

AI AgriBrain – Coffee Farming

Abstract

The increasing demand for sustainable and high-yield coffee production necessitates the integration of intelligent technologies into traditional farming practices. This research proposes the design and development of AI AgriBrain, an AI-driven, IoT-enabled precision agriculture system tailored for coffee plantations. The system aims to optimize irrigation, nutrient management, and plant health monitoring through real-time data acquisition and intelligent decision-making.

AI AgriBrain is structured as a multi-layered architecture comprising field data acquisition, edge communication, cloud connectivity, AI-based analytics, control and actuation, and user monitoring modules. The system collects critical soil parameters such as moisture, temperature, pH, electrical conductivity (EC), and nutrient composition (NPK), along with environmental and visual data. These data streams are integrated with periodic laboratory soil analysis and processed using AI models to generate actionable insights.

The proposed system enables automated irrigation and fertigation, early detection of plant stress and disease, and optimized resource utilization. A mobile-based interface provides real-time monitoring and control, enhancing farmer interaction and decision support. The modular design ensures scalability and adaptability across varying farm sizes and conditions.

The implementation of AI AgriBrain is expected to improve coffee yield and quality, reduce water and fertilizer consumption, and promote sustainable agricultural practices. This research contributes to the advancement of intelligent farming systems by integrating multimodal sensing, AI analytics, and cyber-physical automation into a unified framework for precision coffee farming.

AI IN AGRICULTURE



**AI-DRIVEN
PRECISION
FARMING**



**SMART PEST
AND DISEASE
DETECTION**



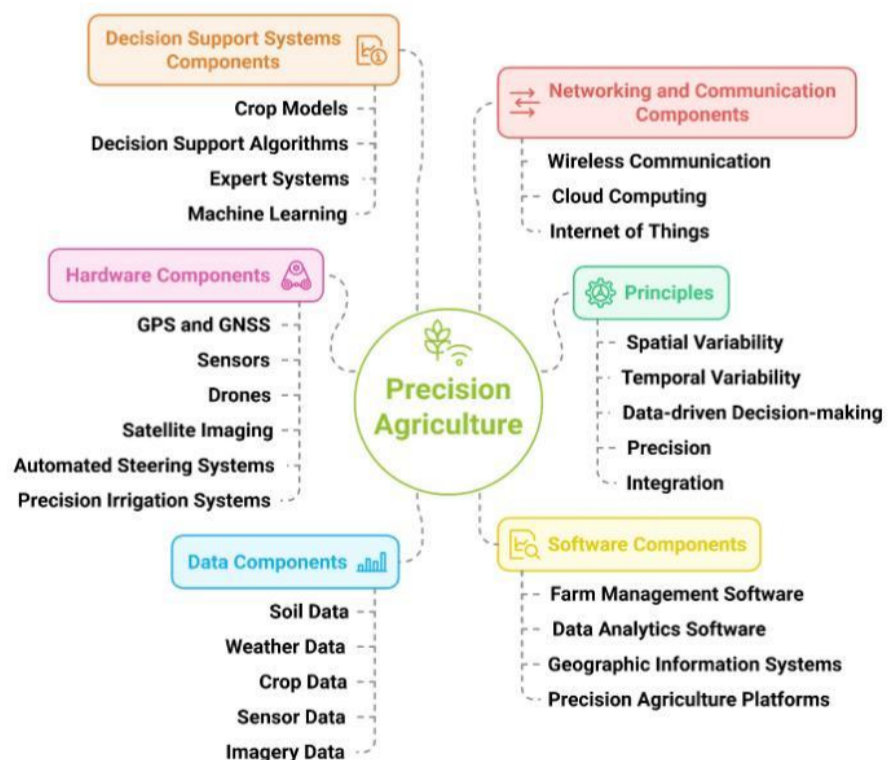
**AUTONOMOUS
AGRICULTURAL
MACHINERY**



**PREDICTIVE
PLANTING AND
HARVEST TIMING**



**RESOURCE
OPTIMIZATION
ENGINE**



AI AgriBrain – Smart Coffee Farming

Transforming Coffee Cultivation through Intelligence, Precision, and Sustainability

AI AgriBrain is an advanced, AI-driven smart farming platform designed specifically for coffee plantations. It integrates real-time field sensing, intelligent analytics, and automated control systems to enable farmers to make precise, data-driven decisions that enhance productivity, optimize resource usage, and improve crop quality.

