

## **1. Computing & Processing**

- High-Performance Desktop / Workstation
  - Intel i7 / AMD Ryzen 7 or better
  - 32 GB+ RAM
  - 1 TB SSD
- Laptops (for field data collection and mobile analysis)
- Servers / Edge Devices
  - For hosting databases, analytics, AI models
  - GPU support (for ML/AI workloads)

## **2. Networking & Connectivity**

- Wi-Fi Routers & Access Points (to connect smart devices)
- 4G/5G USB Dongles / SIM-enabled Routers
- LoRa / Zigbee / NB-IoT Gateway
  - For low-power wide-area sensor networks
- Network Switches, Cables, and Routers

## **3. Sensor Systems & Data Acquisition**

### **Environmental Sensors:**

- Soil Moisture Sensors (capacitive / TDR)
- pH & EC (Electrical Conductivity) Soil Sensors
- Temperature & Humidity Sensors
- Light (PAR / Lux) Sensors
- Rainfall / Weather Stations

- Wind Speed & Direction Sensors

### **Plant & Crop Monitoring:**

- NDVI / NIR Cameras (for vegetation health)
- Multispectral / Hyperspectral Sensors
- Thermal Imaging Cameras
- Chlorophyll Meters

### **Livestock & Environment:**

- GPS Collars / Tags
- RFID Tags & Readers
- Temperature & Motion Sensors

### **General Data Systems:**

- ADC Boards (Analog-to-Digital Converters)
- Data Loggers
- Wireless Sensor Nodes (LoRa, Zigbee, Bluetooth)

## **4. IoT & Embedded Systems**

- Arduino / Raspberry Pi / ESP32 Boards
- GPIO Expansion Modules
- Relay Boards
- Breadboards, Wires, Connectors
- Power Supplies & Battery Packs
- GPS Modules
- Real-Time Clock (RTC) Modules

## **5. Robotics & Automation Platforms**

- Autonomous Ground Robots
  - For crop monitoring / spraying / sampling
- Drones (UAVs)
  - For aerial imaging, mapping, spraying
- Automated Irrigation Controllers
- Motor Drivers, Stepper & Servo Motors
- Actuators & Solenoids

## **6. Agricultural Hardware & Actuators**

- Soil Samplers
- Smart Irrigation Valves
- Water Flow Meters
- Fertilizer / Nutrient Dosing Systems
- Greenhouse Climate Controllers
  - Fans, heaters, shades

## **7. GIS & Mapping Tools**

- GPS Handheld Units
- Drone Mapping Software (Pix4D, DroneDeploy)
- GIS Software (QGIS, ArcGIS)
- Topographic Survey Tools

## **8. Software & Analytics Platforms**

### **Data Analytics & AI:**

- Python / R / MATLAB
- TensorFlow / PyTorch
- Jupyter Notebooks

### **Database & Visualization:**

- PostgreSQL / MySQL
- InfluxDB / TimescaleDB (for time-series)
- Grafana / Power BI / Tableau

### **IoT Platforms:**

- ThingsBoard
- AWS IoT / Azure IoT / Google Cloud IoT
- MQTT Brokers (Mosquitto)

### **Geospatial Tools:**

- QGIS / ArcGIS
- Drone image processing (OpenDroneMap)

## **9. Testing, Calibration & Support Tools**

- Multimeters
- Oscilloscopes
- Power Analyzers
- Calibration Kits
- Signal Generators
- Soldering Iron / Desoldering Tools
- Toolkits (screwdrivers, pliers, cutters)

## 10. Field & Safety Equipment

- Portable Weather Stations
- Portable Soil Testing Kits
- Protective Gear (gloves, boots, helmets)
- Portable Power Banks / Solar Chargers
- Field Tablets / Rugged Devices

## 11. Documentation & Collaboration

- Notion / Confluence / Obsidian
- Git / GitHub / GitLab
- Trello / Jira

## 12. Learning & Simulation Platforms

- Farm management simulators
- Remote sensing data sets
- Open-source smart agriculture projects

## Sample Budget Estimate (India)

Category	Approx Cost (₹)
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High-end PC / Server	70,000 – 3,00,000+
Sensors & Data Loggers	10,000 – 1,50,000+
Drones	30,000 – 2,00,000+

Robotics Kits	20,000 – 1,50,000+
IoT Boards & Accessories	5,000 – 30,000
Networking & IoT Gateway	10,000 – 80,000
Software Licenses / Cloud	Varies

Note: This can scale depending on research scope, field size, and automation level.

## **How to Set It Up (High-Level)**

1. Design Lab Zones
  - Hardware assembly
  - Sensor testing
  - IoT network area
  - Data analytics workstation
2. Install IoT Gateway & Network
3. Deploy Sensors & Collect Data
4. Connect to IoT Platform & Database
5. Process with Analytics / AI Tools
6. Visualize Results & Build Dashboards
7. Prototype Automation (Irrigation, Robotics)