-preneurship that connects farmers with consumers?

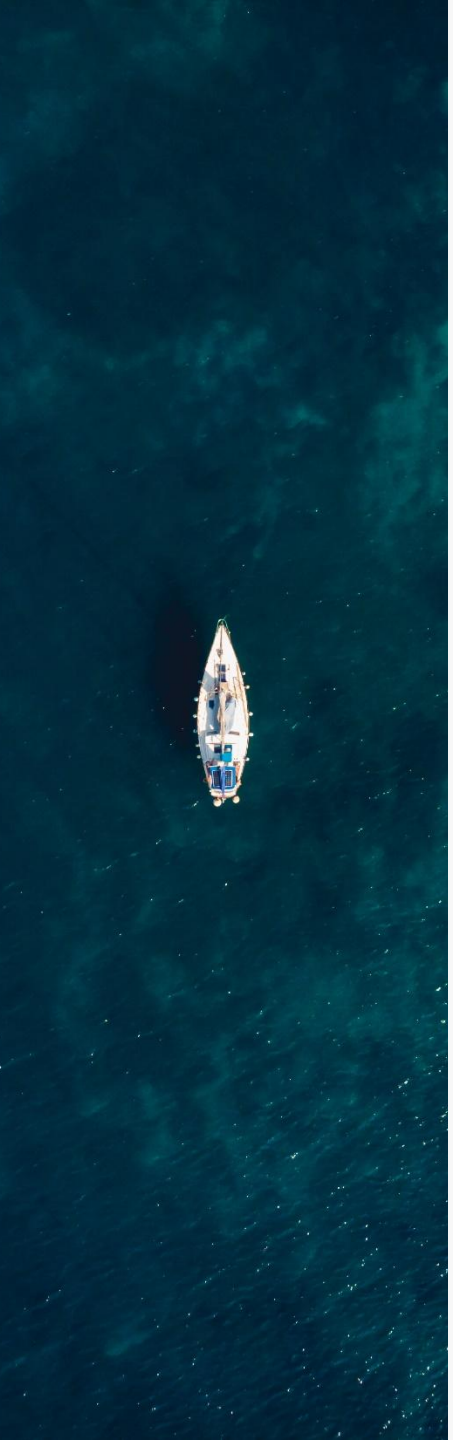
A. Precision farming
B. E-commerce platforms for connecting farmers with consumers
C. Livestock monitoring systems
D. Smart irrigation systems

4. What are some benefits of agri-preneurship?

A. Economic development, food security, rural development
B. Environmental sustainability, improved livelihoods for farmers, innovation in agriculture
C. Reduced costs for farmers, new opportunities for businesses and entrepreneurs in the agricultural sector
D. All of the above

5. What are some forms of agri-preneurship?

A. precision farming, e-commerce platforms for connecting farmers with consumers, livestock monitoring systems, crop and weather forecasting, smart irrigation systems, livestock traceability
B. use of technology such as precision farming, data analytics, and e-commerce to improve efficiency, increase yields, and connect farmers with markets
C. disruption of traditional agriculture practices by agri-preneurs



Quiz

6. **How is agri-preneurship connected to digital transformation?**

Module 2: IT Skills for the Agri-food Sector

Unit 2: Innovation and Agri-preneurship

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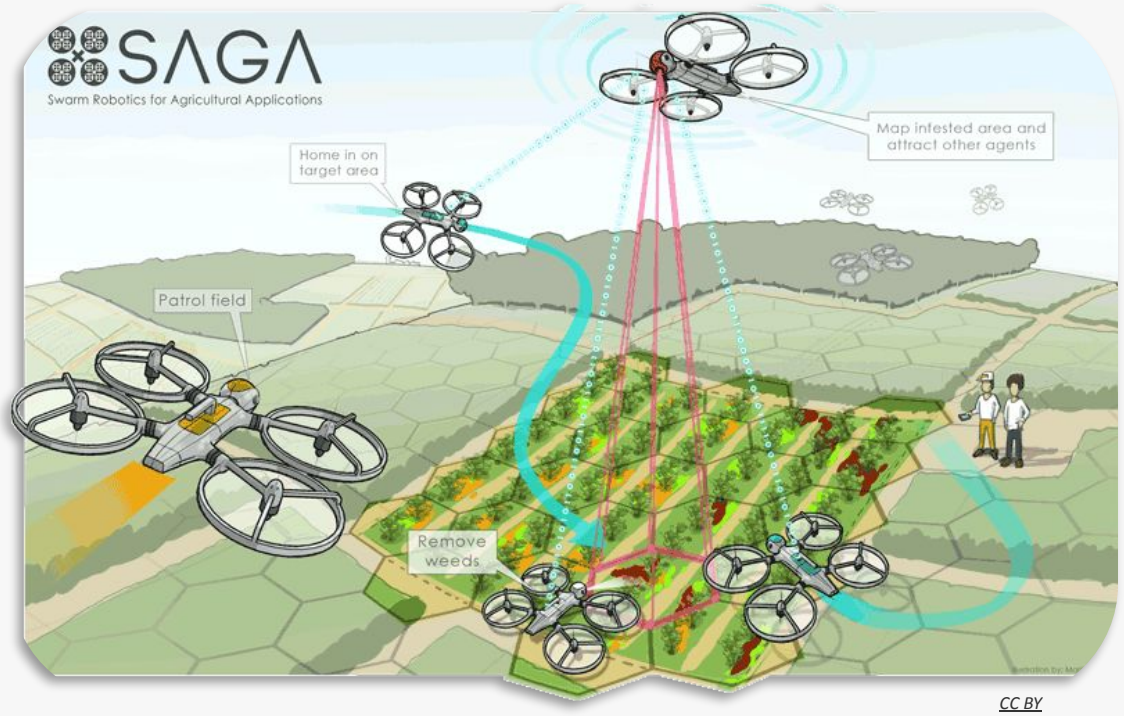
What is precision agriculture?



Precision agriculture is the use of technology to gather, process and analyze data from various sources to optimize crop production, reduce costs and increase sustainability.

manage individual fields according to their specific needs, in order to improve crop yields, reduce input costs and minimize environmental impact

What is precision agriculture?

https://www.youtube.com/watch?v=581Kx8wzTMc

Technologies and techniques

PRECISION FARMING EQUIPMENT

such as tractors, combines and other farm machinery that are equipped with sensors, GPS, and other technologies to gather data on crop growth, soil conditions and weather patterns

Technologies and techniques

REMOTE SENSING

uses drones, satellites and other technologies to gather data on crop growth, soil conditions and weather patterns. This data can be used to create detailed maps of fields, identify problem areas and make more informed decisions about planting, irrigation and fertilization

Technologies and techniques

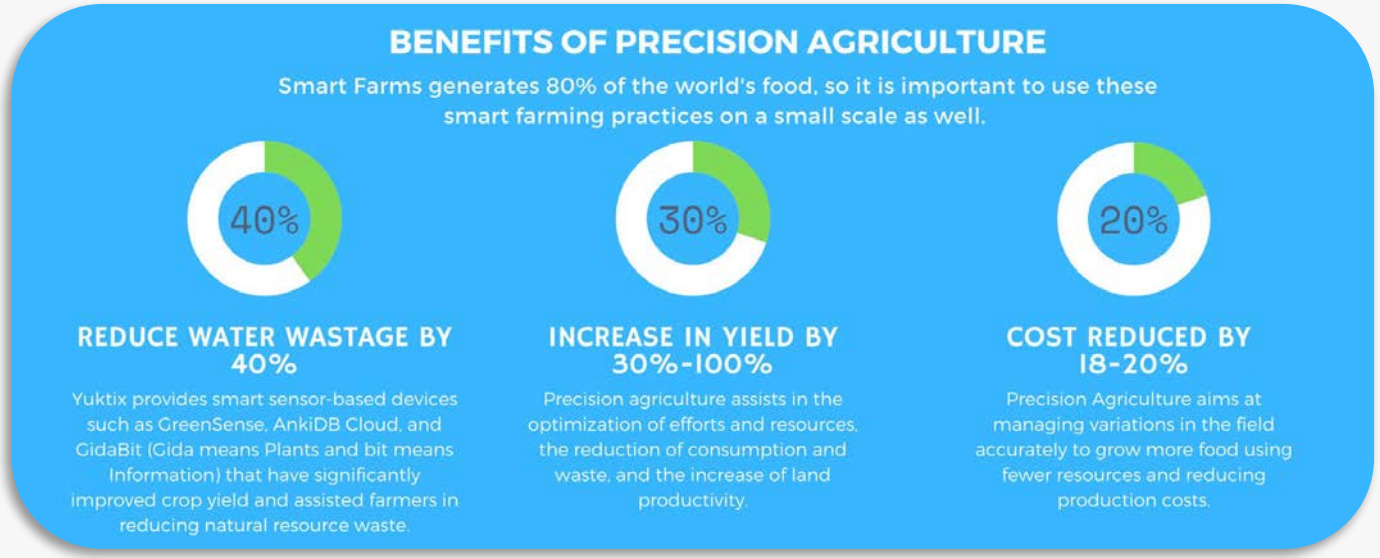
DATA ANALYTICS AND MACHINE LEARNING

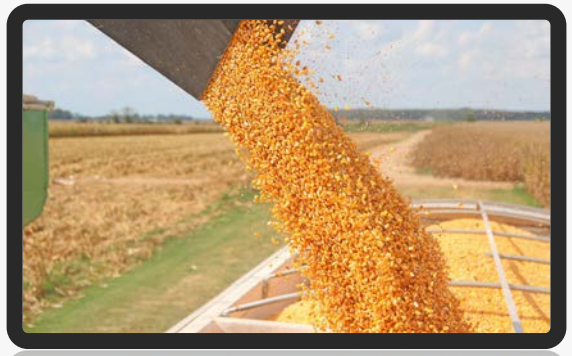
to process and analyze the data gathered by sensors and remote sensing. This can be used to predict crop yields, identify problem areas and make more informed decisions about planting, irrigation and fertilization

Benefits

INCREASED YIELDS

by using data from sensors and remote sensing to identify problem areas and make more informed decisions about planting, irrigation and fertilization, farmers can increase crop yields and improve their bottom line





Benefits

REDUCED COSTS

by using precision farming equipment and remote sensing to gather data on crop growth and soil conditions, farmers can reduce input costs, such as fertilizer and water, by applying them only where they are needed.

Benefits

INCREASED SUSTAINABILITY

by using precision agriculture to optimize crop production and reduce input costs, farmers can reduce their environmental impact and promote sustainable agriculture.

Benefits

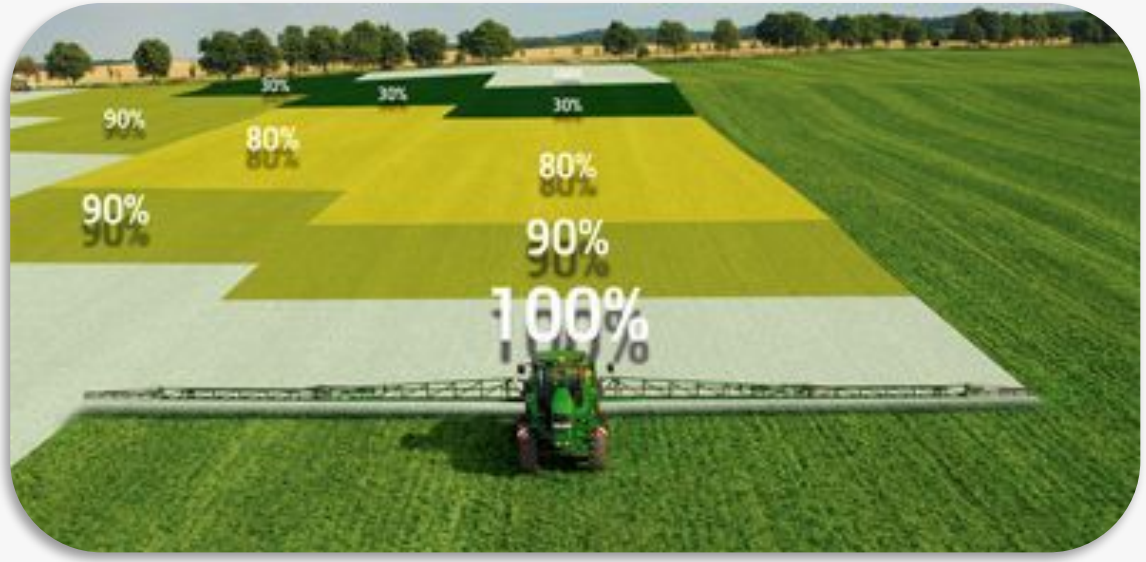
BETTER MANAGEMENT OF RESOURCES

by using data analytics and machine learning to process and analyze data from sensors and remote sensing, farmers can optimize their use of resources, such as water and fertilizer.

Examples and case studies

VARIABLE RATE TECHNOLOGY (VRT)

uses GPS-enabled equipment to apply fertilizer, seed, and other inputs at different rates depending on the specific needs of each area of the field



Examples and case studies

PRECISION PLANTING

uses GPS-controlled equipment to plant seeds at the exact location and depth, reducing seed waste and improving crop yields

Examples and case studies

VARIABLE RATE IRRIGATION

uses sensors and other digital tools to monitor soil moisture levels and adjust irrigation schedules accordingly. This allows farmers to optimize water usage and reduce waste

Examples and case studies

PRECISION SPRAYING

uses GPS-enabled equipment to target pesticides, herbicides, and other inputs to specific areas of the field, reducing waste and improving crop yields

Examples and case studies

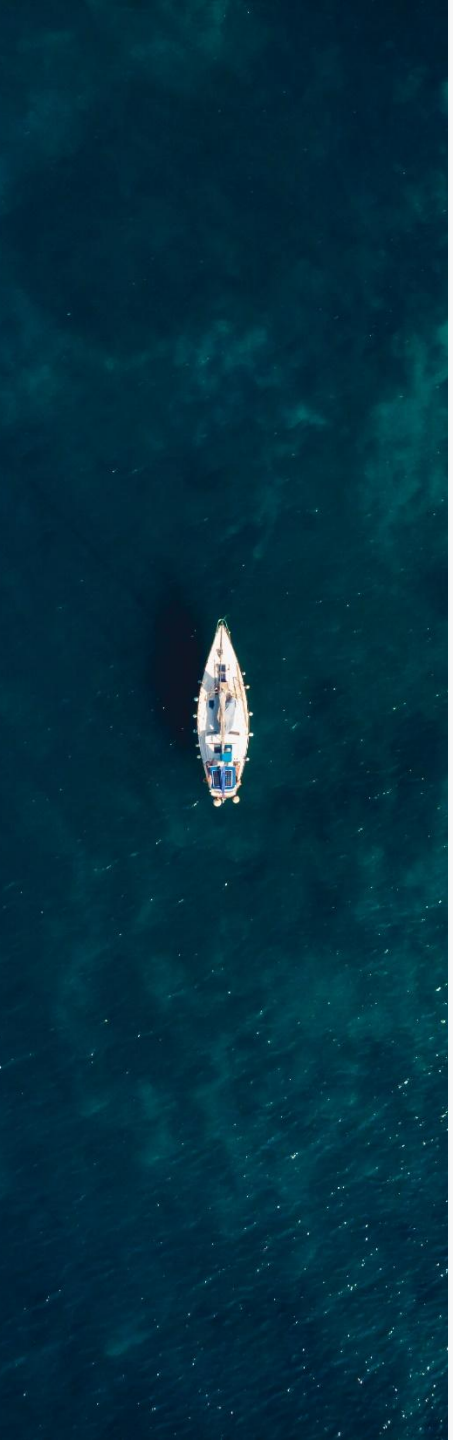
REMOTE SENSING

uses satellites, drones, and other remote sensing technologies to collect data on crop health, growth, and soil conditions

Examples and case studies

SMART SENSORS

uses sensors to monitor soil and climatic conditions, crop growth, and other factors that can impact crop yields



Quiz

1. What is the goal of precision agriculture?

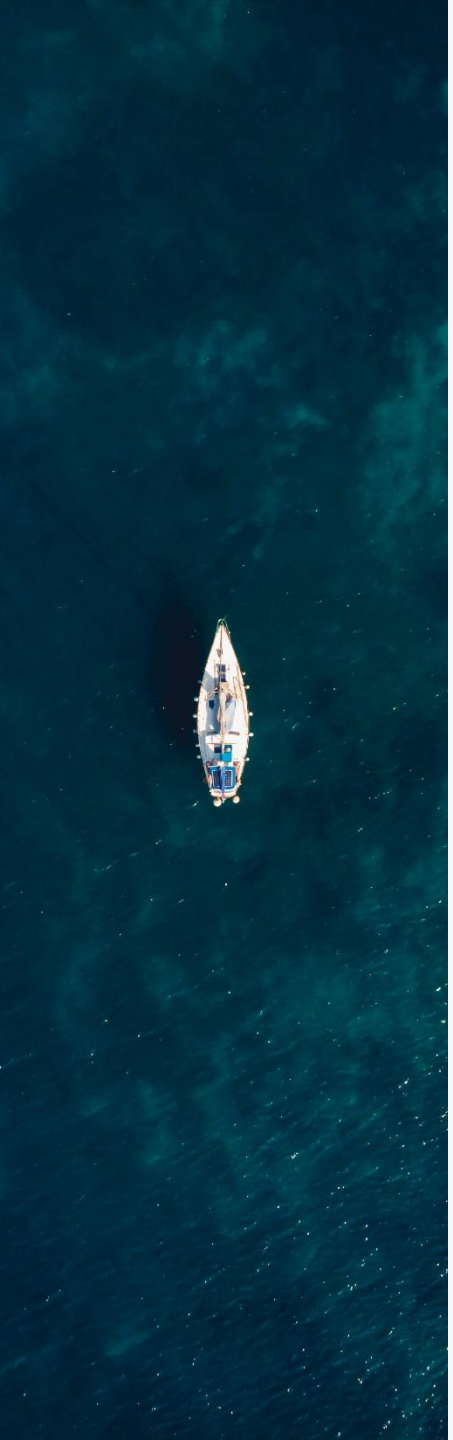
A. To manage individual fields according to their specific needs
B. To improve crop yields and reduce input costs
C. To minimize environmental impact
D. All of the above

2. What are some key technologies used in precision agriculture?

A. Precision farming equipment and remote sensing
B. Data analytics and machine learning
C. Tractors and combines equipped with sensors
D. All of the above

3. What are some benefits of precision agriculture?

A. Increased yields, reduced costs, increased sustainability
B. Better management of resources, reduced environmental impact
C. Improved bottom line, optimized use of resources
D. All of the above



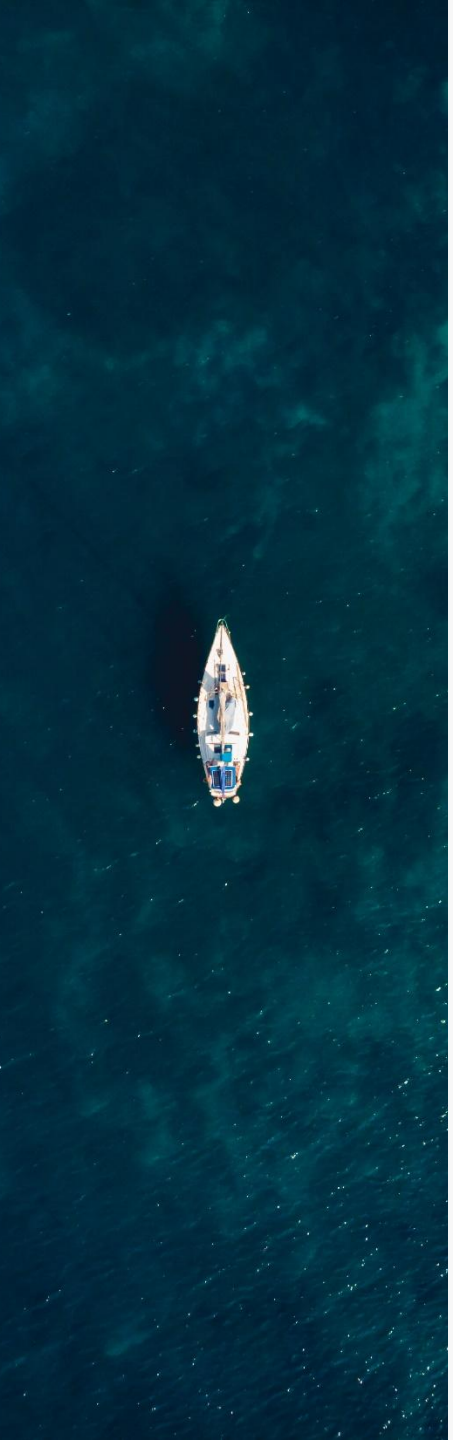
Quiz

4. What is variable rate technology (VRT)?

A. A technique that uses GPS-enabled equipment to apply inputs at different rates depending on the specific needs of each area of the field
B. A technique that uses GPS-controlled equipment to plant seeds at the exact location and depth
C. A technique that uses sensors and other digital tools to monitor soil moisture levels and adjust irrigation schedules

5. What is precision planting?

A. A technique that uses GPS-enabled equipment to apply inputs at different rates depending on the specific needs of each area of the field
B. A technique that uses GPS-controlled equipment to plant seeds at the exact location and depth
C. A technique that uses sensors and other digital tools to monitor soil moisture levels and adjust irrigation schedules



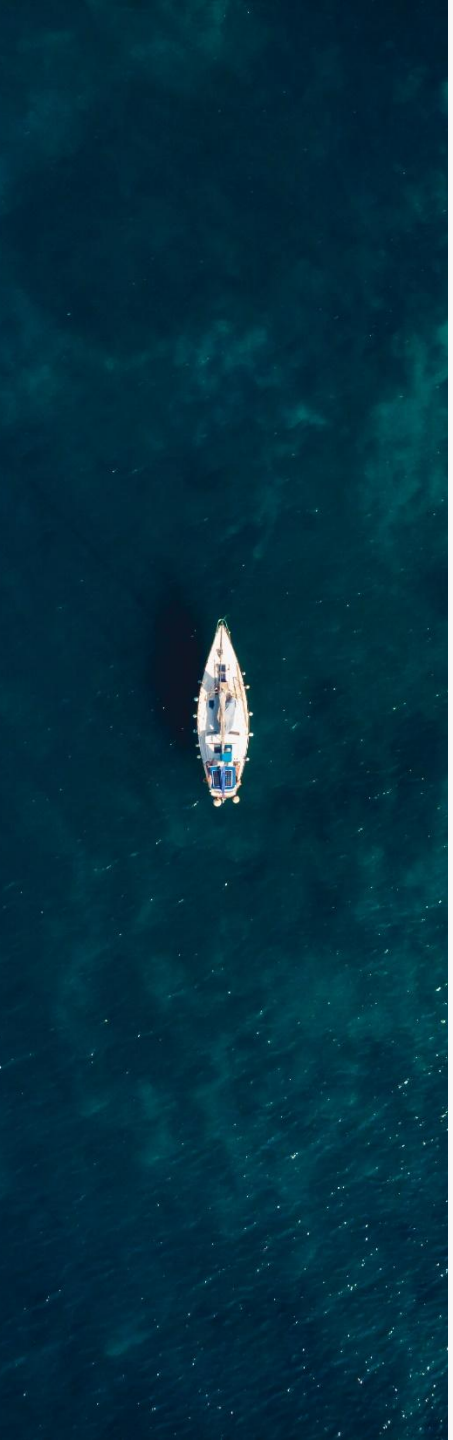
Quiz

6. What is variable rate irrigation?

A. A technique that uses GPS-enabled equipment to apply inputs at different rates depending on the specific needs of each area of the field
B. A technique that uses GPS-controlled equipment to plant seeds at the exact location and depth
C. A technique that uses sensors and other digital tools to monitor soil moisture levels and adjust irrigation schedules

7. What is smart sensors?

A. A technique that uses GPS-controlled equipment to plant seeds at the exact location and depth
B. A technique that uses sensors to monitor soil and climatic conditions, crop growth, and other factors that can impact crop yields
C. A technique that uses data analytics and machine learning to process and analyze data from sensors and remote sensing



Quiz

8. What is precision spraying?

A. A technique that uses GPS-controlled equipment to plant seeds at the exact location and depth
B. A technique that uses sensors and other digital tools to monitor soil moisture levels and adjust irrigation schedules
C. A technique that uses GPS-enabled equipment to target pesticides, herbicides, and other inputs to specific areas of the field

9. How does precision agriculture use technology to optimize crop production?

A. By using precision farming equipment and remote sensing to gather data on crop growth and soil conditions
B. By using data analytics and machine learning to process and analyze the data gathered by sensors and remote sensing
C. By using techniques such as variable rate technology, precision planting, and variable rate irrigation to target inputs where they are needed most
D. All of the above.