How AI AgriBrain Works

AI AgriBrain operates through a seamless integration of field sensors, connectivity systems, and artificial intelligence:

- **Real-Time Field Monitoring:**
Sensors deployed across the farm continuously capture critical parameters such as soil moisture, temperature, pH, nutrient levels (NPK), and environmental conditions.
- **Smart Data Connectivity:**
Data is transmitted securely to the AgriBrain control system through robust communication networks, ensuring reliable access from anywhere.
- **AI-Powered Intelligence:**
The system analyses sensor data, integrates laboratory soil reports, and processes plant health images to generate precise recommendations for irrigation, fertilization, and crop management.
- **Automated Action & Control:**
AI AgriBrain can directly control irrigation systems, nutrient delivery, and field devices, ensuring the right action is taken at the right time.
- **Mobile Monitoring & Alerts:**
Farmers can monitor their entire farm through a user-friendly mobile application, receive alerts, and take manual control when needed.

Key Capabilities

- ✓ Precision irrigation based on real soil conditions
- ✓ Intelligent nutrient management (NPK, pH, EC-based decisions)
- ✓ Early detection of plant stress and disease through AI
- ✓ Automated control of pumps, valves, and fertigation systems
- ✓ Real-time monitoring via mobile and web dashboards
- ✓ Integration with solar-powered, energy-efficient systems

Benefits to Coffee Farmers

- **Higher Yield & Better Quality:**
Optimized water and nutrient delivery improves coffee bean development.
- **Reduced Costs:**
Minimizes wastage of water, fertilizers, and energy.
- **Sustainable Farming:**
Promotes efficient use of natural resources and soil health management.
- **Data-Driven Decisions:**
Replaces guesswork with scientifically validated insights.
- **Scalable Solution:**
Suitable for small farms to large plantations.

From Soil to Smart Decisions

AI AgriBrain bridges the gap between traditional farming and modern intelligence by combining:

Soil Data + Climate Data + Plant Health + AI Analytics = Smart Coffee Farming

Our Vision

To empower coffee farmers with intelligent tools that enhance productivity, ensure sustainability, and build a future of precision agriculture driven by AI.

Copyright & Intellectual Property Disclosure

AI AgriBrain – Coffee Farming System

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This includes, but is not limited to:

- System architecture and modular design
- AgriBrain AI decision framework
- Sensor integration models and deployment strategies
- Data processing and analytics workflows
- Graphical diagrams, visualizations, and GIS frameworks

- Software logic, algorithms, and control systems
 - Documentation, reports, and research outputs
-

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This project may incorporate third-party hardware, platforms, or technologies (e.g., sensors, microcontrollers, IoT platforms). All such components remain the property of their respective owners and are used in compliance with their licensing terms.

Disclaimer

The AI AgriBrain system is a research and development initiative. While every effort has been made to ensure accuracy and reliability, the authors do not guarantee performance under all environmental or operational conditions. Users are advised to validate the system before large-scale deployment.

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Contents

Coffee Specifications	5
Root Dimensions.....	5
Root Structure Breakdown	5
Coffee Plant – Root Structure Formation.....	6
Coffee Plant Root System & Sensor Placement Guide.....	7
Pilot Project Details	8
Coffee Plant – Growth and Yield Nutrient Composition.....	8
First Level – Practical Automation.....	9
Proposed Best AgriBrain approach.....	9
Recommended Nutrient Sensor Placement for 1 Acre Coffee Fram	10
The Task for AgriBrain.....	10
Proposed Sensor Stack- Project AgriBrain.....	10
Level 1 Sensors	10
Level -2 Sensors: Weather Climate Sensors	10
Level -3 : Plant Health (AI + Sensors).....	11
Level-4 Water System Sensors	11
Level-5 : Energy / Power Sensors	11
Level-6 Rover – Field AgriRobot (Mobility Sensors).....	11
AgriBrain- Phase Wise Sensor Implementation.....	12
Sensor Requirement for 1 Acre Coffee Farm	14
MASTER IDEA	14
AgriBrain Architecture.....	14
Choice of Sensors for Implementation	15
AgriBrain – Sensor Comparisons.....	16
Resistive Soil Sensors V/S – Capacitive Sensors – Comparison with Industry Sensors- JXCT RS485 Sensor	17
Proposed List of Sensors for AI AgriBrain	18
Cost-effective Deployment plan for 1 acre / 350 coffee plants	18
Sensor Deployment – Zoning Logic & Considerations.....	18
Core Soil System Deployment Budget 1 Acre in INR	19
Sensor Deployment – Plan.....	19
AgriBrain – Functional Modularisation	20
AgriBrain: System Architecture	21



Coffee Specifications

Age: 3 years

Height: 3.5 Feet

Root Dimensions

(3-YEAR COFFEE PLANT)Depth (Vertical Root Zone)

- 30 cm to 60 cm (1 to 2 feet)
- Majority of active roots:
Top 20–40 cm (this is the critical zone)

Spread (Horizontal Root Zone)

- 60 cm to 120 cm radius (2 to 4 feet from stem)
- Roots spread wider than canopy in many cases

Root Structure Breakdown

1. Tap Root (Primary)

- Goes downward
- ~40–60 cm at this stage

- Helps anchoring

2. Lateral Roots (Most Important)

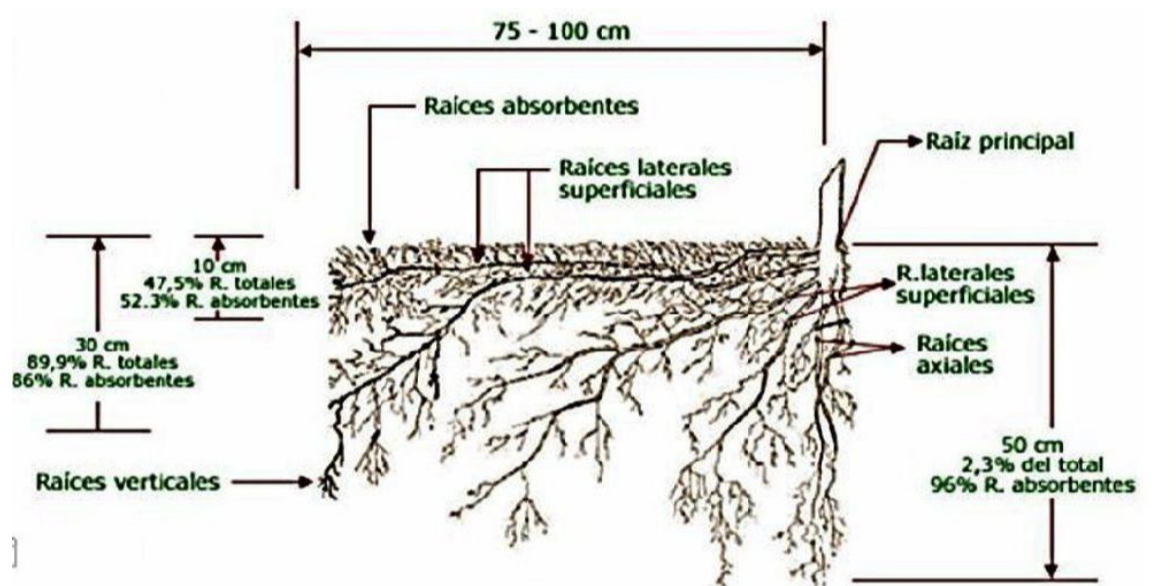
- Spread sideways
- Carry water & nutrient absorption
- Located in:
top 15–30 cm soil layer

3. Feeder Roots (Critical Zone)

- Very fine roots
- Found near surface
- Responsible for:
 - ✓ water uptake
 - ✓ nutrient absorption

Coffee Plant – Root Structure Formation

Age: 3 years



COFFEE PLANT ROOT SYSTEM & SENSOR PLACEMENT GUIDE

AgriBrain Smart Monitoring for Healthy Roots, Better Coffee

ROOT SYSTEM COMPONENTS

- 01 Taproot (Primary Root)**
Deep growing root that anchors the plant and accesses water from deeper soil layers.
- 02 Axial Root (Main Vertical Root)**
Strong vertical root that grows downward and gives structural stability.
- 03 Lateral Roots**
Branch out horizontally from the main root and help the plants explore more soil.
- 04 Support Structure for Absorbing Roots**
Provides support to fine roots and helps in nutrient and water transport.
- 05 Absorbing Roots (Fine Feeder Roots)**
Very fine roots that absorb water and nutrients from the soil.

SENSOR PLACEMENT GUIDE

- 01 Taproot (Primary Root)**
Place deep moisture sensors (30–60 cm) to monitor deep soil moisture.
- 02 Axial Root Zone**
Place moisture & temperature sensors at 20–40 cm depth.
- 03 Lateral Root Zone**
Place sensors 20–30 cm away from the stem, at 15–30 cm depth.
- 04 Support Zone**
Place sensors near the root support area to monitor soil health and structure.
- 05 Absorbing Root Zone**
Best zone for moisture, EC, pH, NPK sensors (15–30 cm depth).

RECOMMENDED SENSORS

-  Soil Moisture & Temperature (RS485)
-  Soil NPK (RS485)
-  Soil pH (RS485)
-  Soil EC (RS485)
-  Weather Station (Temp, Humidity, Rain, Light)
-  Water Flow Sensor
-  Tank Level Sensor

ROOT ZONE DEPTH GUIDE


- 0 – 15 cm**
Top Soil Zone
(High moisture variation)
- 15 – 30 cm**
Active Root Zone
(Best for moisture & nutrient monitoring)
- 30 – 60 cm**
Deep Root Zone
(Moisture reserve zone)

WHY THIS MATTERS FOR AGRIBRAIN

 Precise Irrigation Right water, right time, right depth	 Better Nutrient Uptake Healthy roots, healthy plants	 Stronger Drought Resistance Deep roots stay strong	 Higher Yield & Quality More cherries, better quality	 Data Driven Decisions AI/Analytics for smart farming
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BEST PRACTICES

- ✓ Install sensors in representative zones.
- ✓ Calibrate sensors regularly.
- ✓ Use RS485 communication for long distance & reliability.
- ✓ Combine sensor data with AI insights for best results.