Module 2: IT Skills for the Agri-food Sector

Unit 3: Precision Agriculture

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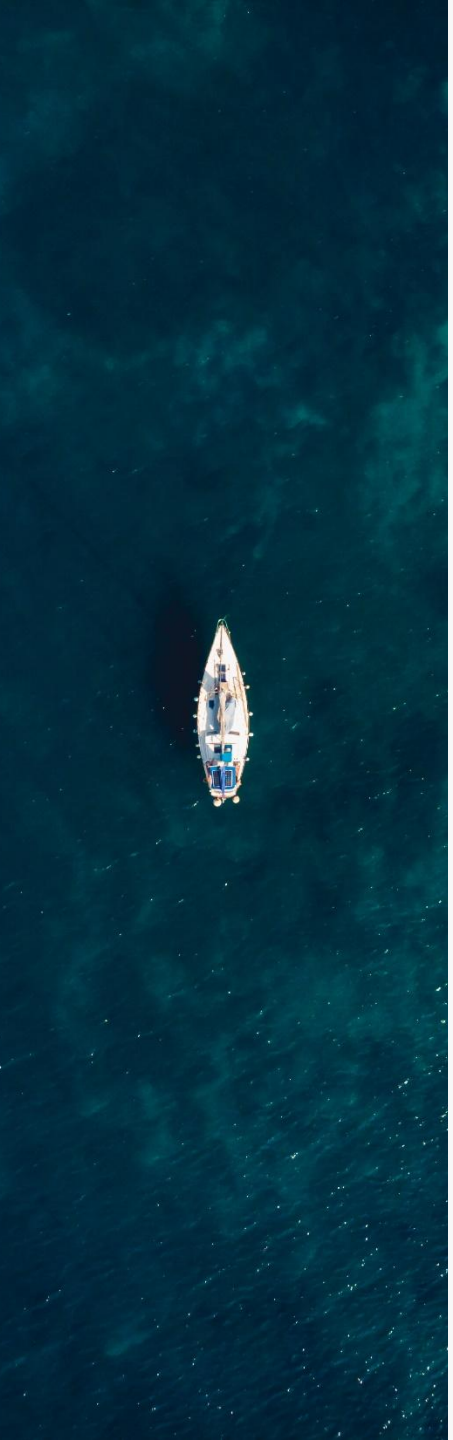
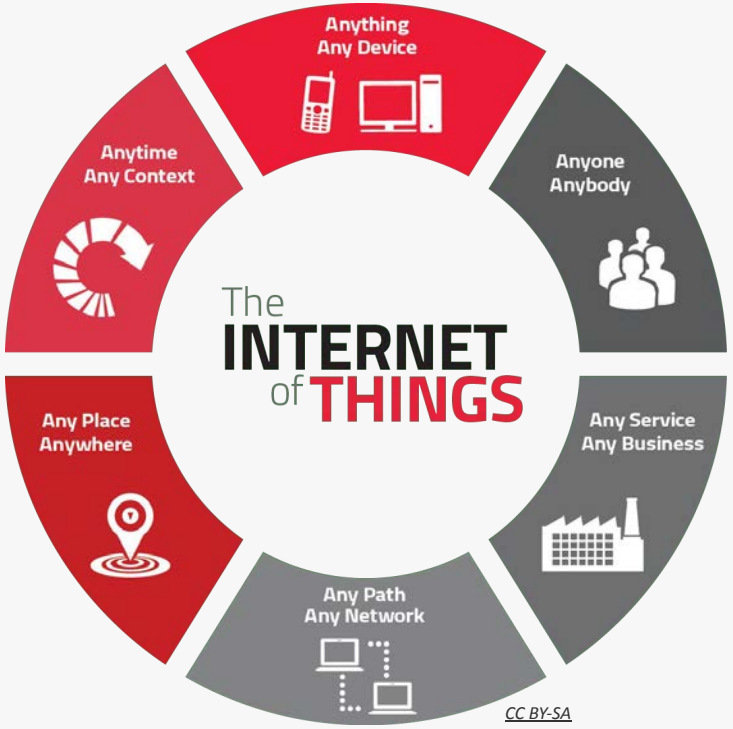
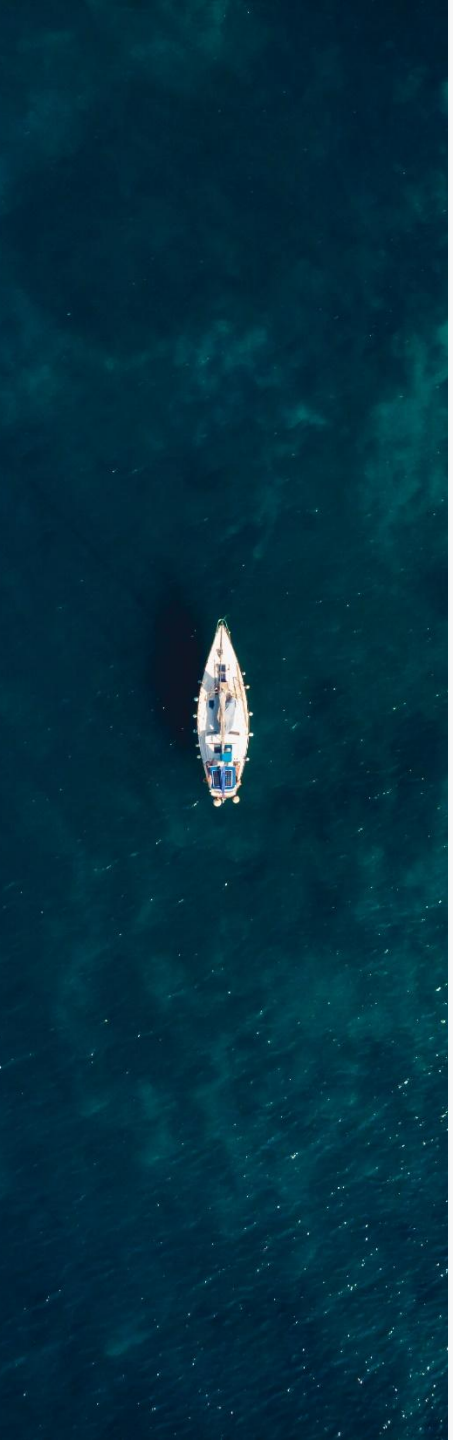


What is IoT technology?

The Internet of Things (IoT) refers to the network of physical objects - devices, vehicles, buildings, and other items embedded with sensors, software, and connectivity which enables these objects to collect and exchange data.



In simple terms, it is the connection of everyday devices to the internet, allowing them to communicate with each other and with a central system.



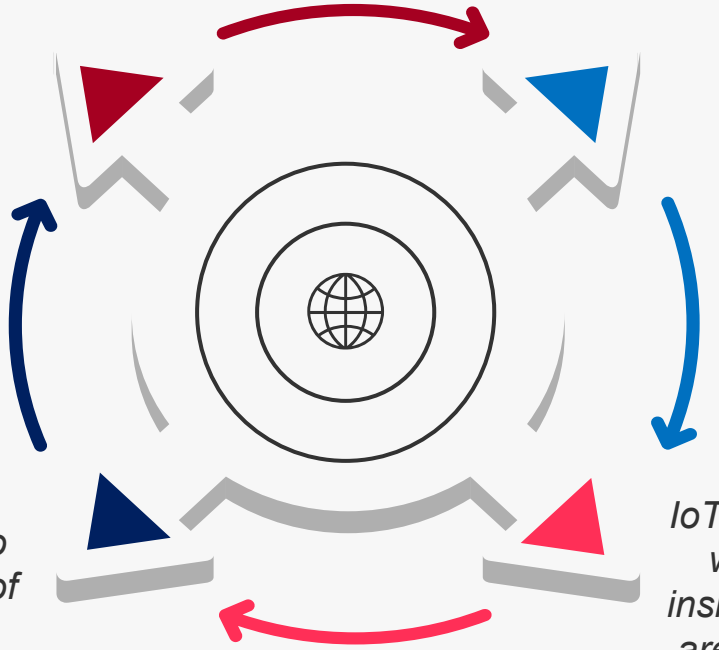
What is IoT technology?

CONNECTIVITY

IoT devices are connected to the internet, which allows them to communicate with other devices and systems, as well as with users. This is made possible by a variety of connectivity technologies, such as Wi-Fi, Bluetooth, and cellular networks.

SENSORS AND ACTUATORS

IoT devices have sensors and actuators that allow them to collect data from their environment and perform actions based on that data. For example, a smart thermostat has a sensor that measures the temperature in a room and an actuator that adjusts the heating or cooling based on that data.



CLOUD COMPUTING

IoT devices rely on cloud computing to store and process the large amounts of data they generate.
Cloud computing also allows for remote access to the data and the devices, which enables users to control and monitor them from anywhere.

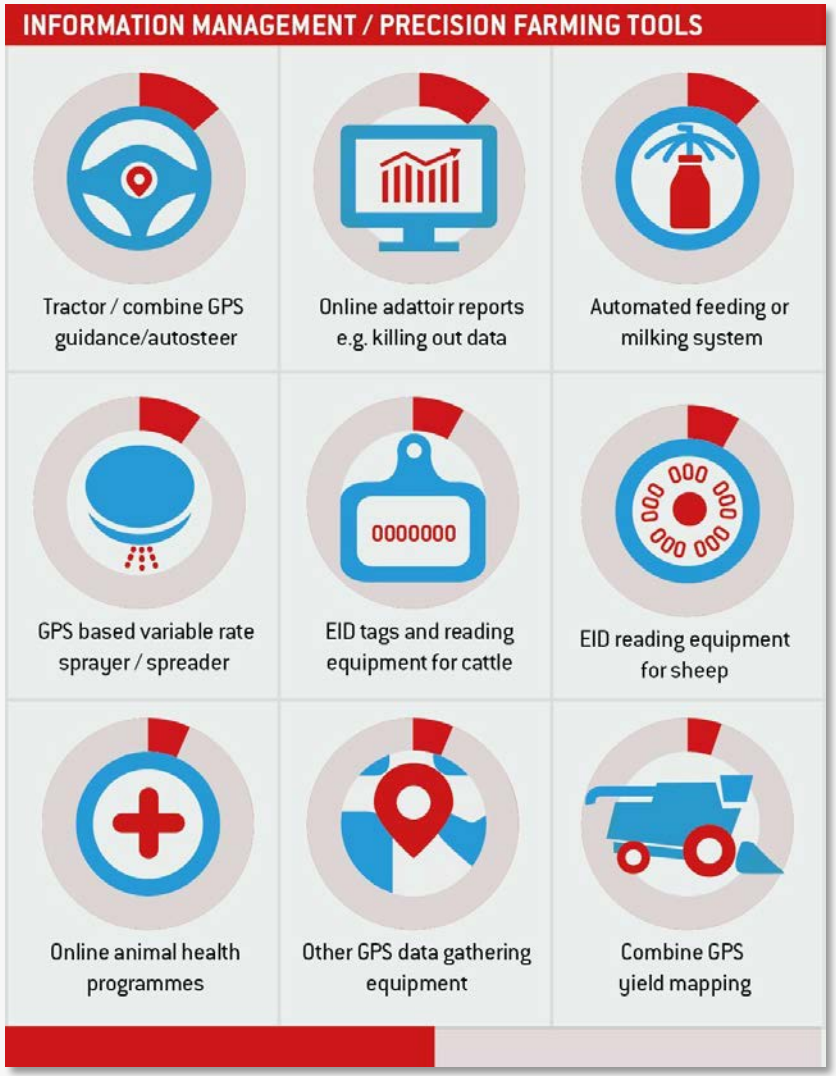
BIG DATA AND ANALYTICS

IoT devices generate large amounts of data, which can be analyzed to extract valuable insights. Big data and analytics technologies are used to process, store, and analyze this data, which can be used to improve decision-making and optimize performance.

What is IoT technology?

https://www.youtube.com/watch?v=pOLAIVUs9S8

Technologies and application in agri-food



Using sensors, drones, and other technologies to gather data on crop growth and soil conditions, which can help farmers make more informed decisions about planting, irrigation, and fertilization.

PRECISION FARMING

Technologies and application in agri-food

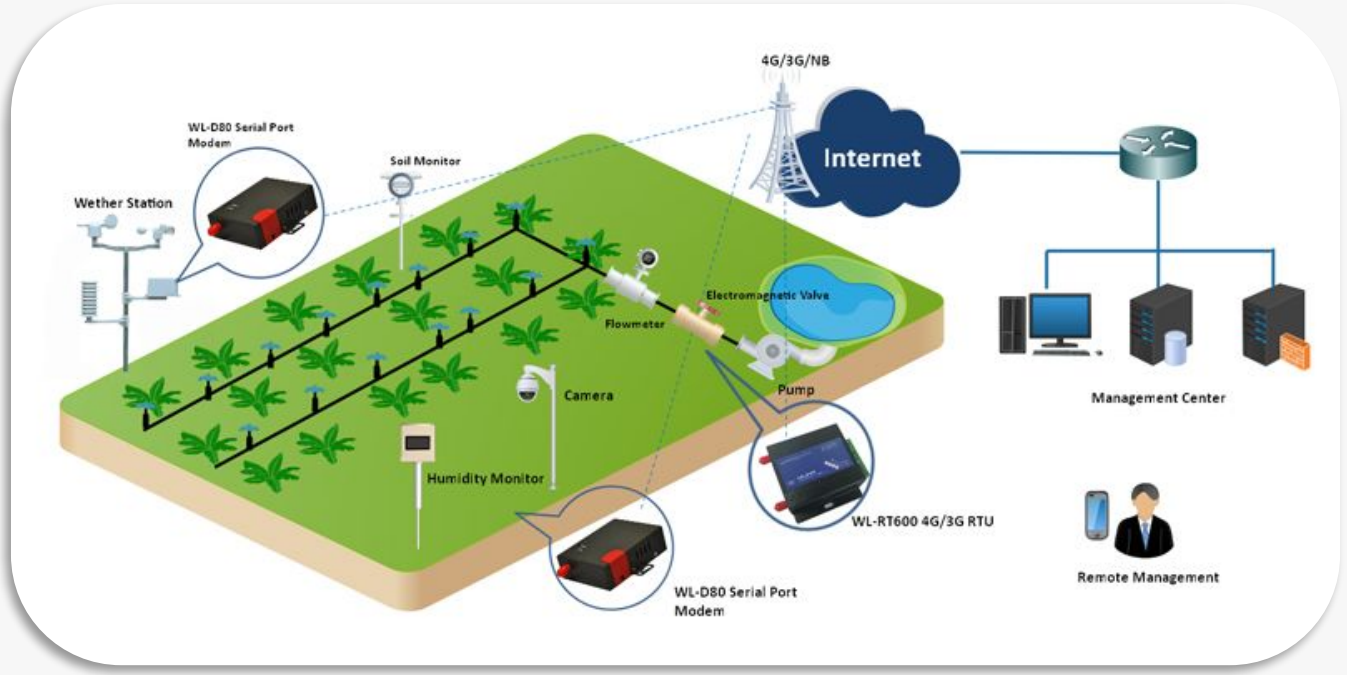
Using sensors and cameras to monitor the health and well-being of livestock, which can help farmers detect and respond to diseases more quickly.

LIVESTOCK MONITORING

Technologies and application in agri-food

SMART IRRIGATION SYSTEMS

Using real-time data on weather, soil moisture, and crop growth to optimize irrigation systems, which can help farmers save water and reduce costs.

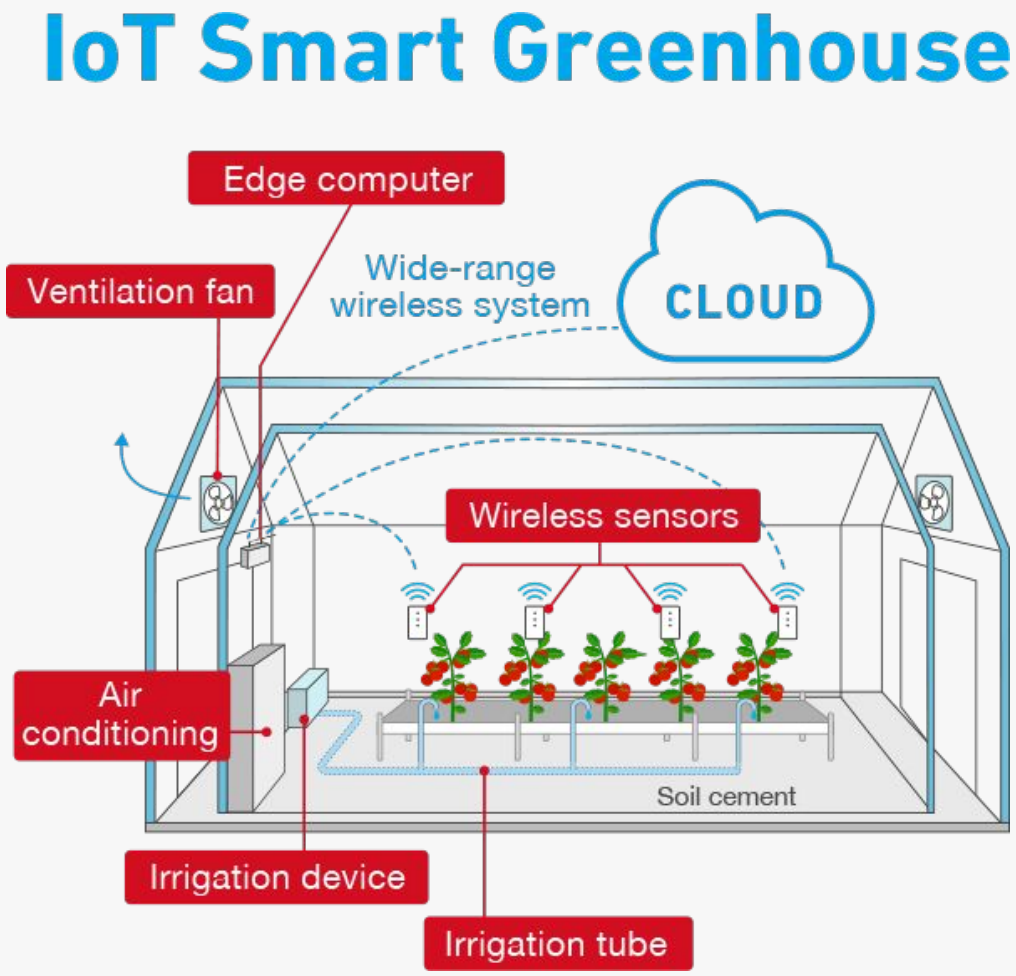


Technologies and application in agri-food

Using RFID tags and other technologies to track the movement of food products from farm to consumer, which can help to improve food safety and reduce waste.

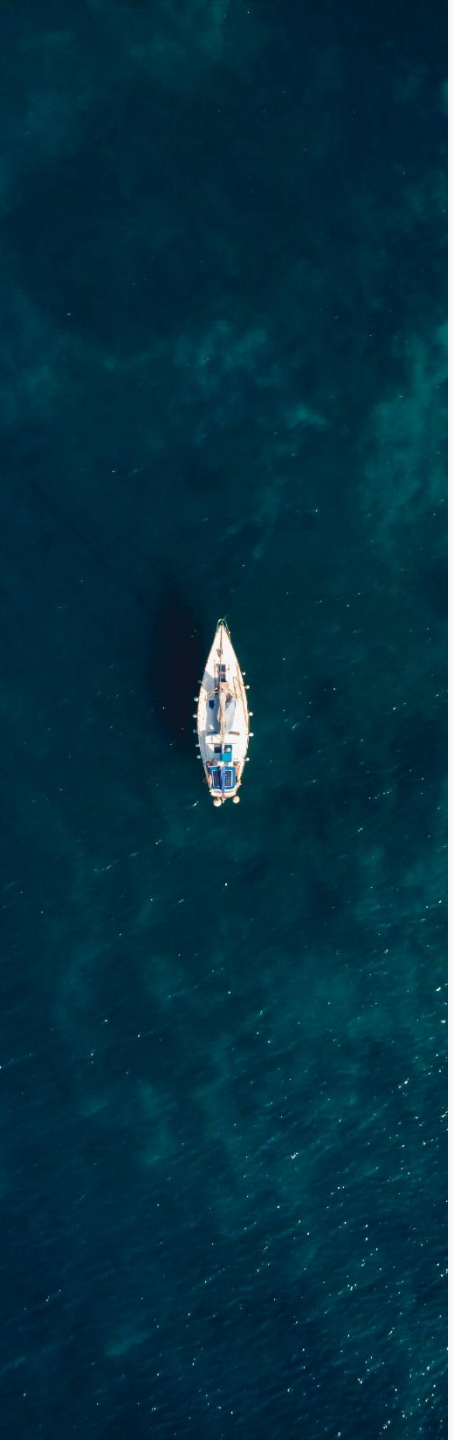
SUPPLY CHAIN TRACEABILITY

Technologies and application in agri-food



Using IoT sensors to monitor temperature, humidity, light, and other environmental factors inside greenhouses, which can help farmers optimize conditions for crop growth and reduce energy costs.

SMART GREENHOUSES



Benefits

INCREASED EFFICIENCY

by providing real-time data on crop growth, soil conditions, and weather patterns

IMPROVED YIELDS

by using data from sensors and remote sensing to identify problem areas

BETTER MANAGEMENT OF RESOURCES

by using data analytics and machine learning to process and analyze data from sensors and remote sensing

IMPROVED FOOD SAFETY

trace the origin of food products, track their movement through the supply chain

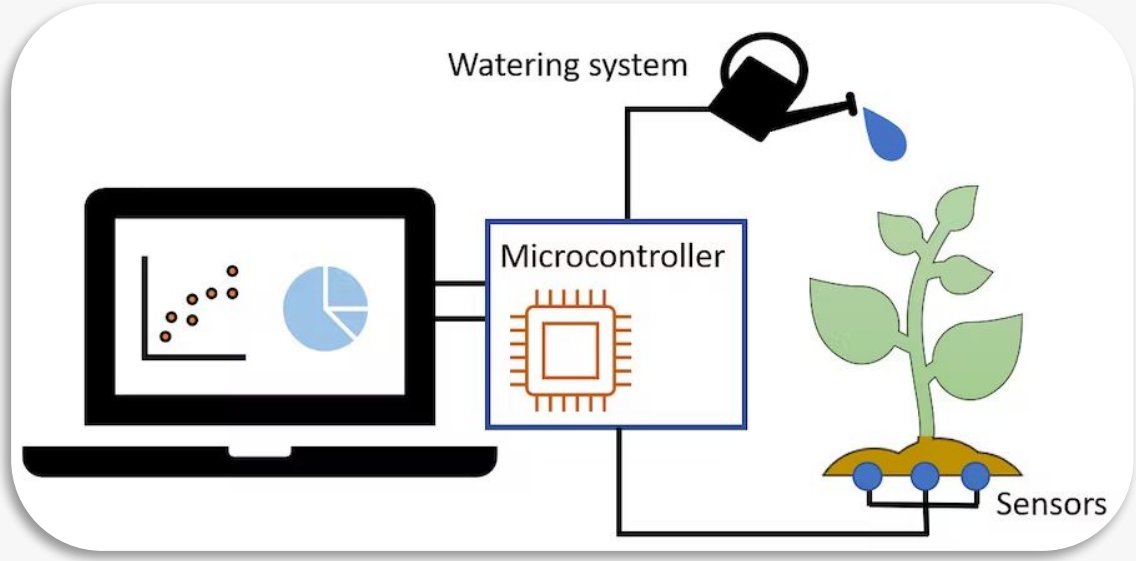
INCREASED SUSTAINABILITY

by using IoT to optimize crop production and reduce input costs

Examples and case studies

SMART IRRIGATION SYSTEMS

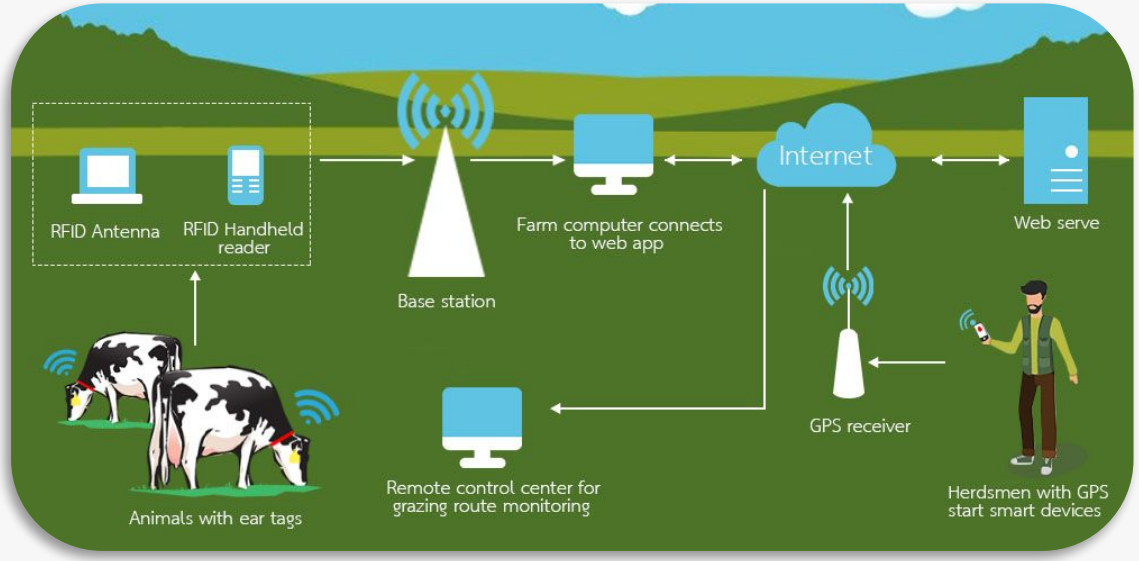
used to monitor soil moisture levels in real-time and adjust irrigation schedules accordingly



Examples and case studies

LIVESTOCK MONITORING

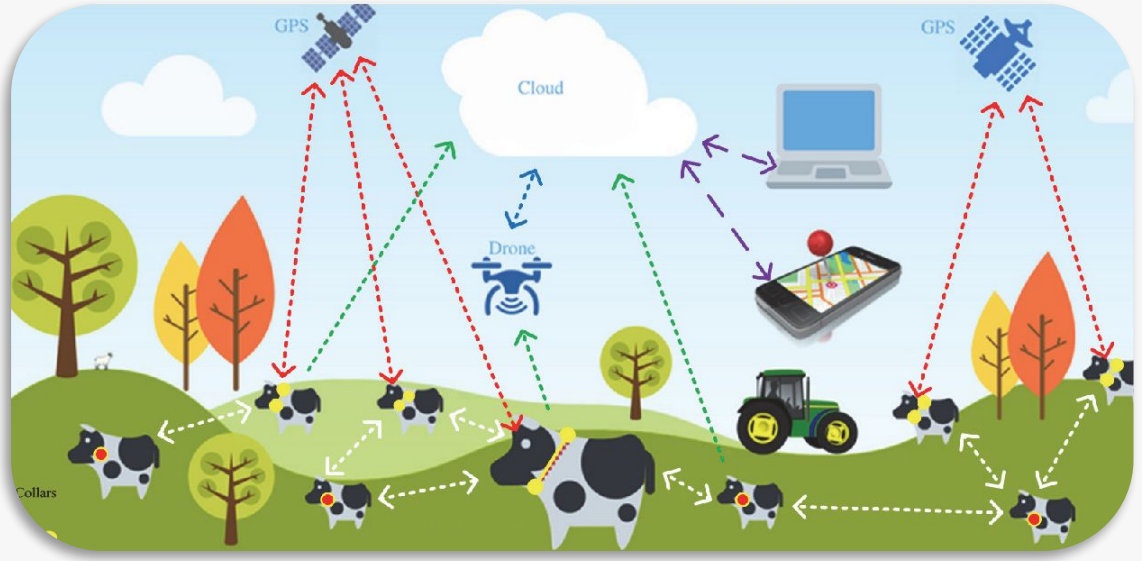
used to monitor the health and behavior of livestock in real-time, identify health issues and improve animal welfare



Examples and case studies

LIVESTOCK TRACKING

used to track the movement of livestock, monitor their health, optimize the use of pasture and improve their welfare



Examples and case studies

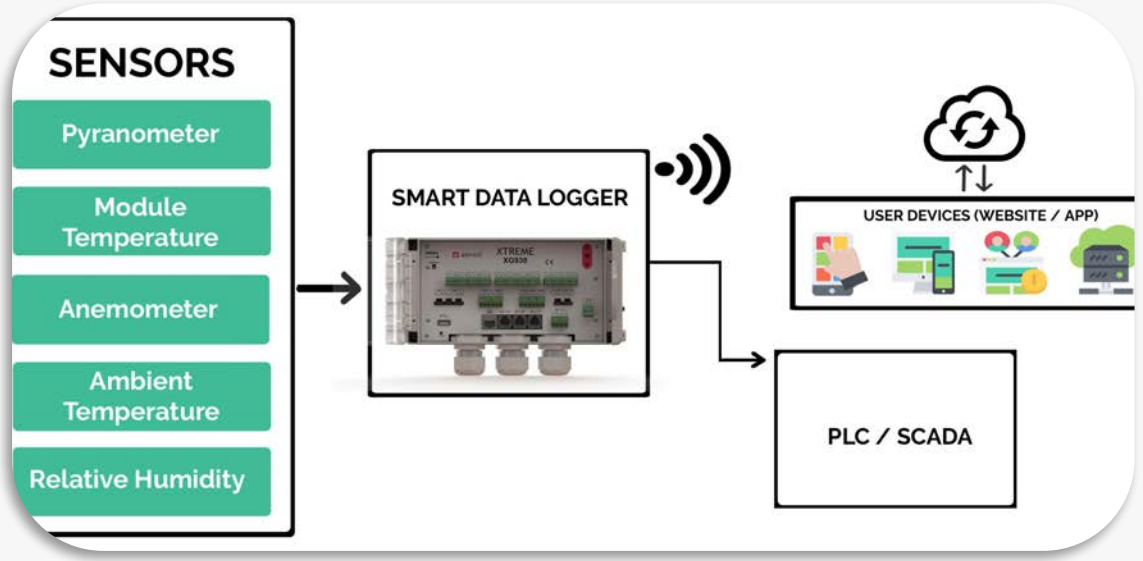
CROP MONITORING

used to monitor crop growth and health in real-time for crop management and irrigation

Examples and case studies

WEATHER MONITORING

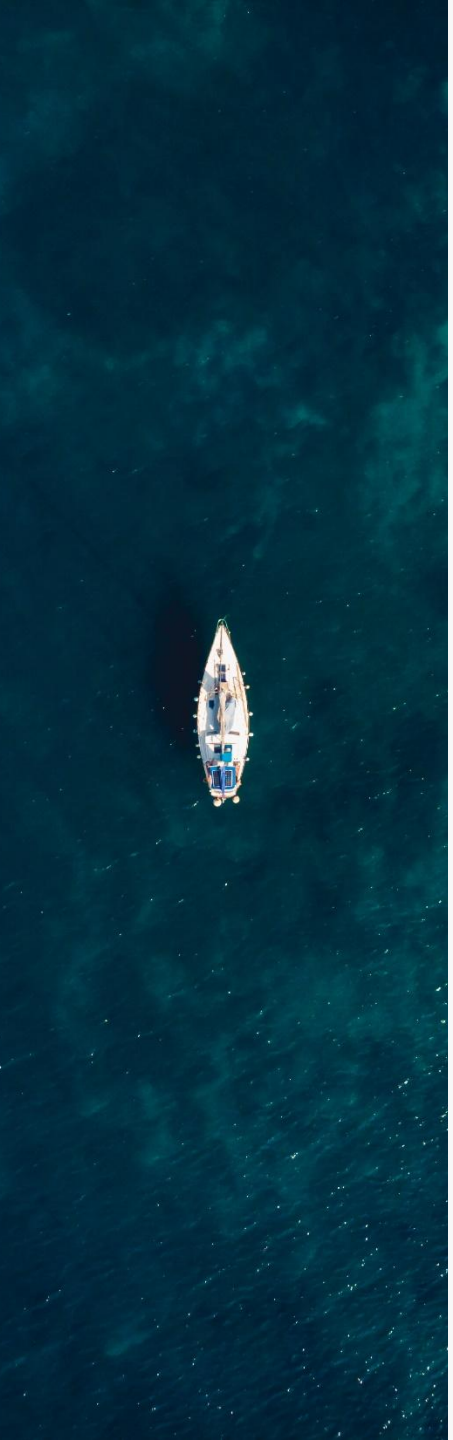
used to collect data on weather conditions in real-time, predict weather patterns and make decisions about planting, harvesting, and crop management.



Examples and case studies

EQUIPMENT MONITORING

used to monitor the performance and maintenance of farm equipment in real-time



Case Study

Groups

- Divide into groups of 10

Case Study

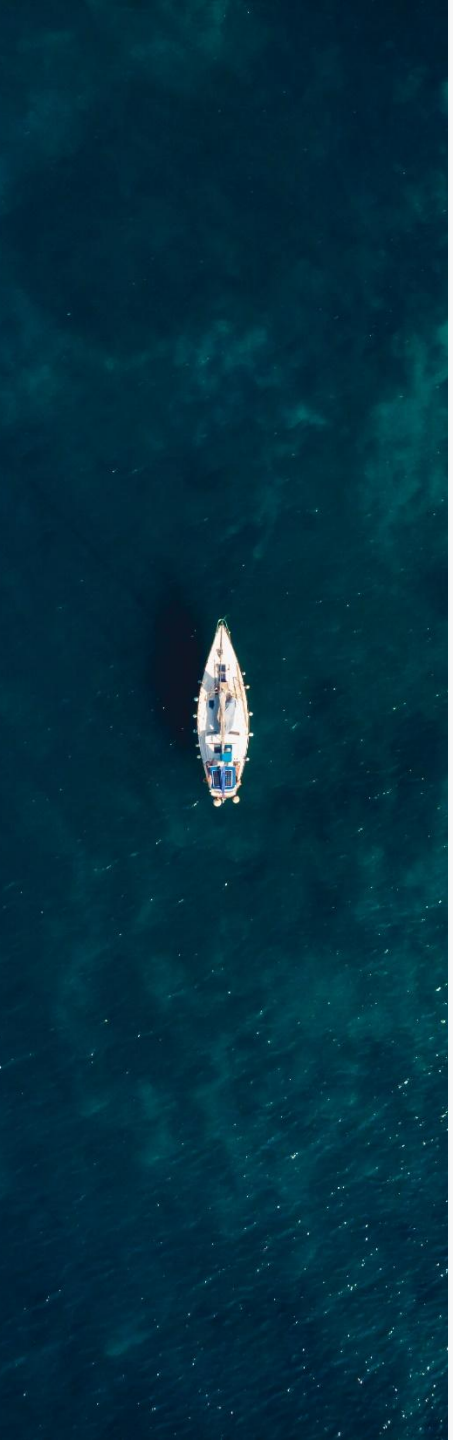
- Develop a case study of IoT application in Agriculture

Brainstorm

- Brainstorm around the sector and develop a case study

Share

- Share your ideas and discuss



Case Study

How could Internet of Things (IoT) apply to the agri-food sector?

Questions to address:

- ✔ What is the problem?
- ✔ Which tools and devices will be used?
- ✔ What are the objectives of the solution?
- ✔ How will IoT solve the problem?

Module 2: IT Skills for the Agri-food Sector

Unit 4: IoT in Agriculture

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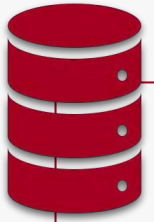
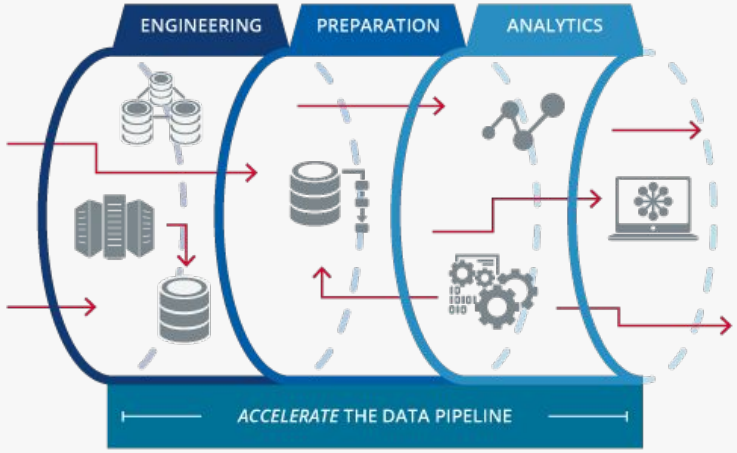
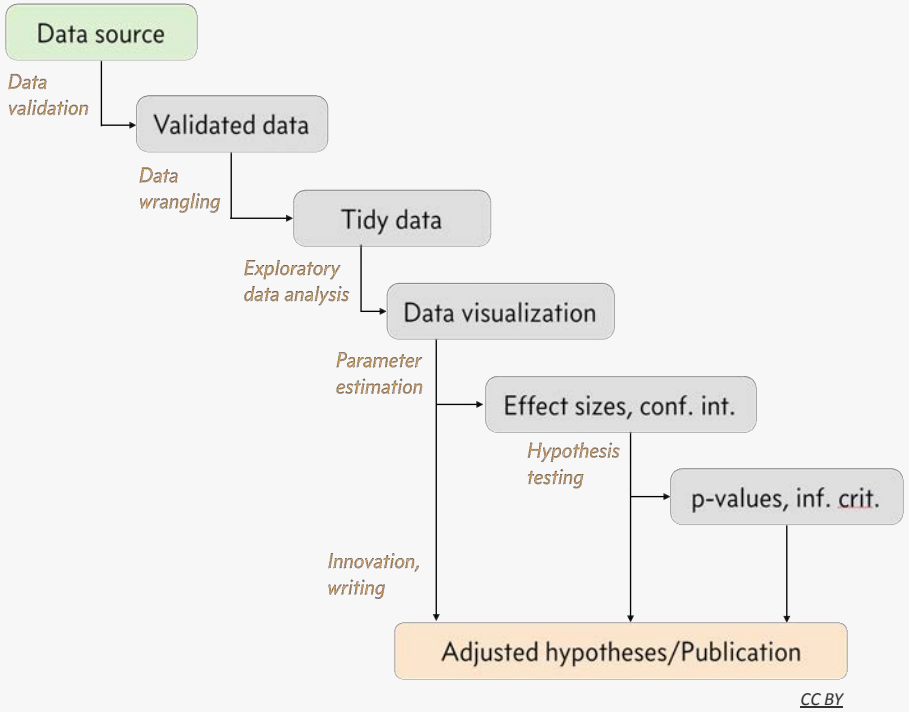
What is big data analysis?

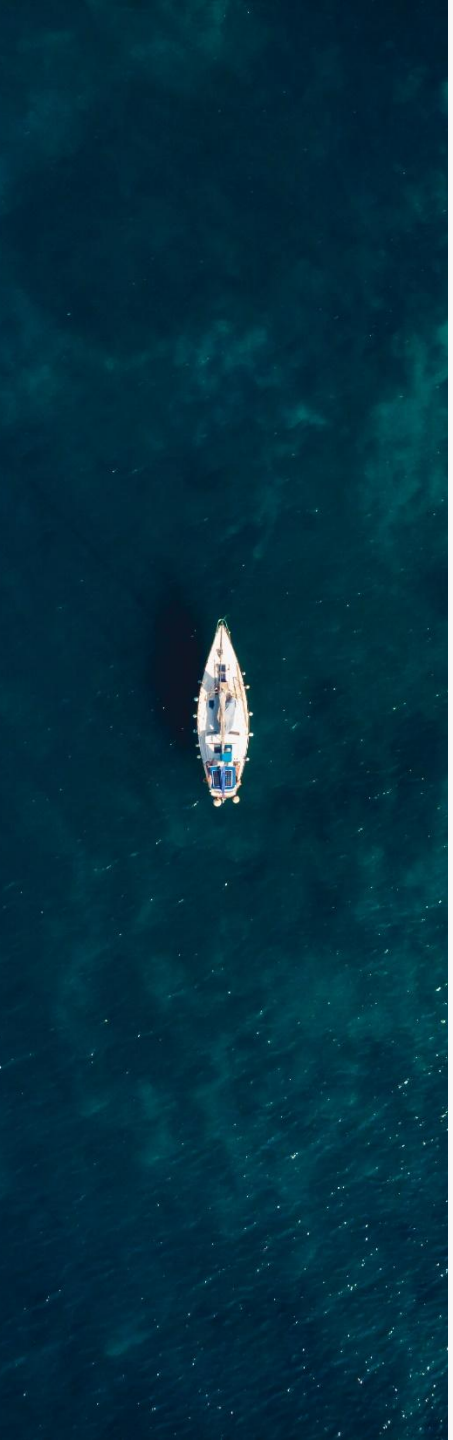


Big data analytics refers to the process of collecting, storing, and analyzing large and complex sets of data in order to uncover patterns, insights, and knowledge.