 Healthy Roots, Smart Monitoring, Higher Yields – Powered by AgriBrain

Pilot Project Details

Land Size: 1 Acre

Number of Coffee Plants : 345 to 350 plants ~ 350 plants for the pilot project

COFFEE PLANTATION LAYOUT – 350 PLANTS IN 1 ACRE

Well Spaced • Healthy Growth • Easy Maintenance • High Yield

LAND DETAILS

- Area : 1 Acre
- Area (sq.ft) : 43,560
- Shape : Approx. Square
- Dimension : 208 ft x 208 ft

PLANT SPACING

- Row to Row : 6 ft
- Plant to Plant : 6 ft

SPACING DIAGRAM

PLANTS PER ACRE

- Total Area (sq.ft) : 43,560
- Area per Plant (sq.ft) : 36
- Total Plants : 350

3 YEAR OLD COFFEE PLANT

- Height
1 - 1.5 m
- First Production
Year 3 Onwards
- Average Yield
0.5 - 1.0 kg/plant
- Spacing Used
6 ft x 6 ft
- Ideal For
Arabica / Robusta

Proper spacing ensures good sunlight, air circulation, easy access for maintenance, and maximum yield per plant.

FIELD OVERVIEW

Coffee Plant – Growth and Yield Nutrient Composition

Nutrient composition is a core AgriBrain parameter , the following nutrients and soil conditions to be measured

Nutrient Group : Coffee Plant	
Nutrient Group	Parameters
Primary macronutrients	Nitrogen (N), Phosphorus (P), Potassium (K)
Secondary nutrients	Calcium (Ca), Magnesium (Mg), Sulphur (S)
Micronutrients	Iron, Zinc, Boron, Copper, Manganese
Soil condition indicators	pH, EC, organic matter

First Level – Practical Automation

For automation, the most practical first level is:

NPK + pH + EC

Nitrogen (N) : Supports leaf growth and plant vigour.

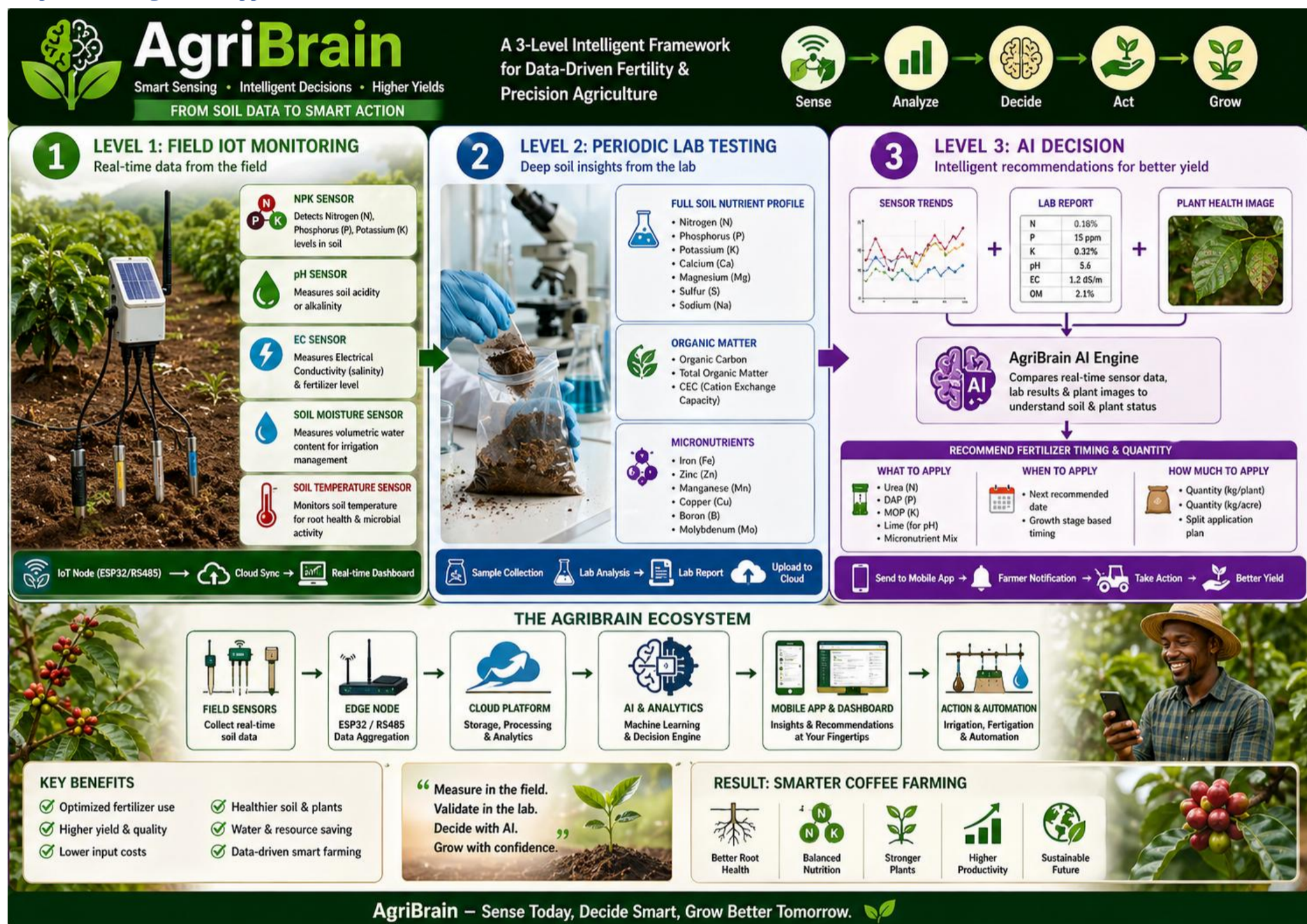
Phosphorus (P): Supports root development and flowering.

Potassium (K) : Important for fruit development, stress tolerance, and coffee cherry quality.

pH : Controls nutrient availability. Even if nutrients exist in soil, wrong pH can block uptake.

EC : Shows dissolved salts/fertilizer strength. High EC may indicate over-fertilization or salt stress.

Proposed Best AgriBrain approach



Level 1: Field IoT monitoring

- NPK sensor
- pH sensor
- EC sensor
- soil moisture
- soil temperature

Level 2: Periodic lab testing

- full soil nutrient profile
- organic matter
- micronutrients

Level 3: AI decision

- compare sensor trend + lab report + plant health image
- recommend fertilizer timing and quantity

Recommended Nutrient Sensor Placement for 1 Acre Coffee Farm

Concept: Use nutrient sensors by zone, not per plant.

Suggested Recommendation :

- 5–7 nutrient sensing points per acre
- soil moisture sensors: 25–30
- pH/EC/NPK sensors: 5–7 points, rotated or fixed by zones

The Task for AgriBrain

The AgriBrain has to Monitor whether the soil is healthy enough to produce Quality Coffee.

Proposed Sensor Stack- Project AgriBrain

Level 1 Sensors

Core Sensor Stack - AgriBrain	
Sensor	Purpose
Soil Moisture	Irrigation control
Soil Temperature	Root activity
Soil pH	Nutrient availability
Soil EC	Fertilizer / salinity
Advanced Sensor Stack	
NPK Sensor	Nutrient Level
Soil Oxygen	Root Respiration

Level -2 Sensors: Weather Climate Sensors

Weather Sensors : AI AgriBrain	
Sensor	Purpose
Temperature (DHT11/DHT22)	Environment
Humidity	Disease + irrigation
Rain Sensor / Rain Gauge	Natural watering
Light Sensor (LDR / Lux)	Sunlight exposure
Advanced Climate Sensors	
Solar Radiation Sensor	Crop energy intake
Wind Speed (Anemometer)	Spray / stress
Wind Direction	Microclimate modelling

Level -3 : Plant Health (AI + Sensors)

AgriBrain - Plant Health Sensors	
Sensor	Purpose
Camera (Pi Camera / USB)	AI disease detection
Advanced Plant Health Sensors	
NDVI Sensor	Plant vigour
Leaf Wetness Sensor	Disease prediction
Growth sensor (height tracking)	Yield estimation

Level-4 Water System Sensors

AgriBrain- Water System Sensors	
Sensor	Purpose
Water Flow Sensor	Usage tracking
Tank Level Sensor	Water availability
Pump Current Sensor	Pump health
Pressure Sensor (optional)	Pipe health

Level-5 : Energy / Power Sensors

AgriBrain: Energy Sensors	
Sensor	Purpose
Battery Voltage Sensor	Power health
Current Sensor (INA219)	Energy usage
Solar Output Sensor	Solar efficiency

Level-6 Rover – Field AgriRobot (Mobility Sensors)



Agri Robot - Mobility Sensors	
Sensor	Purpose
Ultrasonic Sensor	Obstacle detection
IR Sensor	Close detection
Wheel Encoder	Distance tracking
IMU (MPU6050)	Orientation