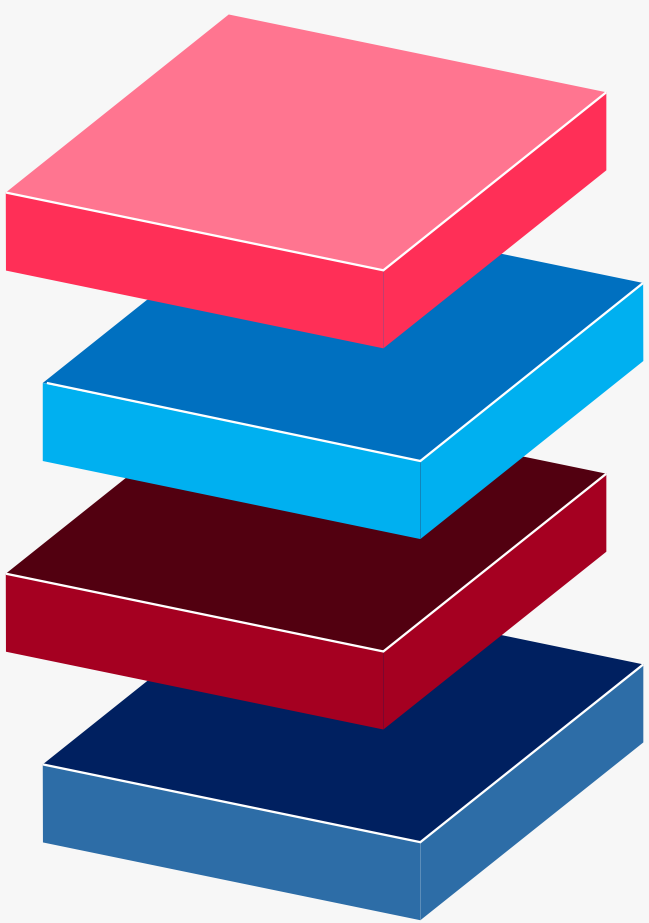




The technology typically includes tools for data collection, storage, and management, as well as advanced algorithms for data analysis and visualization.



Data analysis process



1

DATA COLLECTION

Collecting large and diverse data sets from various sources such as social media, sensors, and transactional systems.

2

DATA STORAGE

Storing the collected data in a scalable and efficient manner using technologies such as Hadoop, NoSQL databases and cloud storage.

3

DATA PREPARATION

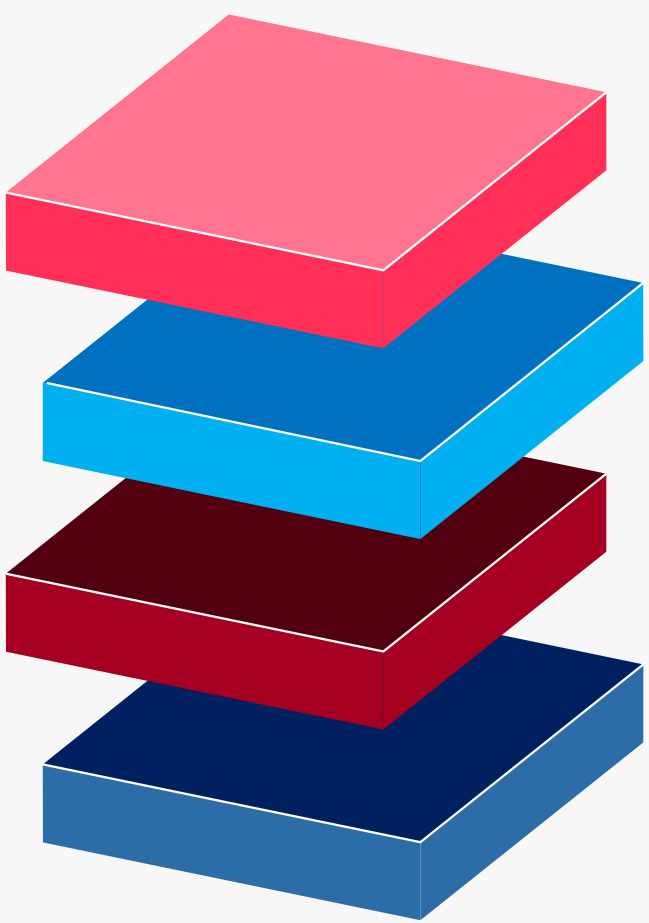
Cleaning, integrating and transforming the data to make it ready for analysis. This step includes data validation, data cleaning, data integration and data transformation.

4

DATA EXPLORATION

Exploring and analyzing the data to identify patterns, trends, and insights using techniques such as descriptive statistics and data visualization.

Data analysis process



DATA MODELING

Building mathematical models and using machine learning algorithms to predict future outcomes or to identify patterns and relationships in the data.

DATA INTERPRETATION

Interpreting the results and insights generated from the previous steps, and communicating them to stakeholders in a meaningful way.

DATA GOVERNANCE

Managing and governing the data, ensuring its quality, security, and compliance throughout the process.

CONTINUOUS MONITORING AND IMPROVEMENT

Continuously monitoring the data and the models, testing new hypotheses and refining the models to improve the results and predictions.

What is big data analysis?

https://www.youtube.com/watch?v=A3-GjKOdUGo

Application in agri-food

PRECISION FARMING

Using big data analytics to analyze data from sensors, drones, and other sources to identify patterns and insights that can help farmers make more informed decisions about planting, irrigation, and fertilization

Application in agri-food

Using big data analytics to predict crop yields and weather patterns, which can help farmers make more informed decisions about planting and harvesting

CROP AND WEATHER FORECASTING

Application in agri-food

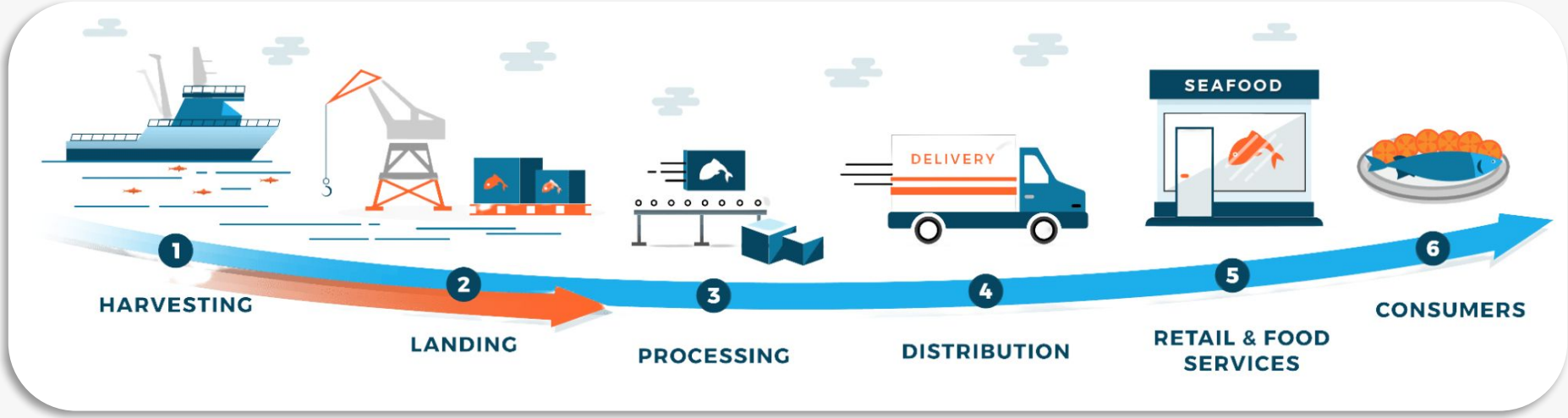
LIVESTOCK MONITORING

Using big data analytics to analyze data from sensors and cameras to monitor the health and well-being of livestock, which can help farmers detect and respond to diseases more quickly

Application in agri-food

Using big data analytics to track the movement of food products from farm to consumer, which can help to improve food safety and reduce waste

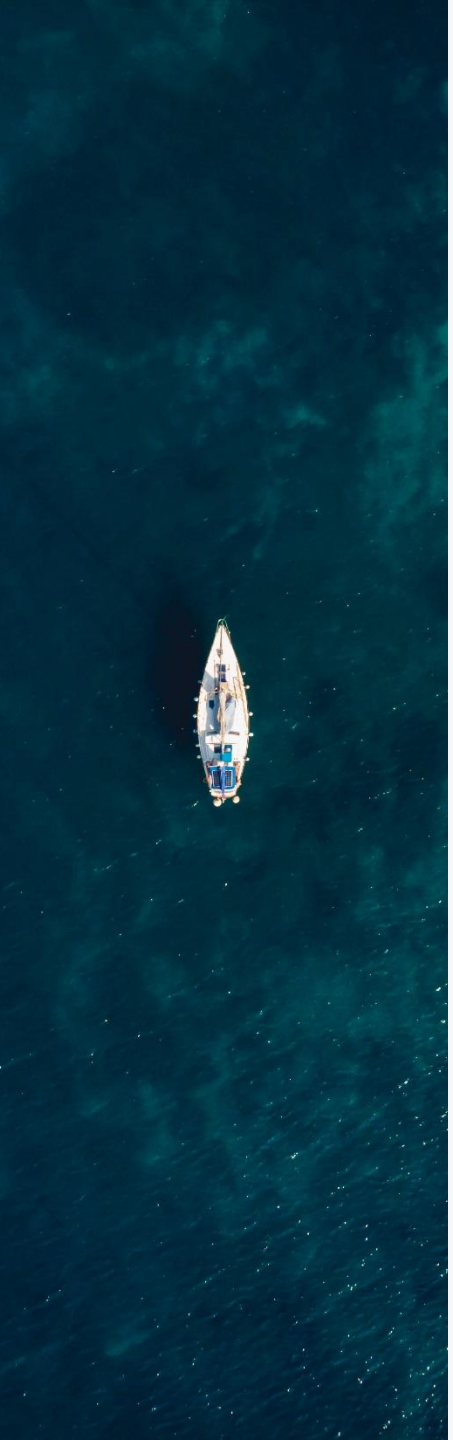
SUPPLY CHAIN TRACEABILITY



Application in agri-food

MARKET ANALYSIS

Using big data analytics to analyze market data and identify trends and patterns, which can help farmers make more informed decisions about pricing, supply, and demand



Benefits

INCREASED EFFICIENCY

by providing insights and predictions based on data from multiple sources

IMPROVED YIELDS

by using data from sensors, drones, and other sources to identify patterns and insights

BETTER MANAGEMENT OF RESOURCES

by using big data analytics to predict crop yields and weather patterns

IMPROVED FOOD SAFETY

by using big data analytics to track the movement of food products from farm to consumer

INCREASED SUSTAINABILITY

by using big data analytics to optimize crop production and reduce input costs

Examples and case studies

CROP MONITORING

used to monitor crop health, growth, and yield. This can be done using data from satellites, drones, and other remote sensing technologies

Examples and case studies

WEATHER FORECASTING

used to make predictions about future weather conditions. This can be done using data from weather forecasts, satellite imagery, and other sources

Examples and case studies

MARKET ANALYSIS

used to analyze market trends and make predictions about crop prices. This can be done using data from market reports, government statistics, and other sources

Examples and case studies

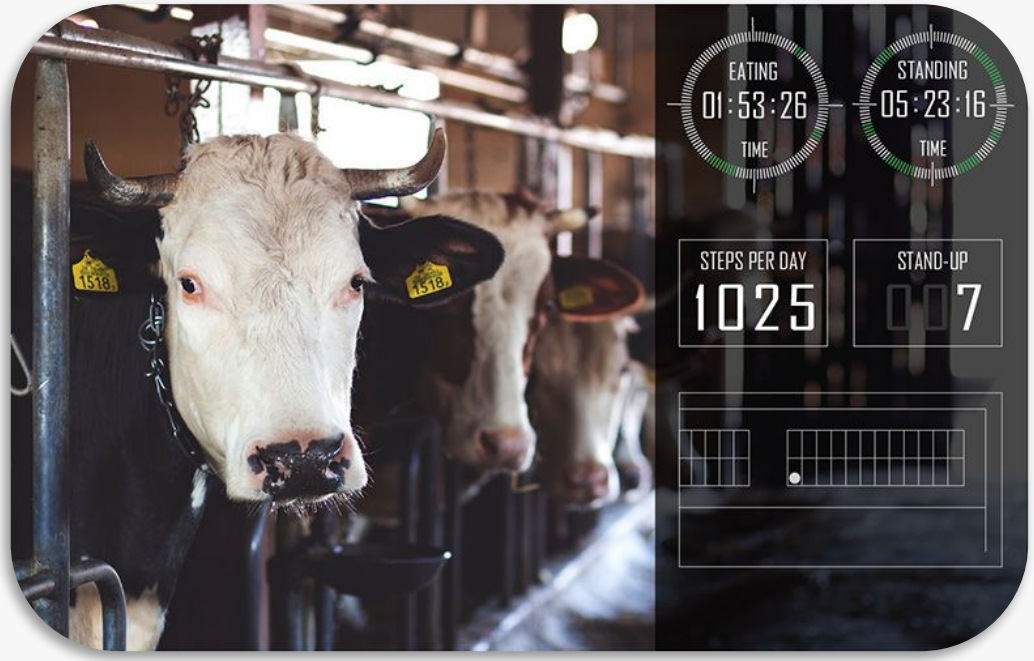
SUPPLY CHAIN MANAGEMENT

used to optimize the supply chain for agricultural products. This can be done using data from transportation and logistics systems, inventory systems, and other sources

Examples and case studies

LIVESTOCK MONITORING

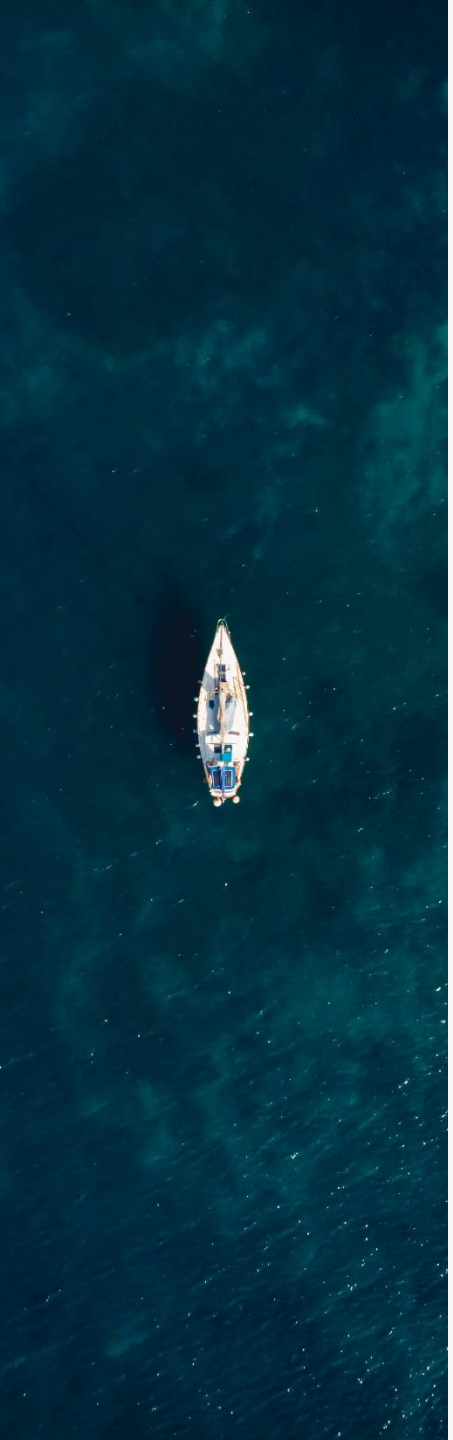
used to monitor the health and productivity of livestock. This can be done using data from sensors, cameras, and other sources



Examples and case studies

SOIL ANALYSIS

used to analyze soil data, such as pH levels, nutrient levels, and other factors that can impact crop growth



Quiz

1. How could the agri-food sector benefit from big data analysis regarding “Increased efficiency”?
2. How could the agri-food sector benefit from big data analysis regarding “Improved yields”?
3. How could the agri-food sector benefit from big data analysis regarding “Better management of resources”?
4. How could the agri-food sector benefit from big data analysis regarding “Increased sustainability”?

Module 2: IT Skills for the Agri-food Sector

Unit 5: Big Data Analysis in Agriculture

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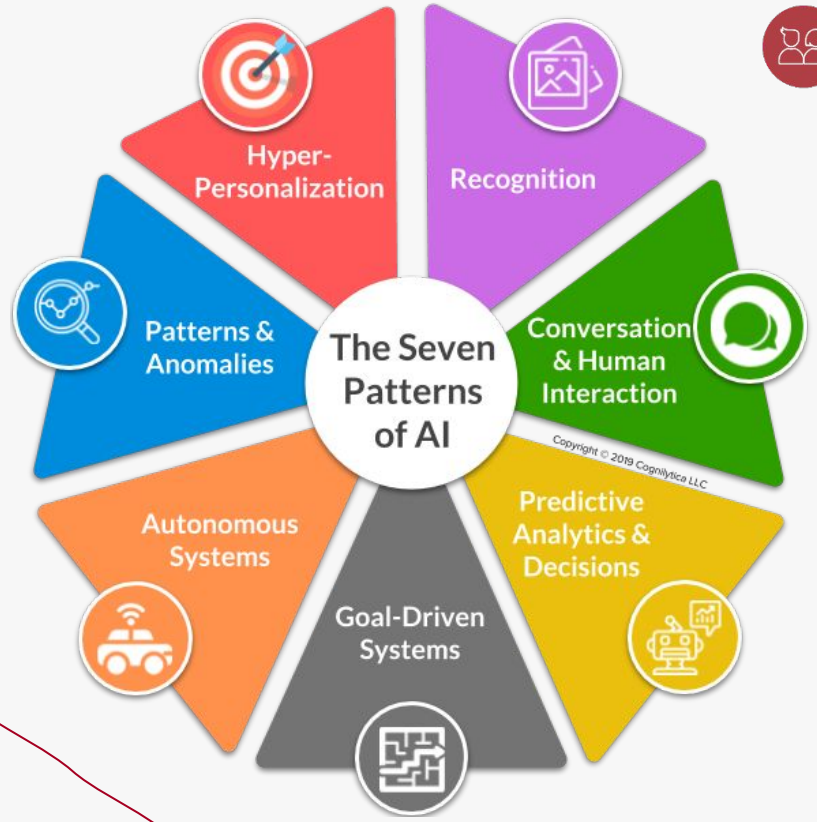
Table of Contents

AI and ML in Agriculture

(AI) is a branch of computer science that deals with creating machines that can perform tasks that would typically require human intelligence, such as visual perception, speech recognition, decision-making, and language translation.



In simple terms, AI is the broader concept of creating intelligent machines and ML is the specific subset of AI that deals with training machines to learn from data

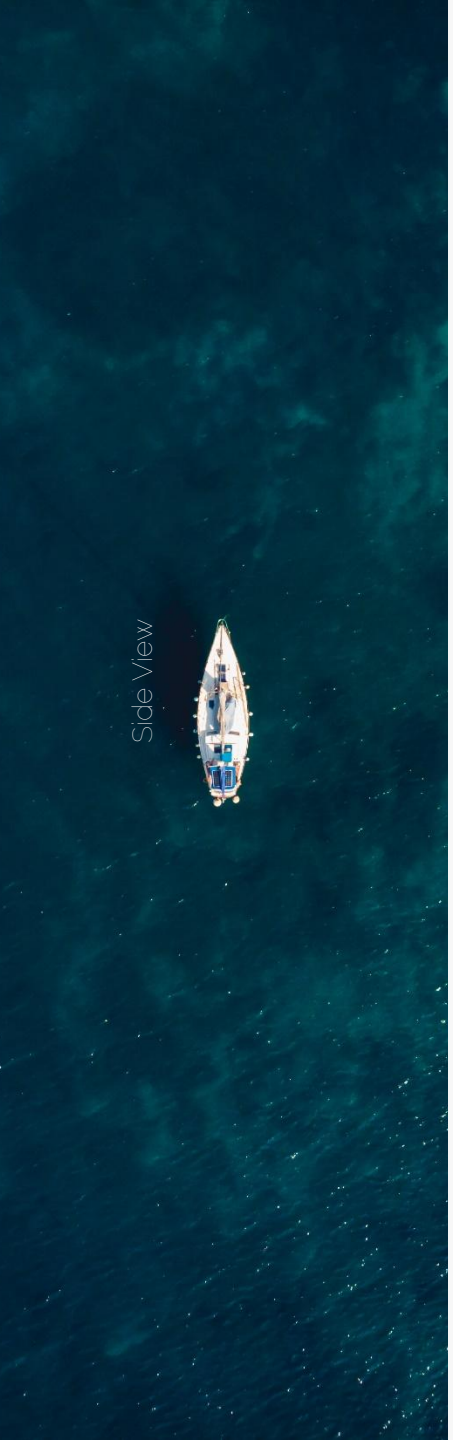
Machine Learning (ML) is a subset of AI that involves training computer systems to learn from data, without being explicitly programmed. This is done by feeding large amounts of data into the system and allowing it to learn patterns and make predictions.

AI and ML in Agriculture

https://www.youtube.com/watch?v=2ePf9rue1Ao

AI and ML in Agriculture

https://www.youtube.com/watch?v=cfSDvPlFFVQ



AI and ML in Agriculture – Predictive Analytics

CROP YIELD PREDICTION

AI algorithms can be used to analyze historical data on weather, soil conditions, and crop growth, to make predictions about future crop yields

FIELD SURVEYS

Ground truth crop conditions to help with yield prediction

CROP MODELS

Simulate crop growth and development based on crop, management, and climate

REMOTE SENSING

Capture current crop health status to forecast yield

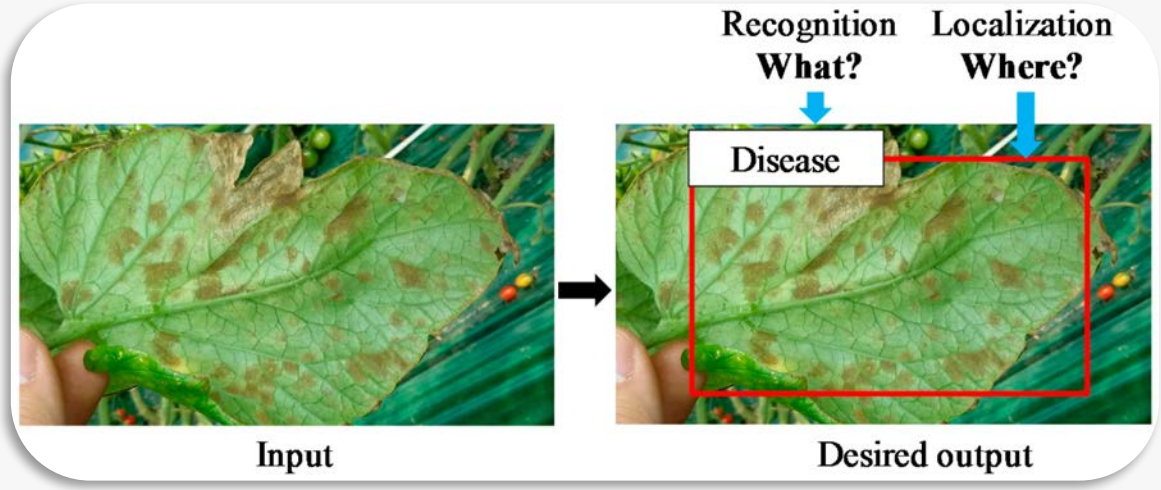
STATISTICAL MODELS

Use climate variables and outputs from other models to estimate crop yield

AI and ML in Agriculture – Predictive Analytics

PEST AND DISEASE PREDICTION

AI-powered monitoring systems can detect the early signs of pests and diseases, and predict their spread.



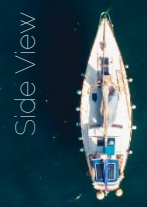
AI and ML in Agriculture – Predictive Analytics

Side View

WEATHER PREDICTION

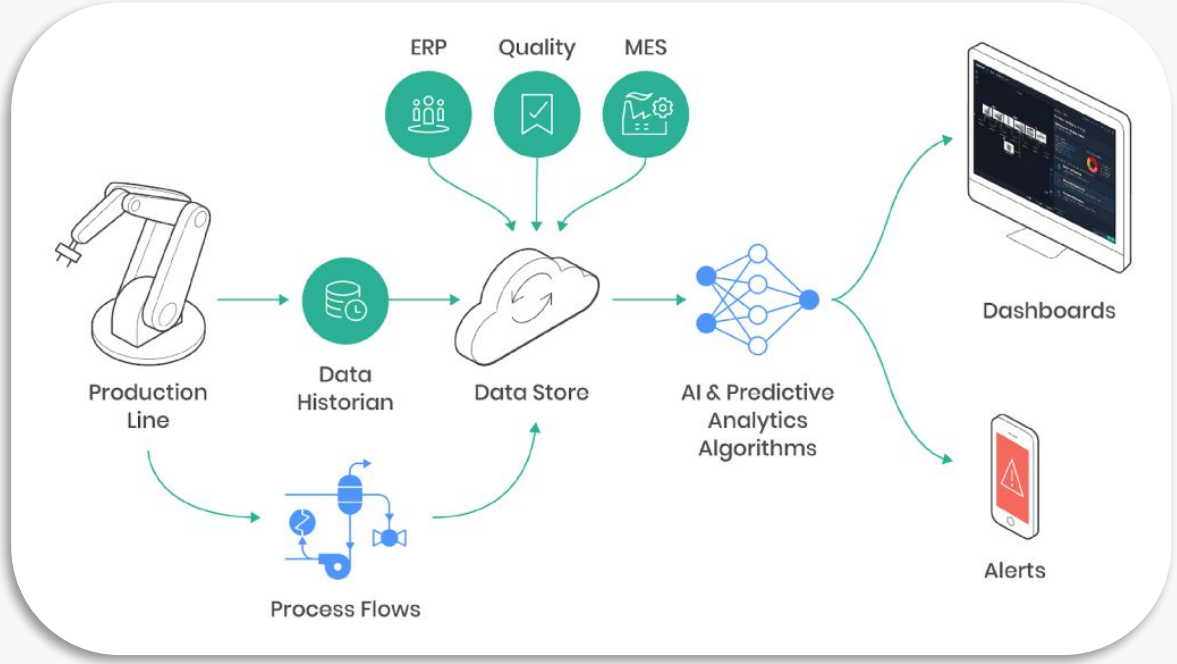
AI-powered weather forecasting can help farmers predict weather patterns, such as temperature, precipitation, and wind, to optimize planting, harvesting and irrigation

AI and ML in Agriculture – Predictive Analytics



PREDICTIVE MAINTENANCE

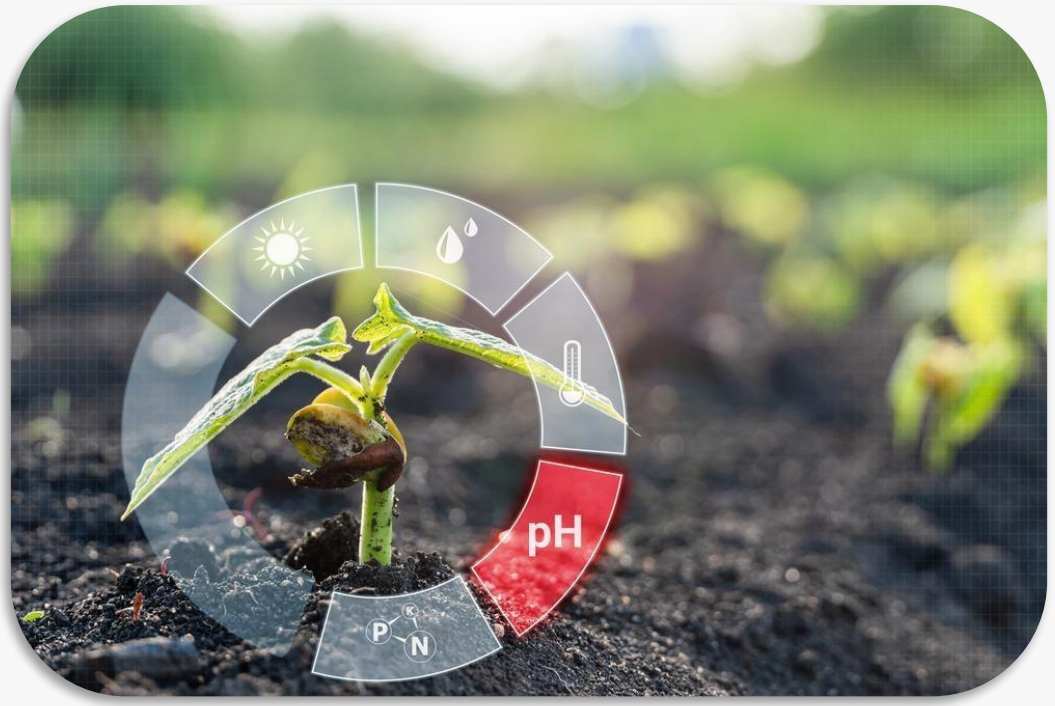
AI can be used to predict when equipment and machinery need maintenance, helping to reduce downtime and increase efficiency.



AI and ML in Agriculture – Predictive Analytics

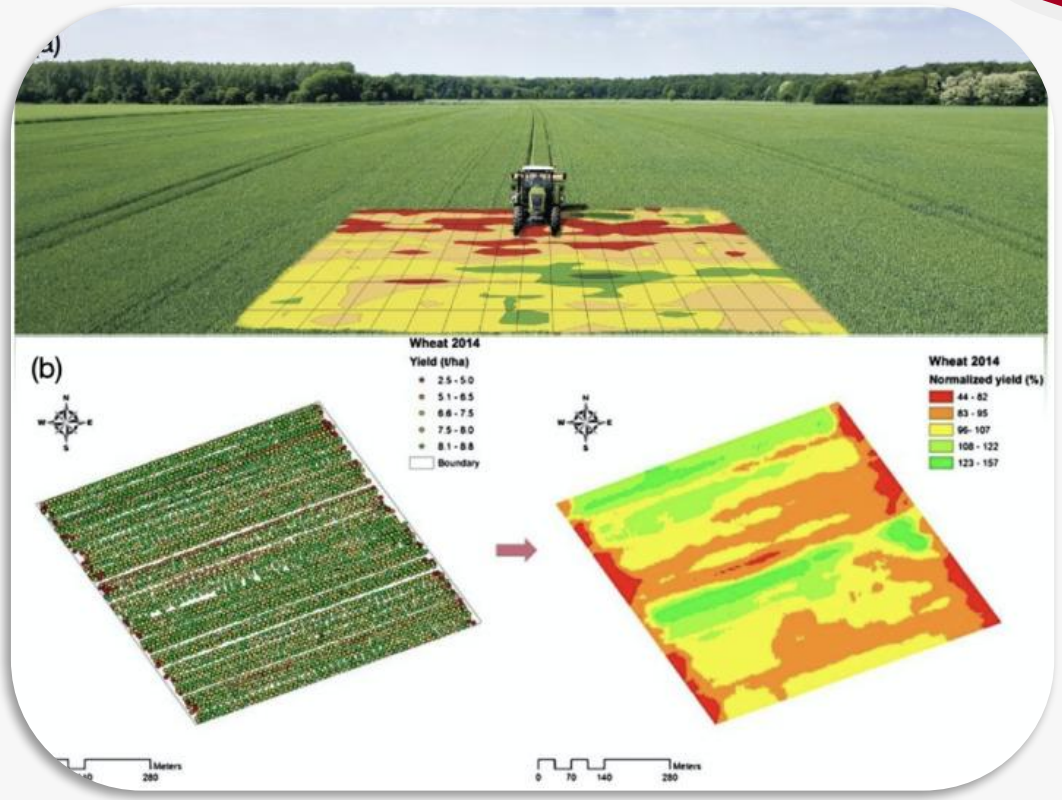
SOIL ANALYSIS AND FERTILITY PREDICTION

AI can be used to analyze soil samples and predict the fertility of the soil and the best time to plant crops.



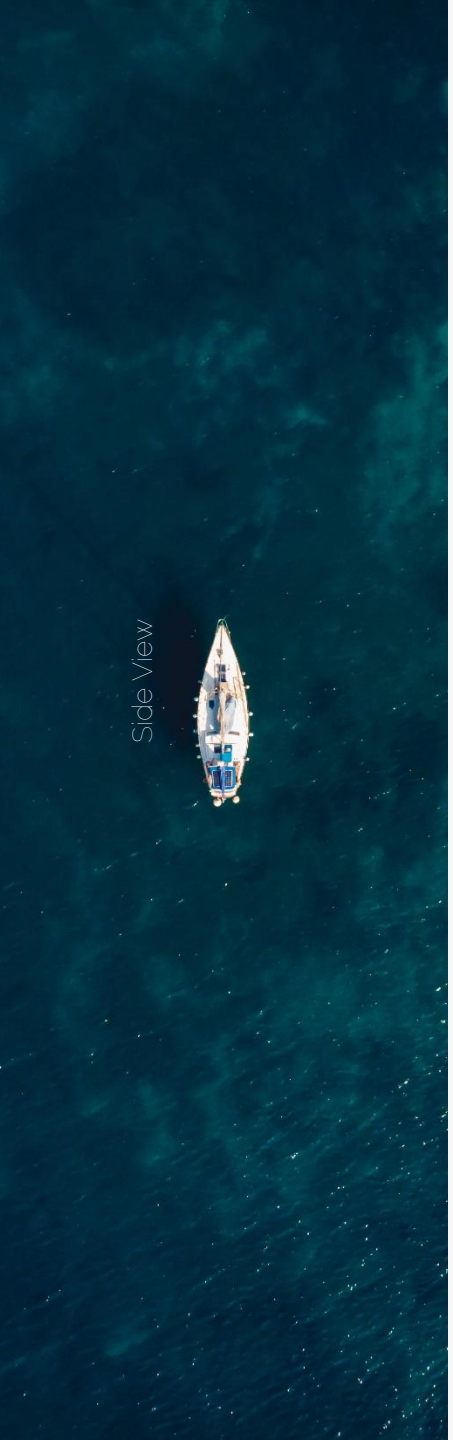
AI and ML in Agriculture

Side View



YIELD MAPPING

It relies on supervised machine learning algorithms to find patterns in large-scale data sets and understand the orthogonality of them in real-time – all of which is invaluable for crop planning.



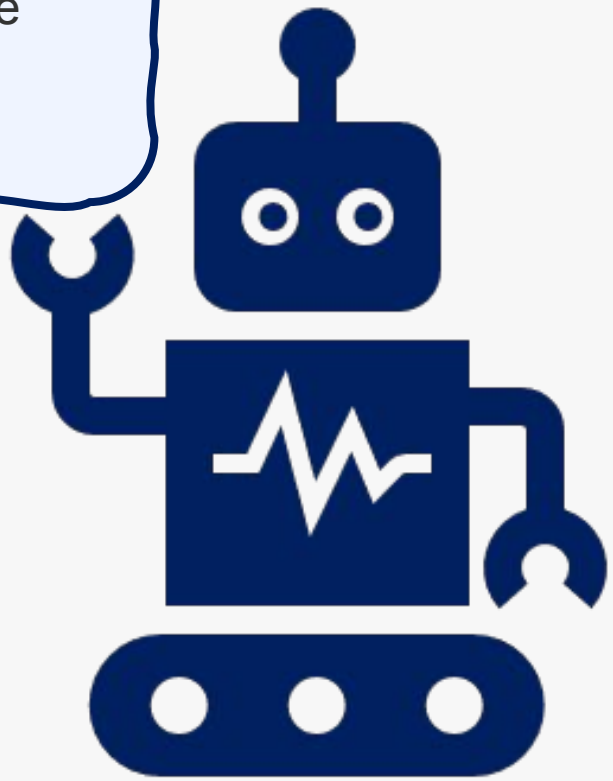
AI and ML in Agriculture

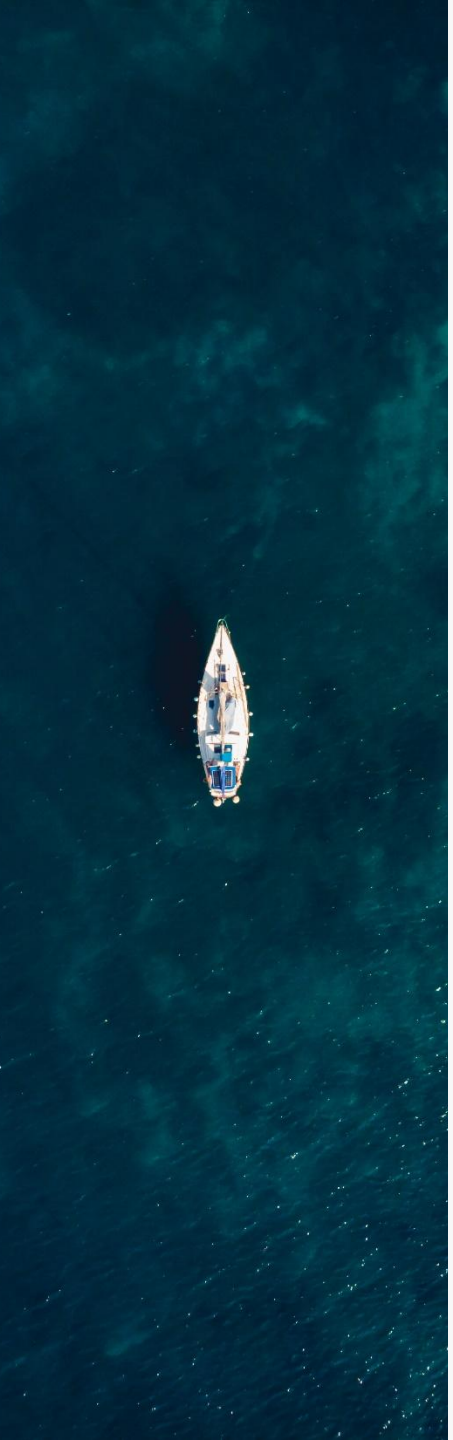
INTELLIGENT SPRAYING

UAVs (such as drones) equipped with computer vision AI make it possible to automate spraying of pesticides or fertilizer uniformly across a field.

Robotic systems

Robotic systems refer to the **use of robots or autonomous machines to perform tasks** that are typically done by humans. These machines can be programmed to perform specific tasks and can be controlled remotely or operate autonomously.



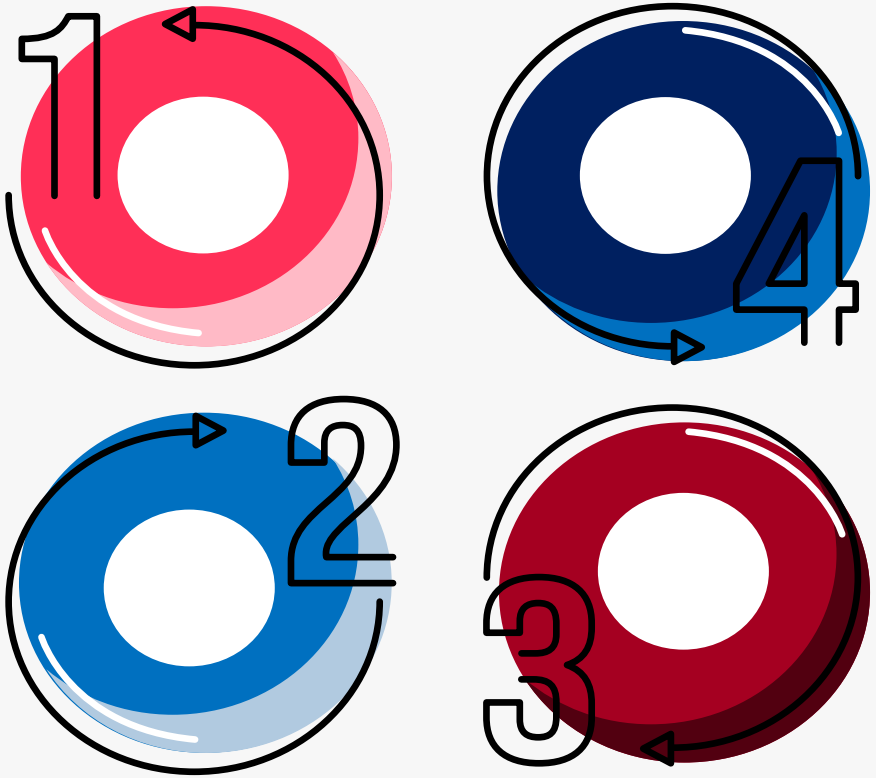


Robotic systems

Robotics systems are composed of several key components:

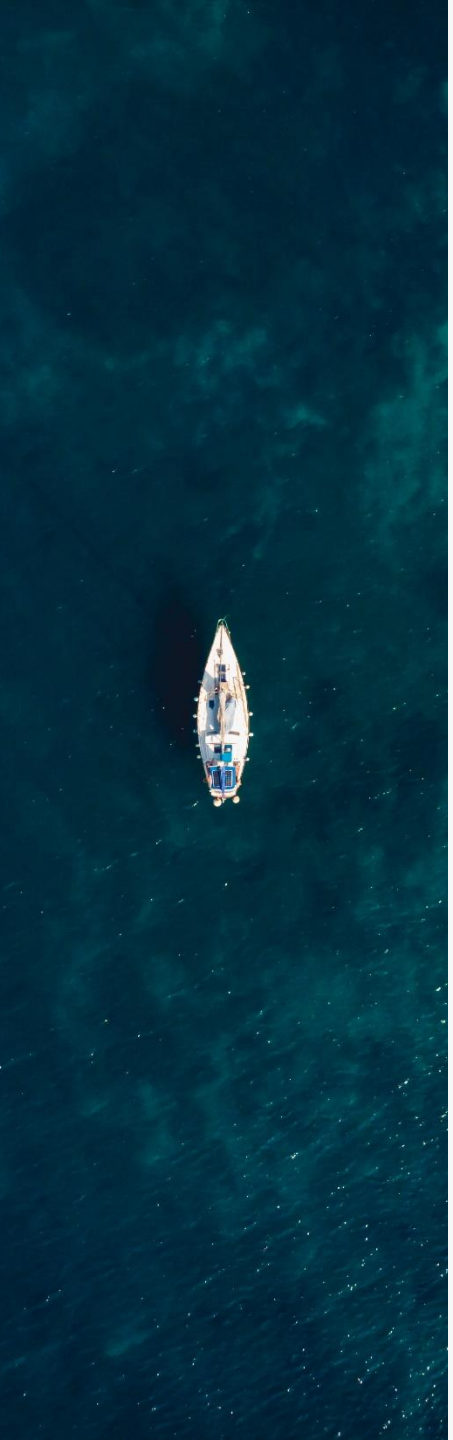
Sensors, which allow the robot to perceive its environment and gather data

A **control system**, which processes sensor data and generates commands for the actuators