AgriBrain- Phase Wise Sensor Implementation

AgriBrain- Phase Wise Sensor Implementation		
Phase	Sensors	Task/ Role
Phase-1	Soil moisture	Irrigation & Energy
	DHT11 (temp + humidity)	
	Pump control	
	Battery Voltage Sensor	
	Current Sensor (INA219)	
	Solar Output Sensor	
Phase-2	Soil pH	Filed ready
	Light sensor	
	Water level	
	Flow sensor	
Phase-3	NPK sensor	AgriBrain
	Camera (AI)	
	Weather station	
	Energy monitoring	
Phase-4	Camera (Pi Camera / USB)	Plant Health
	NDVI Sensor	
	Leaf Wetness Sensor	
	Growth sensor (height tracking)	
Phase-5	Sensor	Core Climate
	Temperature (DHT11/DHT22)	
	Humidity	
	Rain Sensor / Rain Gauge	
	Light Sensor (LDR / Lux)	

	Solar Radiation Sensor	
	Wind Speed (Anemometer)	
	Wind Direction	
Phase - 6	Field robot	Farm Management & Surveillance
	Ultrasonic Sensor	
	IR Sensor	
	Wheel Encoder	
	IMU (MPU6050)	

Sensor Requirement for 1 Acre Coffee Farm

Phase-1 Sensor Placement Requirement	
Category	Quantity
Soil moisture	25-30
pH / EC	5-7
Climate station	1-2
Water sensors	2-3
Camera nodes	2-4

MASTER IDEA

DATA → INSIGHT → DECISION → ACTION

Sensors = Data

AI = Insight

Controller = Decision

Pump/Rover = Action

AgriBrain Architecture



Choice of Sensors for Implementation

Sensor choice from

<https://roboticsdna.in>

The RoboticsDNA page lists it as a **JXCT Soil Temperature and Humidity Sensor, 5V RS485, with IP68 protection, 0-100% humidity range, -40 to 80°C temperature range**, and price around **₹3,863 inc. GST**. It also says it is meant for water-saving irrigation, meteorological monitoring, greenhouses, soil testing, and scientific experiments.

For the project, this is better than cheap DIY/resistive sensors because:

- **RS485** is excellent for long cable runs in a farm.
- **IP68** means it is waterproof/dustproof for field use.
- It gives more stable readings for automation.
- Multiple sensors can be connected in a network using RS485.
- It is suitable for solar-powered field nodes.

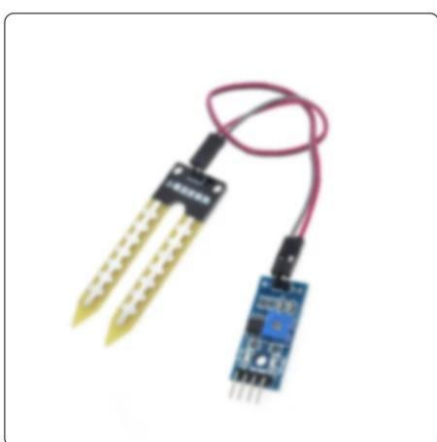
AgriBrain – Sensor Comparisons

AgriBrain _ Sensor Comparisons	
Sensor Type	Use
Cheap DIY sensor	classroom/prototype only
Capacitive soil sensor	low-cost pilot
JXCT RS485 soil sensor	field deployment
JXCT NPK / pH / EC	nutrient intelligence layer

Need an **RS485-to-UART converter** to connect it to ESP32 or Raspberry Pi. RoboticsDNA also suggests a USB-to-RS485 converter for testing.

Best strategy for 1 acre:

- **25–30 RS485 soil moisture/temp sensors** if budget allows
- or start with **5–7 JXCT sensors** for pilot zones
- add **NPK + pH + EC sensors** only in representative zones, not every plant



New Type Soil Humidity Sensor	Others
Capacitive soil humidity sensor	Resistive sensors
Longer service life	Short service life
Resist corrosion	Easily corroded

Resistive Soil Moisture Sensor (Fork Type with LM393 module)

RESISTIVE Soil Sensors	
Factor	Rating
<i>Cost</i>	★ ★ ★ ★ ★ (very cheap)
<i>Accuracy</i>	★ ★
<i>Lifespan</i>	✗ very low
<i>Corrosion</i>	✗ HIGH
<i>Field use</i>	✗ NOT recommended
<i>Stability</i>	✗ unstable

Capacitive Soil Sensor	
Factor	Rating
<i>Cost</i>	★ ★ ★
<i>Accuracy</i>	★ ★ ★ ★
<i>Lifespan</i>	★ ★ ★ ★
<i>Corrosion</i>	✓ low
<i>Field use</i>	✓ small farms
<i>Stability</i>	✓ good

JXCT RS485 Sensor (industrial)	
Factor	Rating
<i>Cost</i>	✗ expensive
<i>Accuracy</i>	★ ★ ★ ★ ★
<i>Lifespan</i>	★ ★ ★ ★ ★
<i>Corrosion</i>	✓ none
<i>Field use</i>	✓ ✓ ✓ BEST
<i>Stability</i>	✓ ✓ ✓ excellent