A **power source**, which supplies energy to the robot

Actuators, which allow the robot to perform actions in the environment



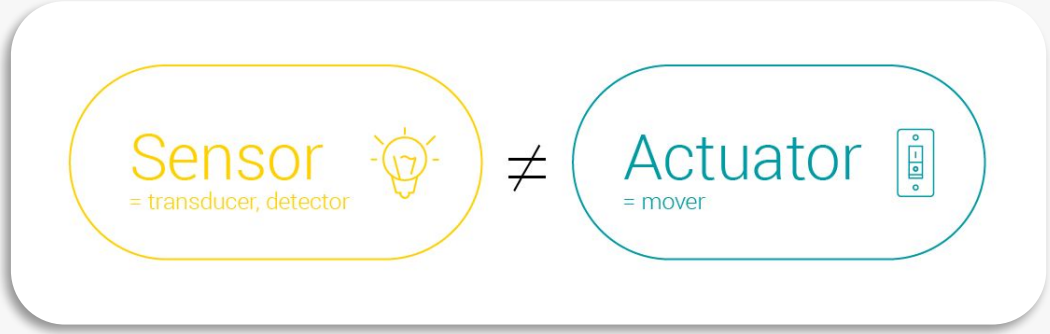
Robotic systems

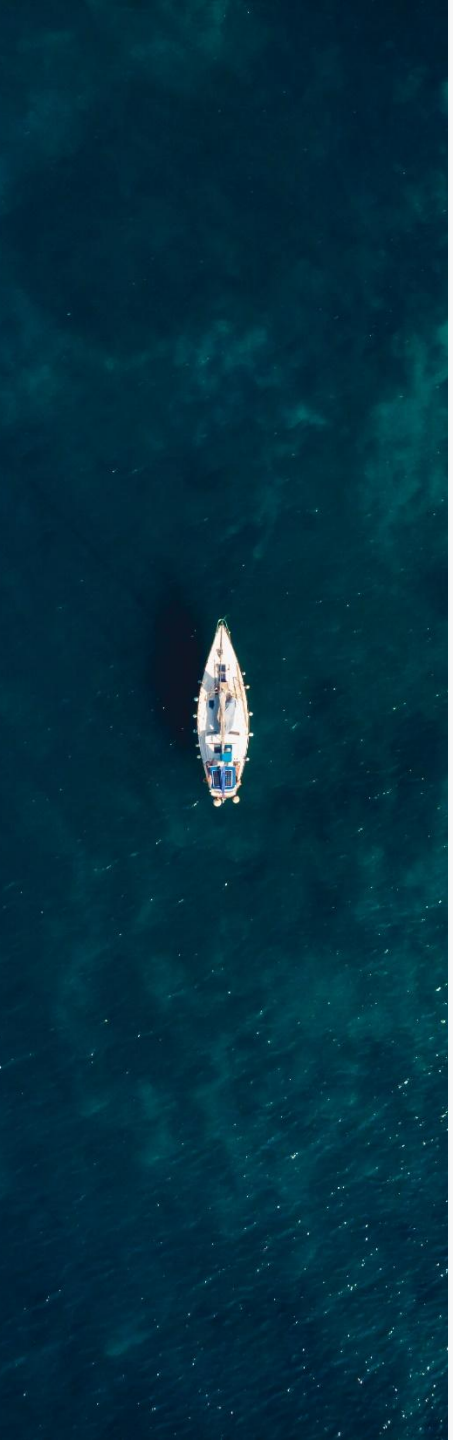
Sensors

Actuators

Sensors used in robotics include cameras, microphones, lidar, and touch sensors, among others

Actuators include motors, servos, and pneumatic systems. The control system is typically implemented using a combination of software and electronics, and may include a microcontroller or computer



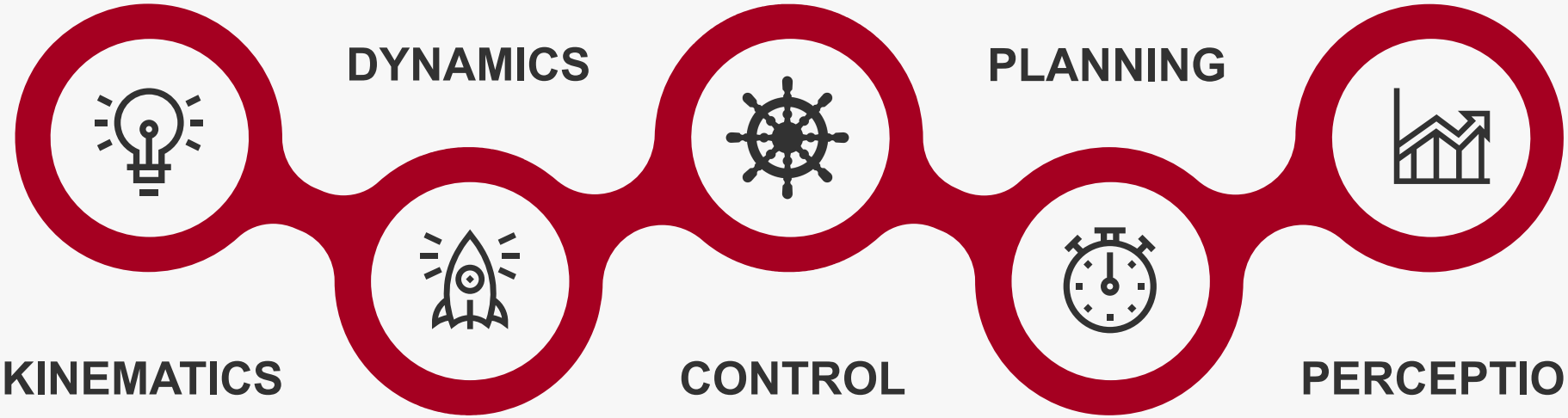


Robotic systems

There are several key areas of theory in robotics, including:

…which deals with the forces and torques that affect the robot's movement…

…which deals with how the robot can accomplish tasks or achieve goals…



…which deals with the movement of the robot and its joints…

…which deals with how the robot's movement is controlled and coordinated…

…which deals with how the robot interprets sensor data and understands its environment…

Robotic systems

https://www.youtube.com/watch?v=4qrlFse5I1U

Robotic systems

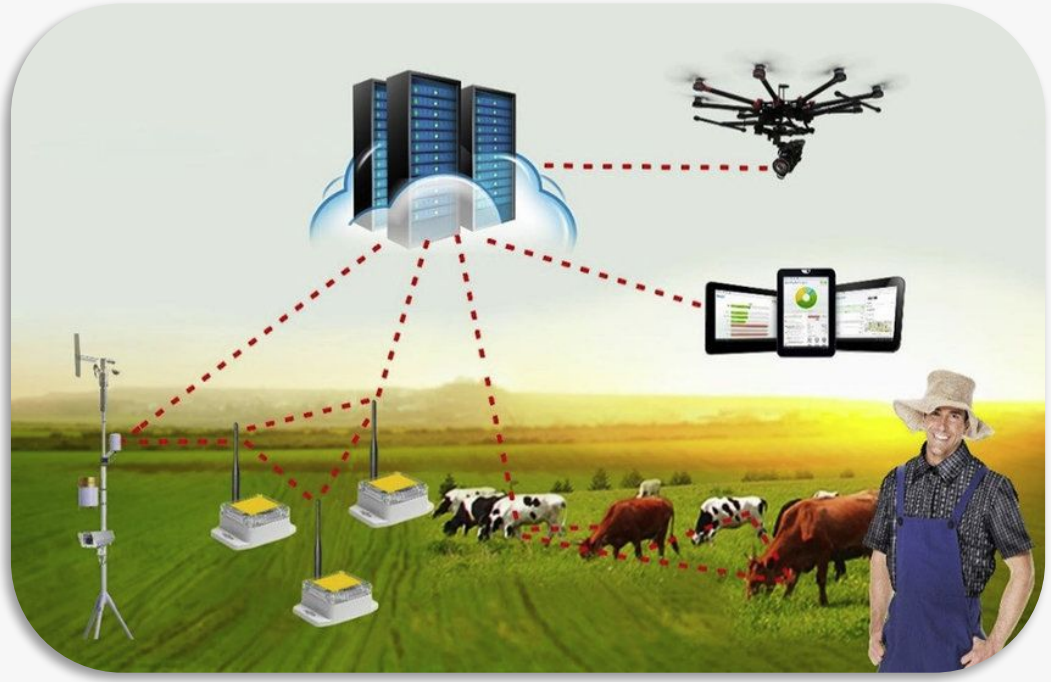
PRECISION FARMING

Using robotic systems such as tractors, drones, and other equipment to gather data on crop growth and soil conditions

Robotic systems

LIVESTOCK MONITORING

Using robotic systems such as drones, cameras, and other sensors to monitor the health and well-being of livestock



Robotic systems

CROP HARVESTING

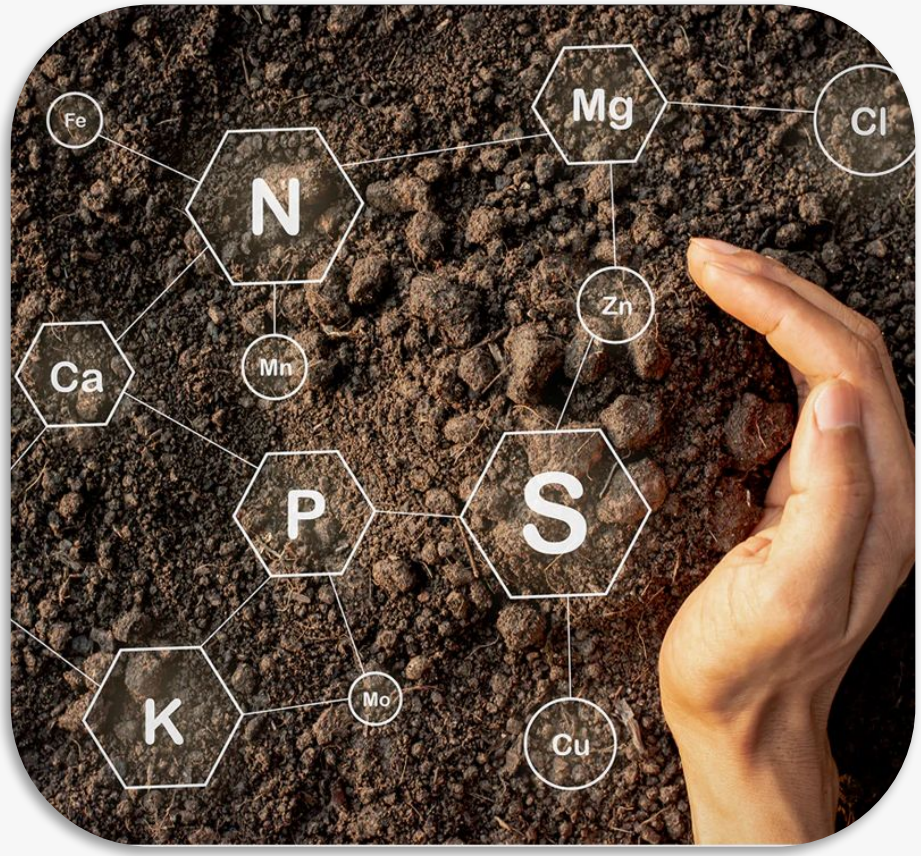
Using robotic systems such as harvesters, pickers, and other machines to automate the process of harvesting crops

Robotic systems

GREENHOUSE MAINTENANCE

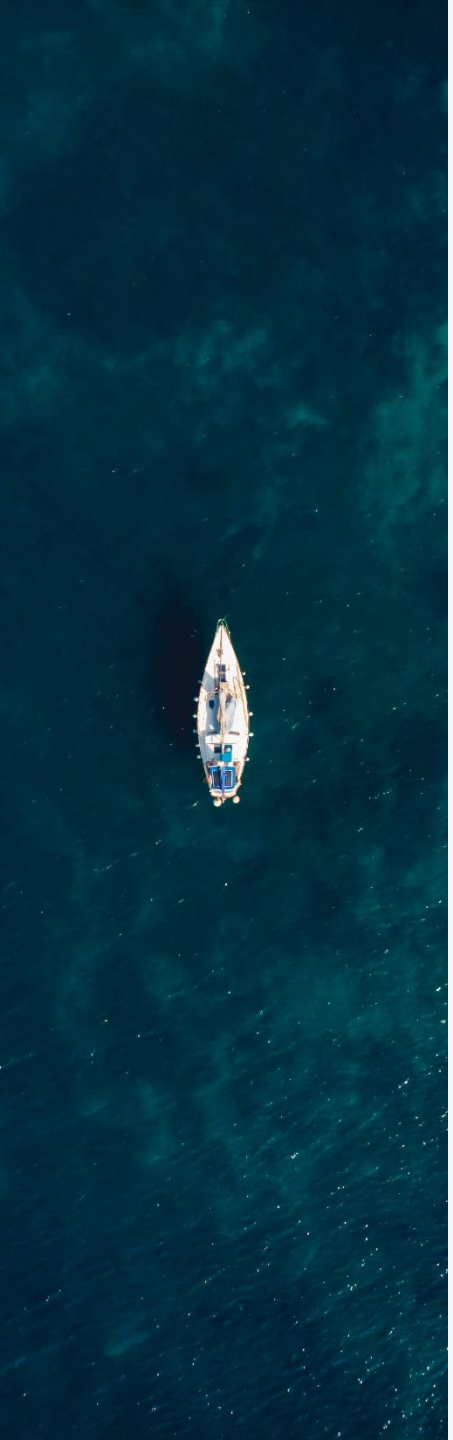
Using robotic systems such as pruning robots, pollination robots, and other machines to automate tasks such as pruning, pollination, and pest control

Robotic systems



SOIL ANALYSIS

Using robotic systems such as soil samplers and other machines to automate the process of collecting and analyzing soil samples



Robotic systems

INCREASED EFFICIENCY

…by automating tasks that are typically done by humans…

IMPROVED FOOD SAFETY

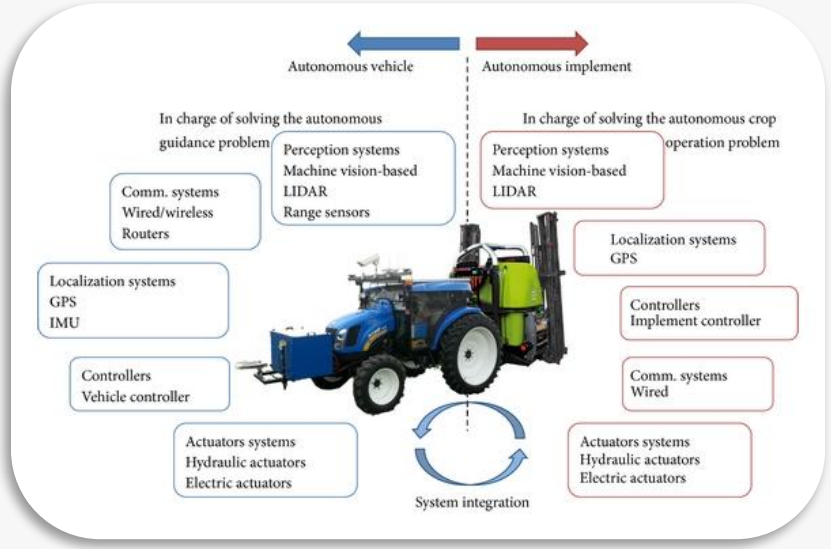
…by using robotic systems to monitor the health and well-being of livestock…

INCREASED SUSTAINABILITY

…by using robotic systems to optimize crop production and reduce input costs…

REDUCED LABOR COSTS

…by automating tasks such as harvesting, pruning, and pest control…

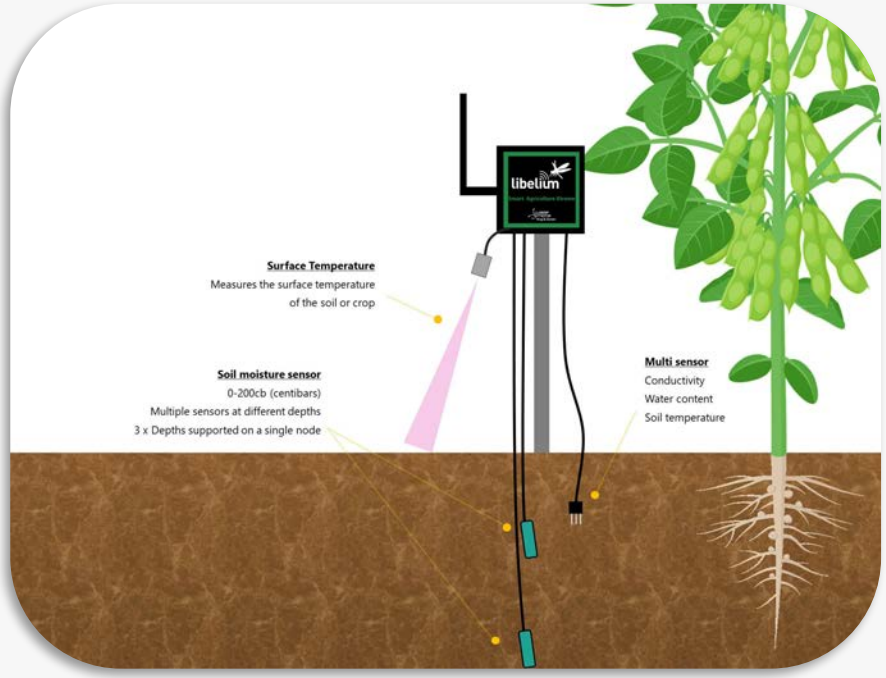


IMPROVED YIELDS

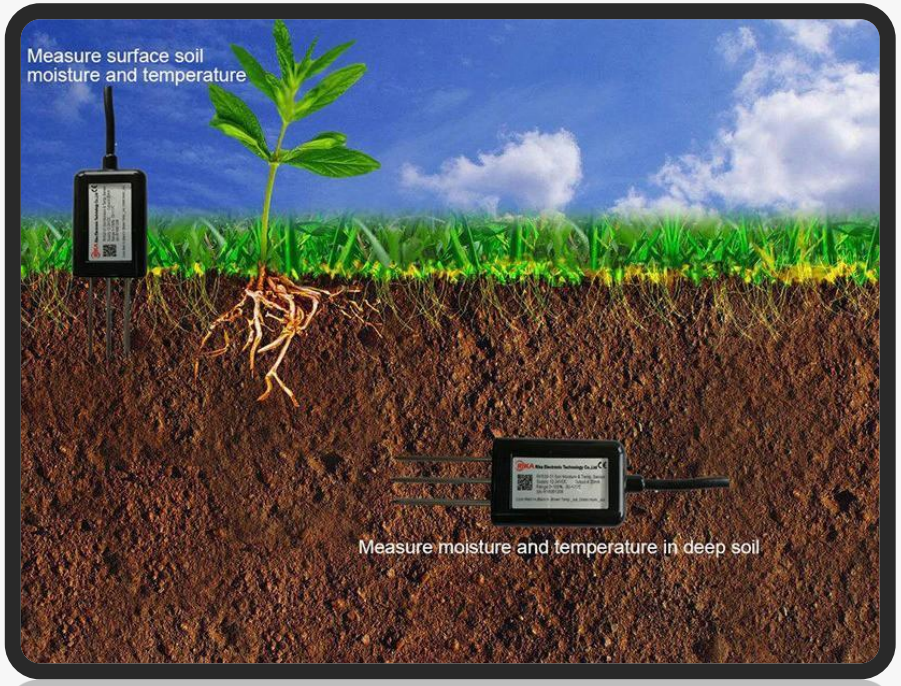
…by using robotic systems to gather data on crop growth and soil conditions…

Temperature and moisture sensors

Temperature and moisture sensors are devices that are used to **measure and monitor temperature and moisture levels** in various environments. These sensors can be placed in soil, air, or other areas to collect data on temperature and moisture levels.



Temperature and moisture sensors



Temperature and moisture sensors

PRECISION FARMING

Using temperature and moisture sensors to gather data on soil and air temperature and moisture levels

Temperature and moisture sensors

GREENHOUSE AND INDOOR FARMING

Using temperature and moisture sensors to monitor and control the temperature and humidity inside greenhouses and indoor farms

Temperature and moisture sensors

LIVESTOCK MONITORING

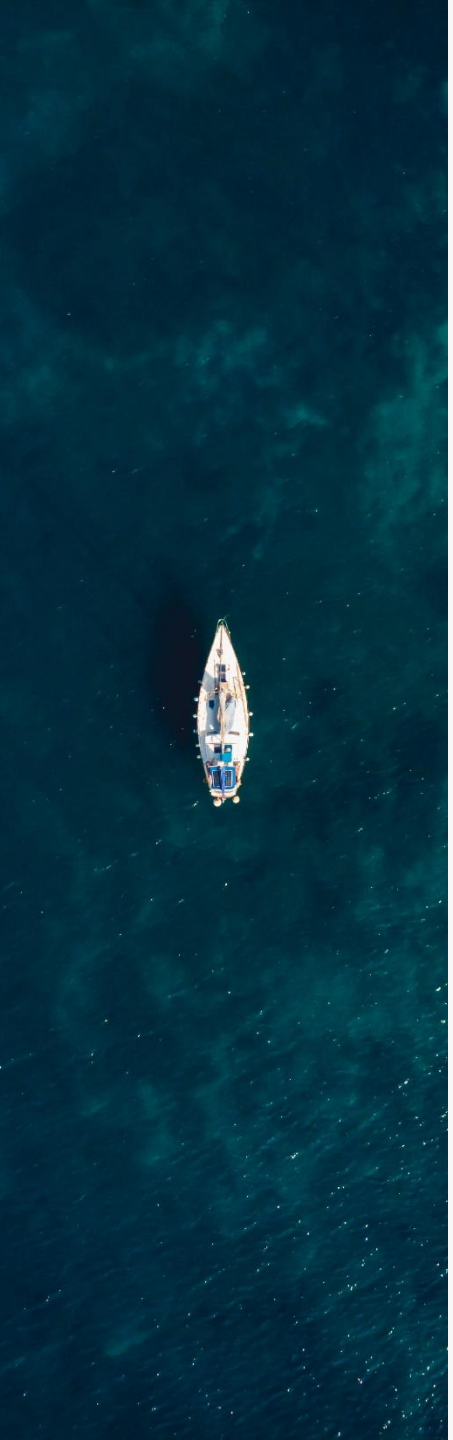
Using temperature and moisture sensors to monitor the temperature and humidity in animal housing

Temperature and moisture sensors

IRRIGATION SYSTEMS

Using temperature and moisture sensors to optimize irrigation systems by providing real-time data on weather, soil moisture, and crop growth

Temperature and moisture sensors



WEATHER FORECASTING

Using temperature and moisture sensors to predict weather patterns, which can help farmers make more informed decisions about planting and harvesting

Temperature and moisture sensors

INCREASED EFFICIENCY

…by providing real-time data on soil and air temperature and moisture levels…

IMPROVED FOOD SAFETY

…by using temperature and moisture sensors to monitor the temperature and humidity in animal housing…

INCREASED SUSTAINABILITY

…by using temperature and moisture sensors to optimize crop production and reduce input costs…

BETTER MANAGEMENT OF RESOURCES

…by using temperature and moisture sensors to predict weather patterns…

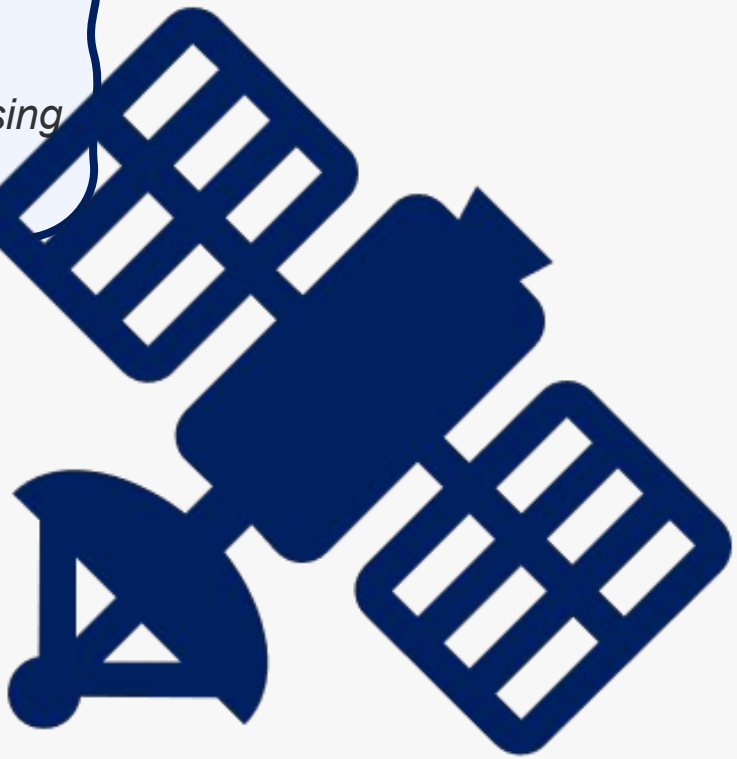
IMPROVED YIELDS

…make more informed decisions about planting, irrigation, and fertilization…

GPS technology

GPS (Global Positioning System) technology is a **satellite-based navigation system that provides location and time information** anywhere on or near the Earth.

GPS technology can be used to determine a precise location using a GPS receiver, which receives signals from GPS satellites and processes the data to calculate the user's location.



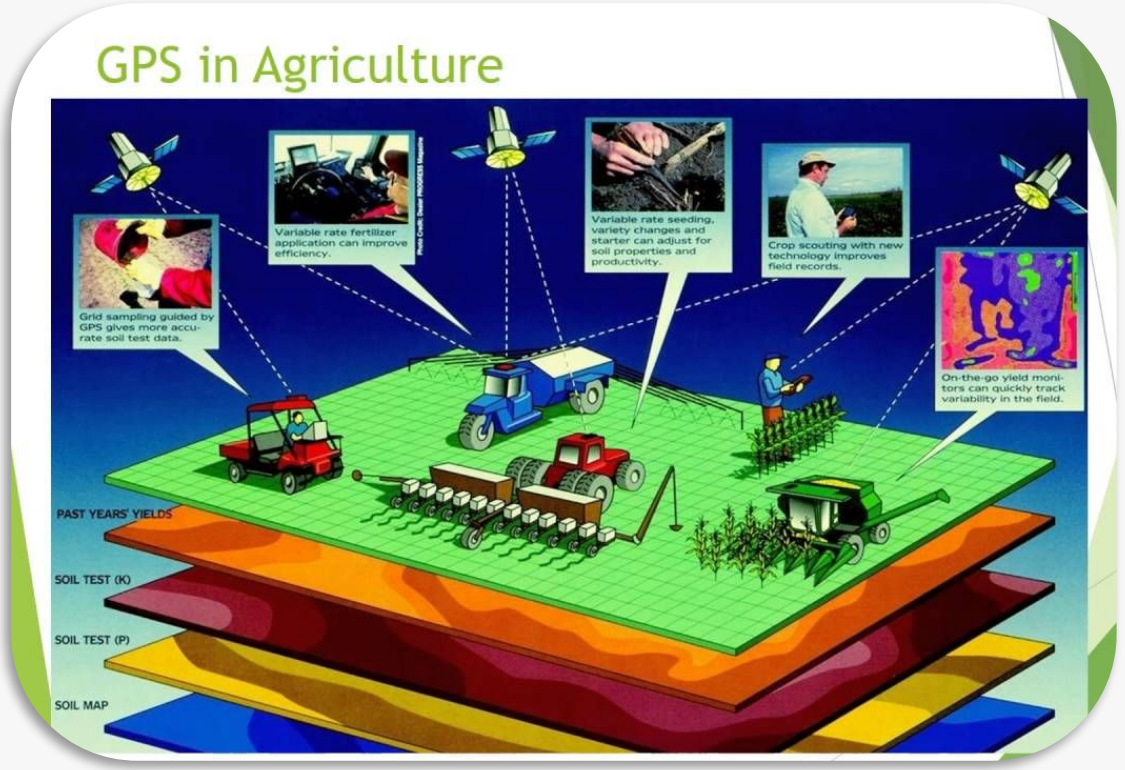
GPS technology

https://www.youtube.com/watch?v=ZFDsqC_JJYU

GPS technology

PRECISION FARMING

Used to map fields, track equipment, and guide tractors and other vehicles for planting, fertilizing, and harvesting crops



GPS technology

CROP MONITORING

Used to track crop growth and health, by using sensors that measure factors such as temperature, humidity, and soil moisture

GPS technology

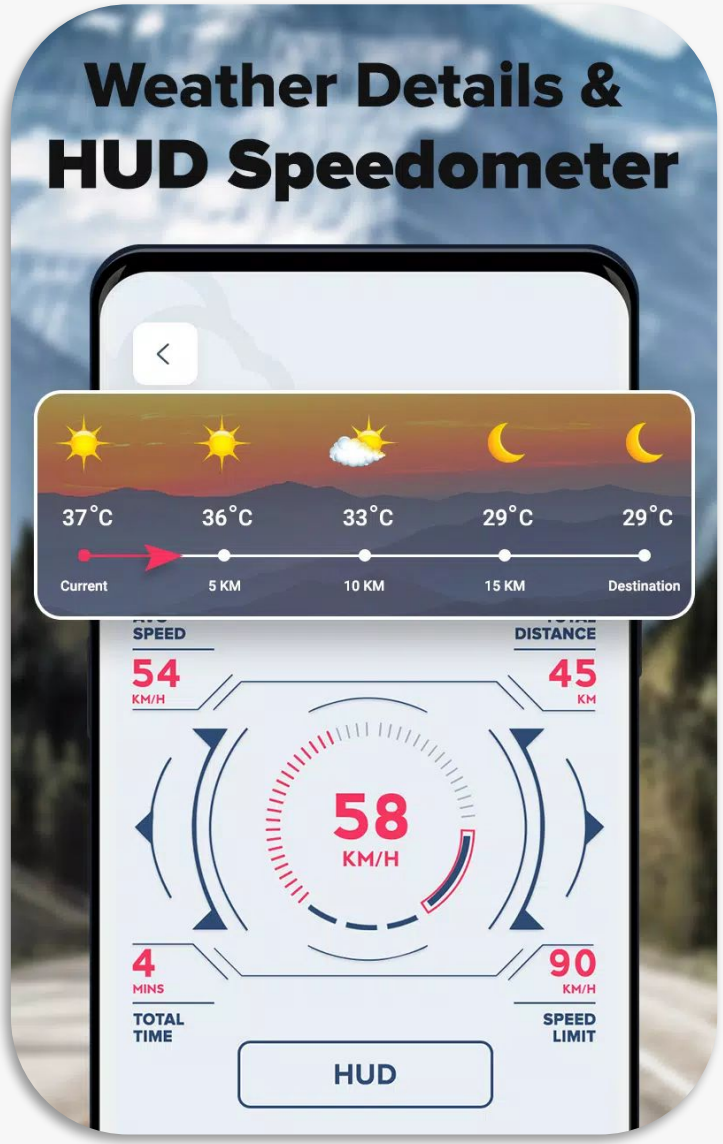
LIVESTOCK TRACKING

Used to track the location and movement of livestock, allowing farmers to monitor their health and well-being, and to manage grazing patterns

GPS technology

WEATHER FORECASTING

Used to collect meteorological data, such as temperature, humidity, and precipitation



GPS technology

YIELD MAPPING

Used to map the yield of a field, by measuring the quantity of crop harvested in different areas

GPS technology

INCREASED EFFICIENCY

…by providing real-time data on crop growth, soil conditions, and weather patterns…

IMPROVED FOOD SAFETY

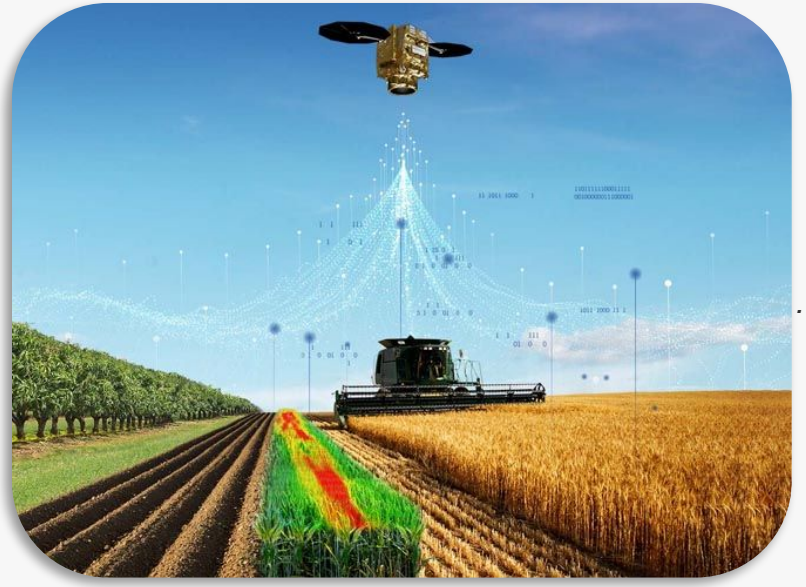
…by using GPS technology to track the location and movements of vehicles and equipment…

INCREASED SUSTAINABILITY

…by using GPS technology to optimize crop production and reduce input costs…

BETTER MANAGEMENT OF RESOURCES

…GPS technology allows farmers to map fields, track equipment, and guide tractors and other vehicles for planting, fertilizing, and harvesting crops…

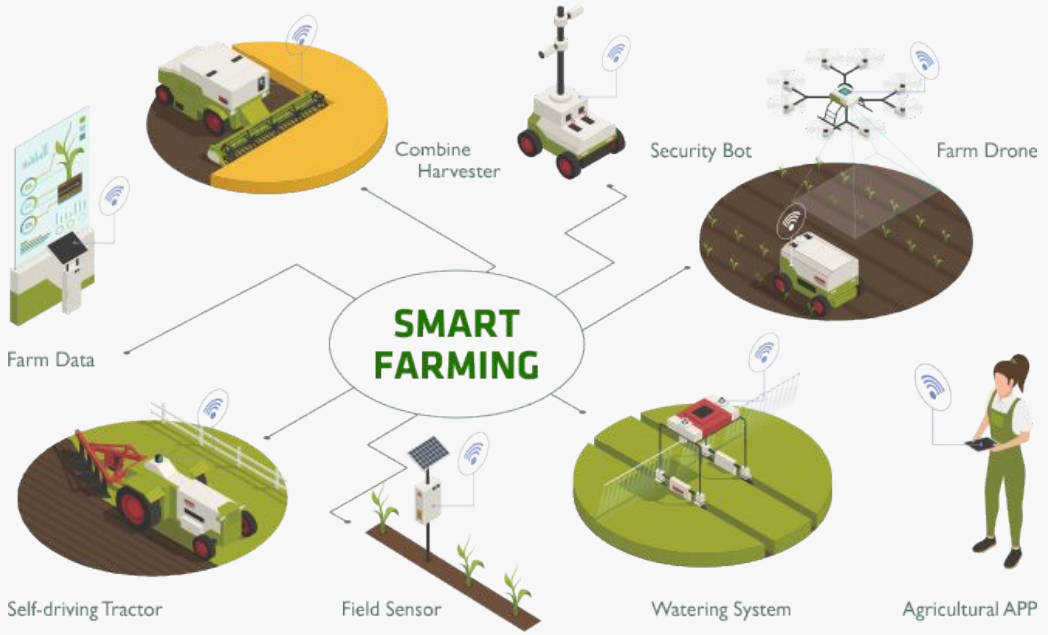


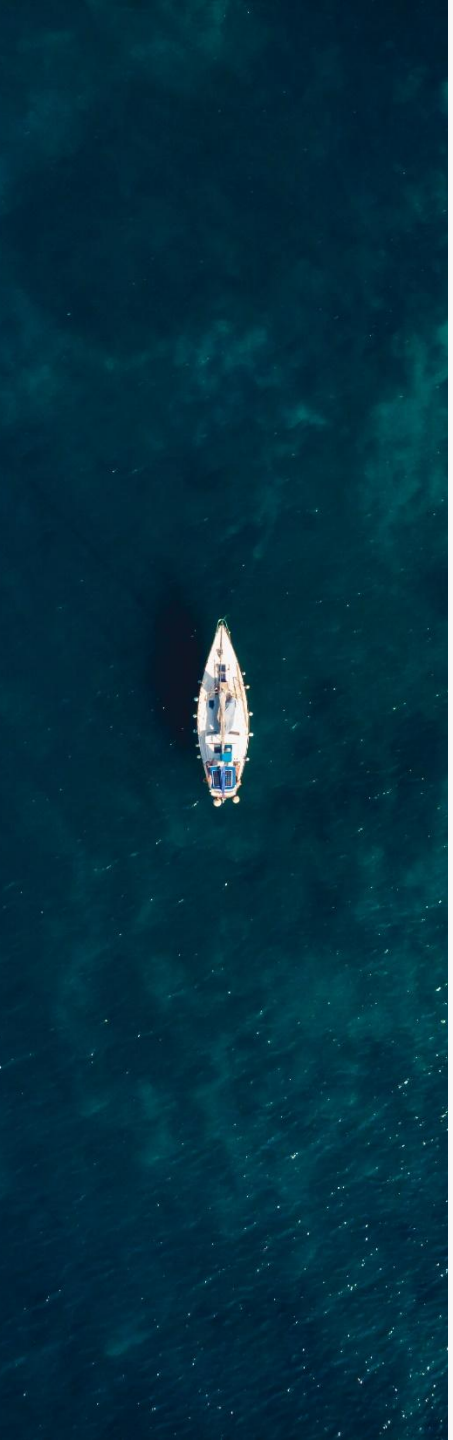
IMPROVED YIELDS

… by providing real-time data on the field, crop growth, soil conditions, and weather patterns…

Smart farming and food security

Smart farming and food security refer to the use of technology, data analytics, and other advanced techniques to **optimize crop production, reduce input costs, and improve food safety and security**.
Smart farming technologies can be used to improve efficiency, increase yields, and reduce costs.



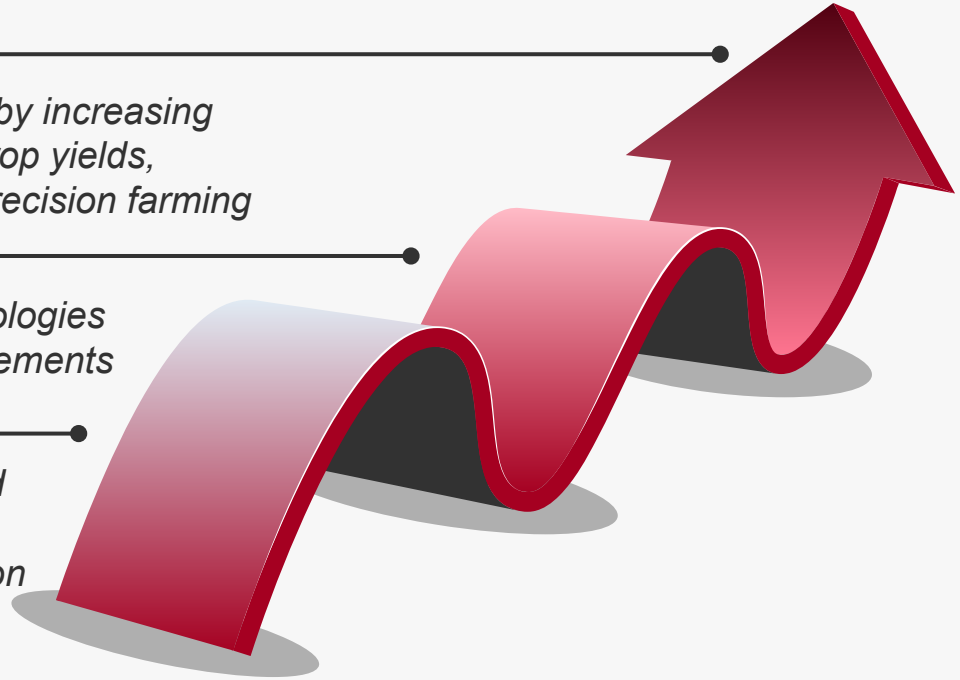


Smart farming and food security

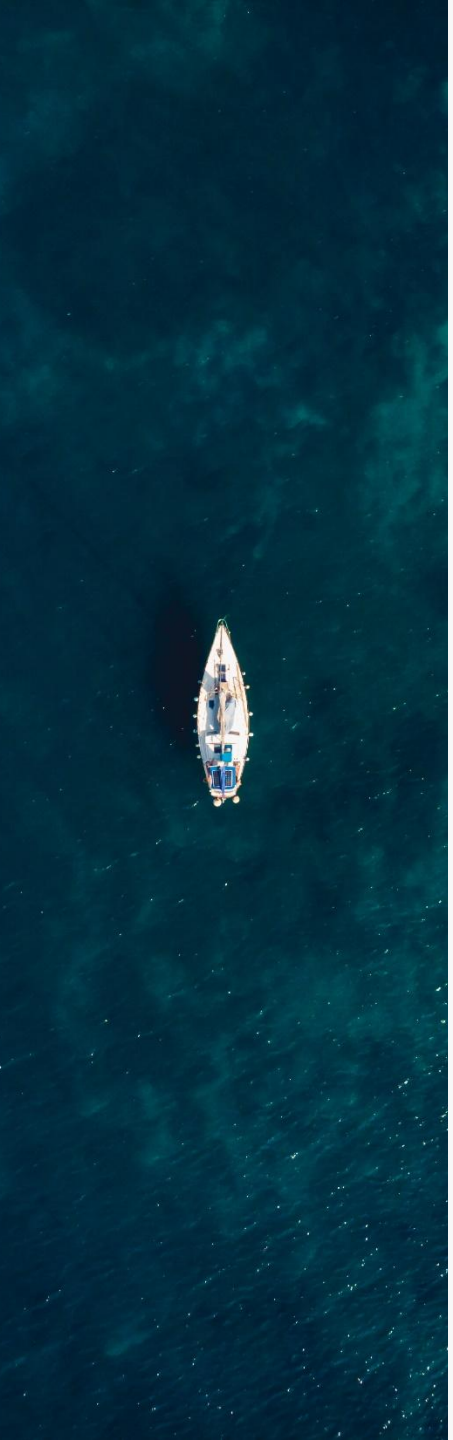
Digital agriculture — *Digital agriculture can save the sector by increasing efficiency, reducing costs, improving crop yields, enhancing food safety, and enabling precision farming*

Digital transformation — *The level of improvement in digital technologies has been tremendous, with rapid advancements*

Demand — *With global population constantly increasing and climate change affecting agriculture in many ways, the agri-food sector is in need of innovation*



…combining digital technologies can be the key to digital transformation because it allows organizations to create new, more powerful solutions, increase efficiency and productivity, gain a competitive advantage, make data-driven decisions, scale operations, provide personalized experiences, and be more flexible in their operations…



Smart farming and food security

AI + BIG DATA
FOR INFORMED DECISION-MAKING

In farming, data analytics can result in massive productivity increases and significant cost savings. By combining AI with big data, farmers can get valid recommendations based on well-sorted real-time information on crop needs

AI + IOT SENSORS
FOR CAPTURING AND ANALYZING DATA

By combining AI farming tools with IoT devices and software, farmers can get more accurate information faster. Better data means better decisions and less time and money spent on trial and error

Smart farming and food security

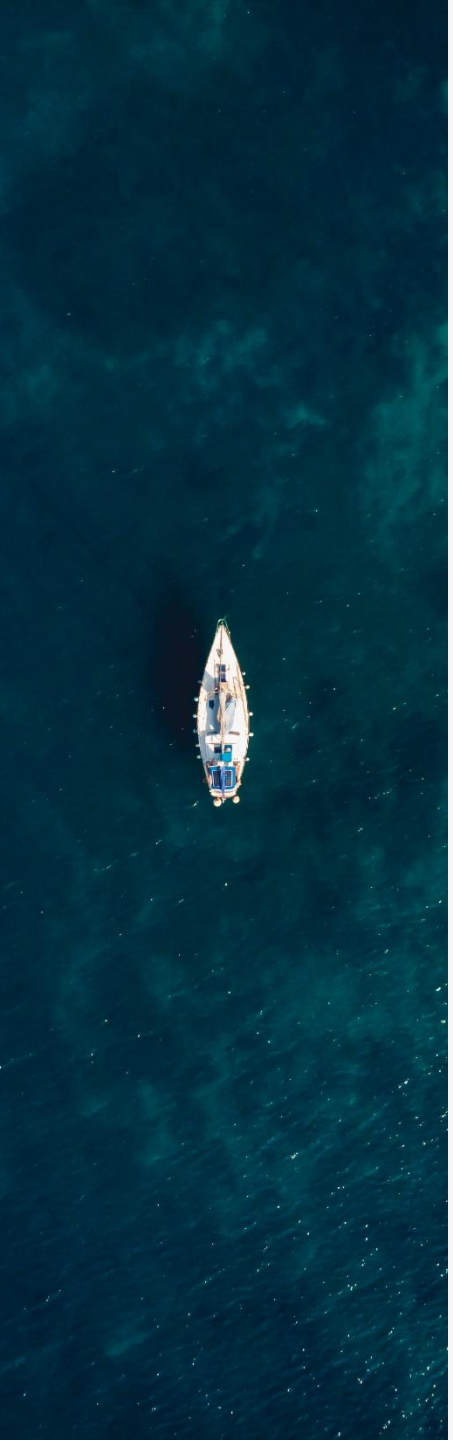
AI + AUTOMATION AND ROBOTICS FOR MINIMIZING MANUAL WORK

Artificial intelligence combined with autonomous tractors and IoT can solve one of the most common problems in farming: a shortage of labor. These technologies are also potentially cost-effective because they're more accurate and thus reduce errors. Taken together, AI, autonomous tractors, and IoT are the key to precision agriculture.