Proposed List of Sensors for AI AgriBrain

<https://roboticsdna.in/product>

JXCT Sensor Selection - AI AgriBrain	
Purpose	Recommended sensor
<i>Irrigation decision</i>	JXCT Soil Temperature & Humidity RS485 sensor
<i>Nutrient monitoring</i>	JXCT Soil NPK RS485 sensor
<i>Soil acidity</i>	JXCT Soil pH RS485 sensor
<i>Fertilizer/salinity status</i>	JXCT Soil EC RS485 sensor
<i>All-in-one premium option</i>	JXCT Soil 7-in-1 RS485 sensor
<i>Water tank level</i>	Float water level sensor
<i>Water flow verification</i>	Water flow sensor
<i>Climate monitoring</i>	DHT22 / temperature-humidity sensor
<i>Light condition</i>	Lux / light intensity sensor

Cost-effective Deployment plan for 1 acre / 350 coffee plants

Cost Effective JXCT Sensor Deployment Plan - 1 Acre	
Sensor	Quantity
Soil moisture/temp RS485	25–30
NPK RS485	5–7
pH RS485	5–7
EC RS485	5–7
Weather station/climate node	1–2
Tank level sensor	1
Water flow sensor	1–2

Sensor Deployment – Zoning Logic & Considerations

- Zoning logic:** 25 moisture sensors \approx 1 per 12–15 plants (good balance of cost vs. accuracy).
- Representative zones:** NPK, pH, EC are **not needed everywhere** — 5 zones are enough to infer the field.
- Optional consolidation:** You can replace the separate NPK + pH + EC (₹90k) with **5× JXCT 7-in-1 sensors** (~₹12k each \rightarrow ~₹60k), reducing cost and wiring.
- Network:** All JXCT sensors are **RS485** \rightarrow use an RS485 bus (with ESP32 + RS485 transceivers) to reduce cable runs and improve reliability.
- Power:** Design for **solar + 12V battery**, duty-cycle reads (wake \rightarrow read \rightarrow sleep) to save power.

Core Soil System Deployment Budget 1 Acre in INR

Core Soil System - Sensor Deployment Budget -1 Acre in INR				
Category	Sensor Type	Qty (1 acre)	Approx Cost / Sensor (₹)	Subtotal (INR)
Soil (zones)	RS485 Soil Moisture + Temp (JXCT)	25	3,800	95,000
Soil (rep. zones)	RS485 Soil NPK (JXCT)	5	7,000	35,000
Soil (rep. zones)	RS485 Soil pH (JXCT)	5	6,000	30,000
Soil (rep. zones)	RS485 Soil EC (JXCT)	5	5,000	25,000
Water system	Water Flow Sensor	2	800	1,600
Water system	Tank Level Sensor (float/ultrasonic)	1	1,000	1,000
Climate	Temp + Humidity (DHT22 class)	2	500	1,000
Climate	Rain Gauge	1	2,000	2,000
Climate	Light (Lux) Sensor	1	300	300
	Total	47		190,900

Sensor Deployment - Plan

AGRI BRAIN
AI POWERED SMART COFFEE FARM
SENSE • ANALYZE • DECIDE • ACT • GROW

VISION
An intelligent, connected and autonomous agriculture ecosystem that optimizes resources, increases yield and ensures sustainable farming.

SYSTEM OVERVIEW

KEY BENEFITS

- ✓ Up to 30-50% Water Saving
- ✓ Better Crop Health & Yield
- ✓ Timely Nutrient Management
- ✓ Real-time Monitoring Anywhere
- ✓ Lower Labour & Operating Cost
- ✓ Data Driven Decisions

1. SENSORS USED

	RS485 Soil Moisture & Temperature (JXCT)	Measures soil moisture (0-100%) and temperature (-40 to 80°C).
	RS485 Soil NPK (JXCT)	Measures Nitrogen (N), Phosphorus (P), Potassium (K) in soil.
	RS485 Soil pH (JXCT)	Measures soil pH (0-14) for acidity / alkalinity.
	RS485 Soil EC (JXCT)	Measures Electrical Conductivity (0-20,000 µS/cm) for salinity & fertilizer level.
	Water Flow Sensor	Measures water flow rate (L/min) in irrigation line.
	Tank Level Sensor (Float Type)	Monitors water level in storage tank.
	Temperature & Humidity (DHT22)	Measures ambient temperature & humidity.
	Rain Gauge	Measures rainfall (mm).
	Light (Lux) Sensor	Measures light intensity (0-200,000 Lux).

All JXCT sensors are RS485 (Waterproof, IP68)

2. 1 ACRE COFFEE FARM - SENSOR DEPLOYMENT MAP

1 ACRE (≈ 43,560 sq.ft) - 350 COFFEE PLANTS (Approx.)

- Soil Moisture (25 Nos.)
- NPK (5 Nos.)
- pH (5 Nos.)
- EC (5 Nos.)
- Weather Station (2 Nos.)