Smart farming and food security

DIGITAL TECHNOLOGIES FOR CLIMATE-CONTROLLED STORAGE

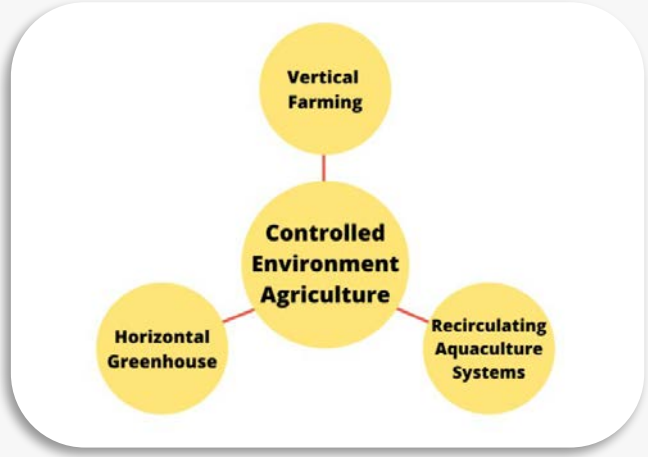
By using digital technologies such as IoT, cloud computing, and predictive analytics, organizations can monitor and control the temperature, humidity, and other environmental factors in storage facilities, which can help preserve the quality of perishable products.



Control environment agriculture

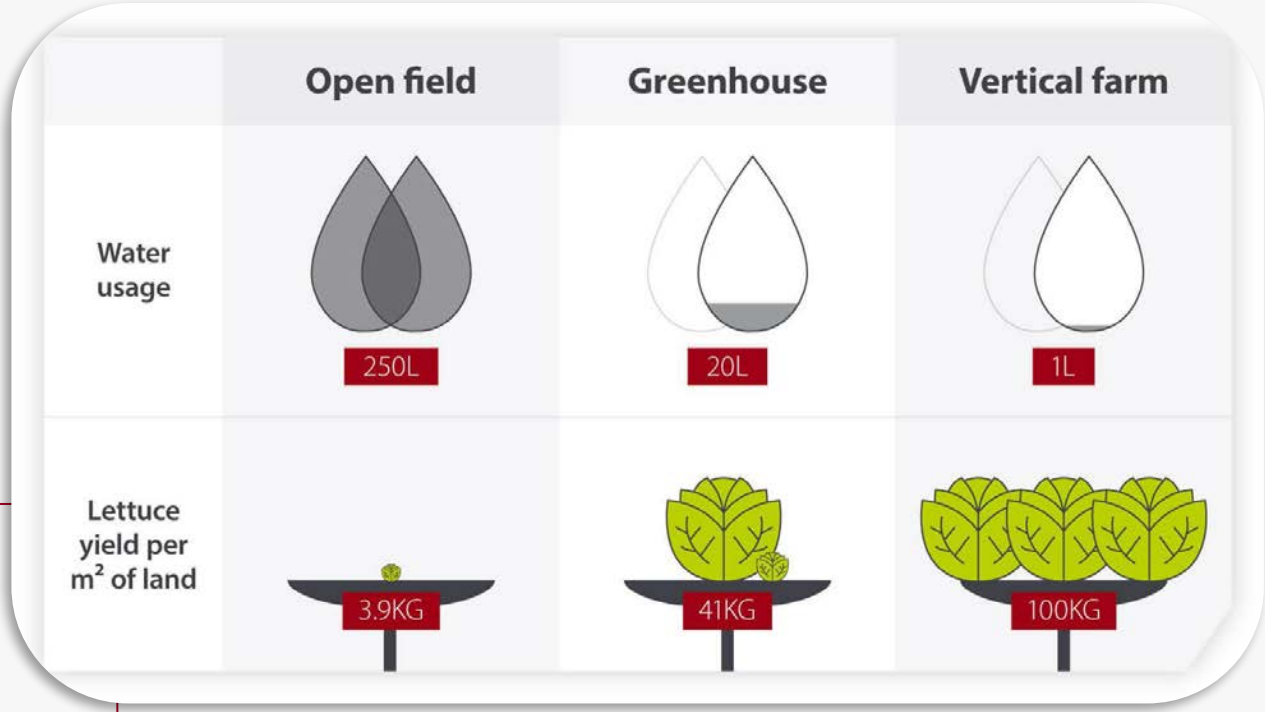
Control environment agriculture (CEA) refers to the use of controlled environments such as greenhouses, vertical farms, and indoor farms to grow crops.

These environments are designed to provide optimal conditions for plant growth by controlling factors such as temperature, humidity, light, and nutrition.



"The goal of CEA is to produce high-quality crops in a sustainable and efficient manner, regardless of weather conditions or seasonality"

Control environment agriculture



CEA

CEA uses digital technologies such as IoT, automation and machine learning to improve the efficiency of operations, and to optimize the crop's growth, health and yield.

Control environment agriculture

Overall, the three types of CEA have different characteristics, but all have the goal of providing a controlled environment for crop growth, using digital technologies to monitor and optimize the growth conditions, and producing high-quality crops in a sustainable and efficient manner.

This approach can result in

- ✔ reduced water consumption
- ✔ reduced pesticide use
- ✔ increased crop yields

CEA also enables farmers to grow crops in urban areas and in places where traditional farming is not possible.

Control environment agriculture

GREENHOUSES

Greenhouses are structures that are covered with transparent or translucent material such as glass or plastic.

They are used to protect crops from external environmental factors such as wind, rain, and pests, while also providing a controlled environment for the plants to grow.

Greenhouses can be heated or cooled to maintain optimal temperatures for plant growth and can also use artificial lighting to supplement natural light.

Control environment agriculture

VERTICAL FARMS

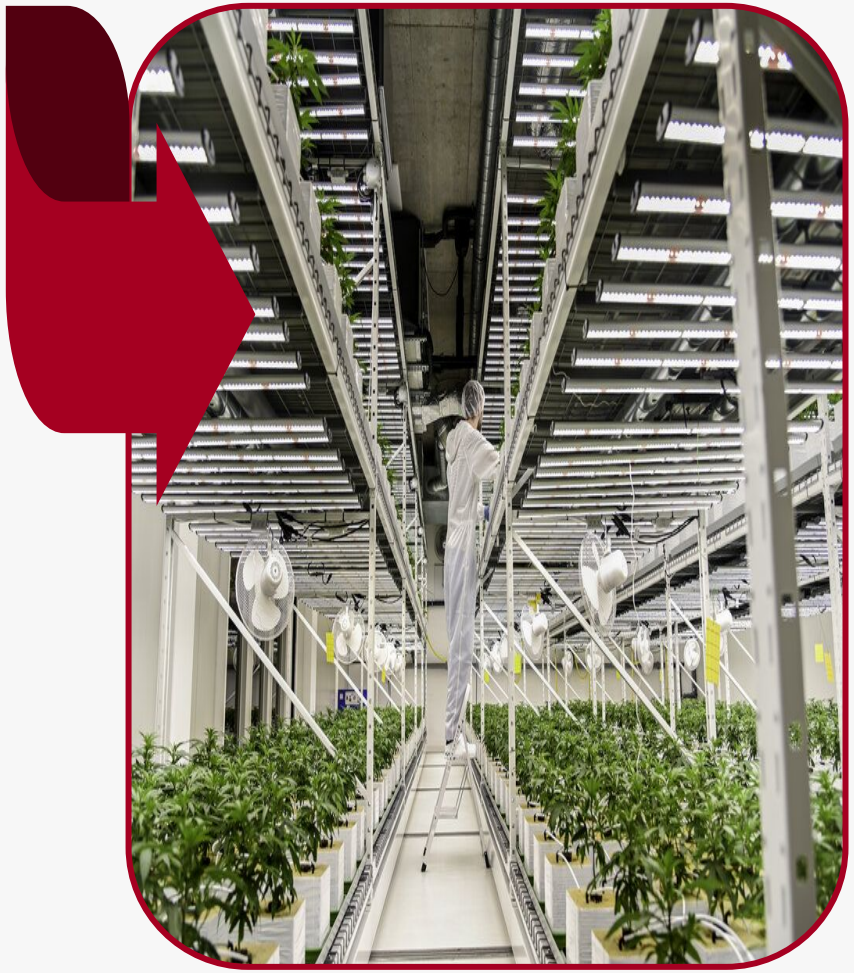
Vertical farms are indoor farming systems that use stacked layers to grow crops in a controlled environment.

They are designed to maximize the use of space and resources, and can be used to grow a wide variety of crops, including vegetables, fruits, and herbs.

Vertical farms use LED lighting, controlled temperature and humidity, and nutrient-rich water to create the optimal growing conditions for plants.

They often use less water and pesticides than traditional farming methods, making them more sustainable.

Control environment agriculture

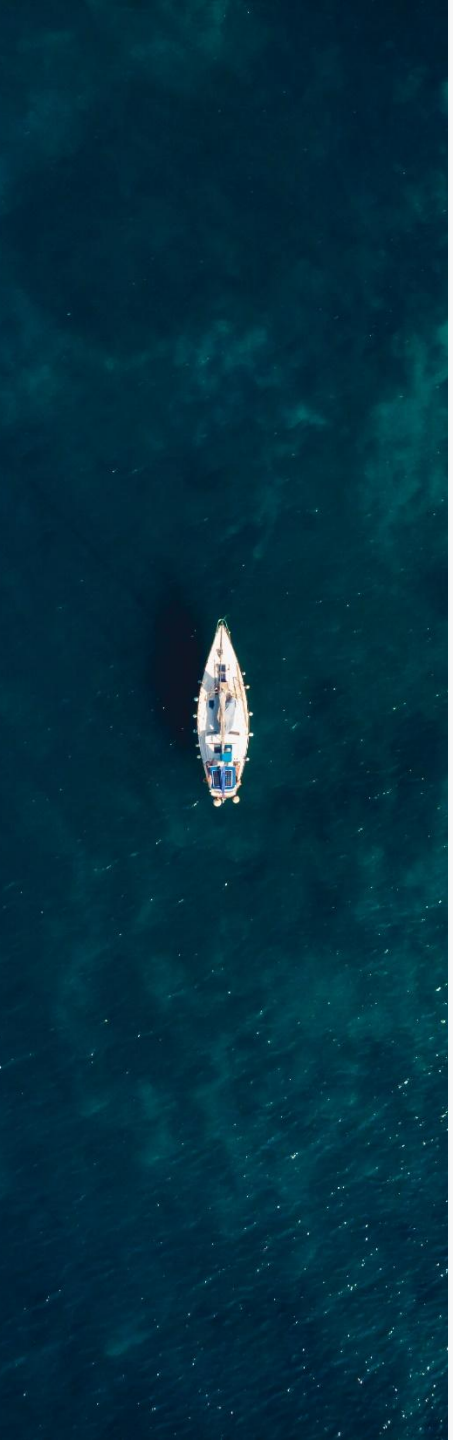


INDOOR FARMS

Indoor farms are similar to vertical farms but can take different forms, such as container farms, shipping containers that are retrofitted to grow crops, or grow rooms.

They use advanced technologies to replicate natural sunlight, temperature and humidity to grow crops indoors.

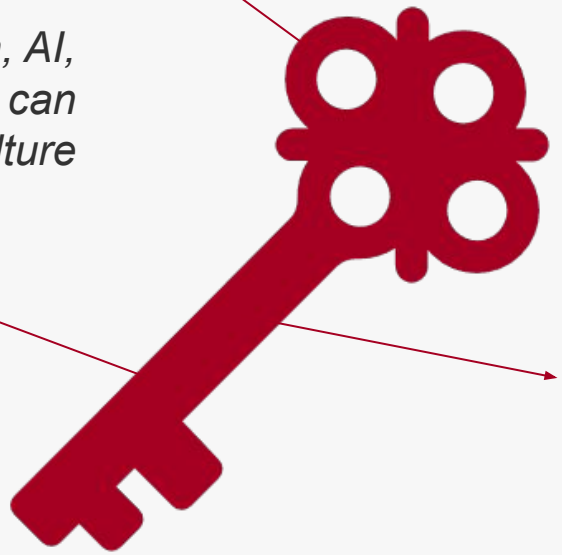
Indoor farms are often used for growing highly sought-after crops, such as mushrooms, microgreens and herbs, as well as for year-round production of vegetables and fruits.



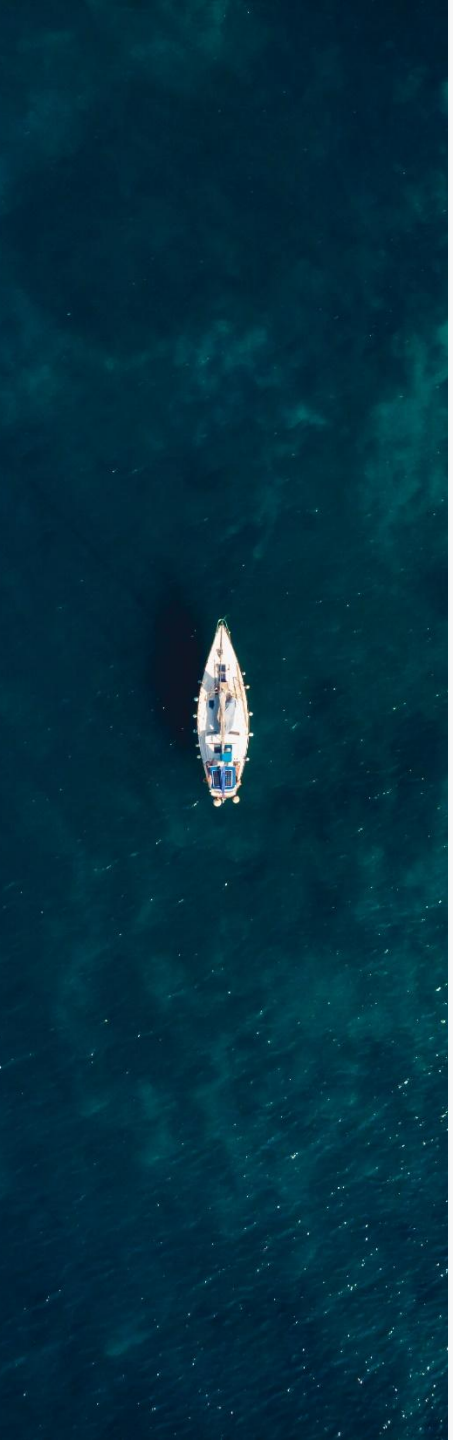
Key takeaways

The future of digital agriculture is expected to be characterized by continued advancements in technology and increased adoption of smart farming practices

Digital tools such as IoT, Big Data, AI, ML, Robotics, GPS, and sensors can be utilized for digital agriculture

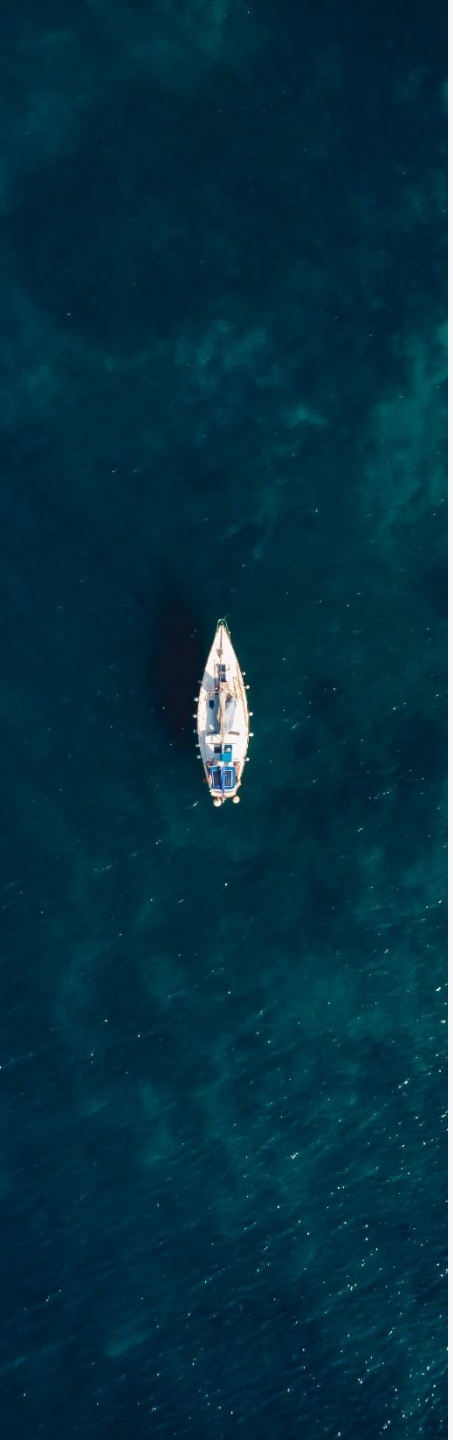


Smart farming improves yields, efficiency, food security, and sustainability while also manages better the resources and provides data for better decision-making



Challenges

- Lack of access to technology and internet connectivity in rural areas
- Limited data literacy among farmers and lack of understanding of how to use digital tools
- Lack of standardization and interoperability of digital tools and systems
- Concerns around data privacy and security
- Limited funding and resources for research and development of digital agriculture solutions
- Inadequate infrastructure, including power and transportation
- Limited scalability of digital agriculture solutions, as many are designed for small-scale operations



Presentation

Groups

- Divide into groups of 4-5

Research

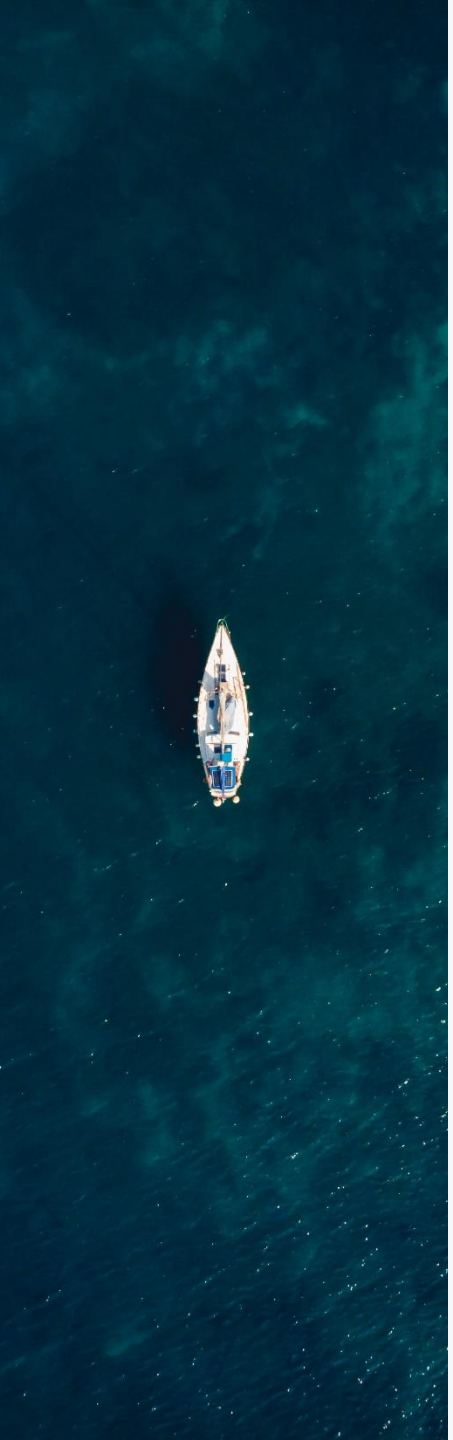
- Make a short research regarding the topic that will be assigned to your group (~45 min)

Prepare

- Take some notes and prepare your bullet points

Present

- Present shortly your findings in the classroom (~ 5-7 min)



Presentation

What are the current trends in the agri-food sector?

What are some future directions in the agri-food sector?

Module 2: IT Skills for the Agri-food Sector

Unit 6: Other examples and Case Studies

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Thank you