3. COMMUNICATION ARCHITECTURE (RS485 NETWORK)

Power Supply (Each Node)
Solar Panel → Charge Controller → 12V Battery → DC to 5V/3.3V

4. EDGE NODE SPECIFICATIONS

- ESP32 Dev Module
- RS485 to TTL Converter (MAX485 / SP3485)
- 12V DC Power Input
- IP65 Weatherproof Enclosure
- Stores data locally (SD Card)
- Sends data to Cloud (4G/WiFi/Lora)

5. SYSTEM WORKFLOW

6. ACTUATION & CONTROL

- Irrigation Pump
- Solenoid Valves (Zone Control)
- Fertilizer Doser (Future)
- Fogger / Misting (Optional)
- Lights / Fans (Nursery)

7. BILL OF MATERIALS & COST ESTIMATE (1 ACRE)

S.No.	Sensor / Item	Quantity	Cost / Unit (₹)	Total (₹)
1	RS485 Soil Moisture & Temp (JXCT)	25	3,800	95,000
2	RS485 Soil NPK (JXCT)	5	7,000	35,000
3	RS485 Soil pH (JXCT)	5	6,000	30,000
4	RS485 Soil EC (JXCT)	5	5,000	25,000
5	Water Flow Sensor	2	800	1,600
6	Tank Level Sensor (Float Type)	1	1,000	1,000
7	Temperature & Humidity (DHT22)	2	500	1,000
8	Rain Gauge	1	2,000	2,000
9	Light (Lux) Sensor	1	300	300
10	Edge Node (ESP32 + RS485 + Enclosure)	2	3,500	7,000
11	Power (Solar, Battery, Accessories)	1 Set	15,000	15,000
12	Cables, Connectors, Poles, Misc.	1 Set	8,000	8,000
TOTAL ESTIMATED COST (APPROX.)				₹ 1,91,900

8. NOTES

- 25 moisture sensors = 1 per 12-15 plants.
- NPK, pH, EC sensors installed in representative zones.
- All sensors are RS485 for long distance and noise immunity.
- Use twisted pair cable (RS485) with proper termination.
- Solar power with battery backup for 24x7 operation.
- Data interval: 10-30 minutes (configurable).
- AI models will learn from historical data to predict irrigation, nutrient needs and yield.

DESIGNED FOR: SMART COFFEE FARM (1 ACRE)

TECHNOLOGIES: IoT • RS485 • AI/ML • CLOUD • AUTOMATION

GOAL: INTELLIGENT FARMS • BETTER FUTURE

AgriBrain - functional Modularisation				
Module No.	Module Name	Role	Sub-components	Output
Module 1	<i>Field Data Acquisition & Sensing Module</i>	Capture real-time, multimodal data from the farm ecosystem	<ul style="list-style-type: none"> • Soil sensors (Moisture, Temp, pH, EC, NPK) • Climate sensors (Temp, Humidity, Rain, Light) • Water sensors (Flow, Tank Level) • Visual sensing (Camera, Rover imaging) 	Raw environmental & plant data
Module 2	<i>Edge Communication & Transceiver Module</i>	Aggregate sensor data and transmit; receive control signals	<ul style="list-style-type: none"> • Sensor interfacing (RS485, Analog, Digital) • Edge controller (ESP32 / Raspberry Pi) • Communication protocols (UART, I2C, SPI) • Transceivers (RS485, LoRa, Wi-Fi) 	Structured data packets ↔ command signals
Module 3	<i>Network & Cloud Connectivity Module</i>	Enable data exchange between field system and central platform	<ul style="list-style-type: none"> • Internet gateway (Wi-Fi, 4G, Ethernet) • Cloud server & database • APIs & middleware • IoT platforms (Blynk, MQTT, REST APIs) 	Cloud-synced data streams
Module 4	<i>AgriBrain AI Analytics & Decision Engine</i>	Convert data into intelligence and actionable decisions	<ul style="list-style-type: none"> • Data analytics (trend, anomaly detection) • Soil–plant–climate models • Lab data integration • Computer vision (plant health) • Predictive models (irrigation, nutrients) 	Optimized decisions (irrigation, fertilization, alerts)
Module 5	<i>Actuation, Control & Command Module</i>	Execute AI decisions through field actions	<ul style="list-style-type: none"> • Pump control • Solenoid valves • Fertigation system • Rover navigation • Alert systems (SMS/App) 	Automated field operations
Module 6	<i>Monitoring, Visualization & User Interface Module</i>	Provide real-time monitoring and user interaction	<ul style="list-style-type: none"> • Mobile app (Blynk) • Web dashboard • Data visualization • Alerts & notifications • Manual override 	User insights & control interface

