

Project - **VeriHarvest**, which integrates **AI, IoT, and Blockchain** for food authentication and safety, here is a structured **MVP development plan**, broken down into **modules and submodules** with a step-by-step execution plan.

MVP Development Plan for VeriHarvest

Phase 1: Ideation & Research

1. Market & Competitor Analysis

- Research existing blockchain-based food traceability solutions (**IBM Food Trust, VeChain**, etc.).
- Identify gaps in existing solutions and how VeriHarvest differentiates itself.

2. Technical Feasibility Study

- Evaluate AI-based **hyperspectral imaging** and pattern recognition feasibility.
 - Choose IoT sensors (**temperature, humidity, gas sensors**) and connectivity options.
 - Select the **blockchain platform** (Ethereum, Hyperledger Fabric, or Polygon).
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Phase 2: System Architecture & Tech Stack Selection

1. Define System Components

- **AI Module:** Food fingerprinting using hyperspectral imaging.
- **IoT Module:** Sensors embedded in packaging for real-time monitoring.
- **Blockchain Module:** Smart contracts for automated safety rules.
- **Frontend & Consumer Interface:** Web & mobile application for food verification.
- **Admin & Regulatory Dashboard:** Access for suppliers, regulators, and logistics.

2. Choose Tech Stack

- **Frontend:** React.js (Web), Flutter/React Native (Mobile)
 - **Backend:** Node.js (Express) / Python (FastAPI)
 - **AI Processing:** Python (TensorFlow/PyTorch)
 - **IoT Integration:** MQTT, AWS IoT, Raspberry Pi, ESP32
 - **Blockchain:** Solidity (Ethereum), Hyperledger (Private Blockchain)
 - **Database:** PostgreSQL, MongoDB (for off-chain data)
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Phase 3: MVP Development Plan



Module 1: AI-Driven Food Fingerprinting



Goal: Create a **food authentication** system using **hyperspectral imaging** and **AI pattern recognition**.

Submodules:

1. **Data Collection & Preprocessing**
 - Collect hyperspectral images of food samples.
 - Label datasets for AI training.
 2. **Model Development**
 - Train AI for **food fingerprinting** to detect **adulteration & substitution**.
 - Validate against real-world food datasets.
 3. **Integration with Blockchain**
 - Store the AI-verified food fingerprint as a unique **hash** on the blockchain.
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Module 2: IoT-Powered Real-Time Monitoring



Goal: Ensure food safety compliance using **IoT sensors** in packaging & logistics.

Submodules:

1. **Select & Test Sensors**
 - Choose sensors for **temperature, humidity, gas levels**.
 - Test data transmission via **MQTT/AWS IoT**.
 2. **Develop IoT Communication Layer**
 - Configure real-time data streams from sensors.
 - Store data on **blockchain & cloud database**.
 3. **Trigger Smart Alerts**
 - Set up **alerts** for threshold breaches.
 - Integrate with **smart contracts** for automated actions.
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Module 3: Blockchain-Based Traceability & Smart Contracts

 **Goal:** Implement **tamper-proof tracking** of food supply chain events.

Submodules:

1. **Blockchain Setup**
 - Choose between **Ethereum, Polygon, or Hyperledger**.
 - Create smart contracts to **log food journey** events.
 2. **Smart Contract Development**
 - **Trigger actions** (e.g., alert regulators if quality drops).
 - Implement **dynamic trust scoring** for food batches.
 3. **Data Storage**
 - Store critical data **on-chain** (fingerprints, safety breaches).
 - Store additional logs **off-chain** (IPFS, AWS).
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Module 4: Consumer & Regulatory Dashboard

 **Goal:** Provide a **transparent view** of food history to consumers & regulators.

Submodules:

1. **Consumer Mobile App**
 - Users scan **QR codes/NFC tags** to verify food authenticity.
 - Display **origin, freshness, and compliance history**.
 2. **Supplier & Regulatory Dashboard**
 - Live **monitoring dashboard** for food safety tracking.
 - **Audit logs** of all transactions & violations.
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Phase 4: Testing & Deployment

1. Security & Performance Testing

- **Smart contract audits** (check for vulnerabilities).
- **IoT stress testing** (sensor data accuracy & connectivity).
- **AI model validation** (check for false positives/negatives).

2. Deploy on Testnet & Pilot Testing

- Deploy smart contracts on **Ethereum Ropsten or Hyperledger Testnet**.
 - Conduct a **small-scale pilot with real food suppliers**.
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Phase 5: MVP Launch & Feedback

1. Launch Public MVP

- Open **limited access** to **early adopters & pilot users**.
- Market through **food industry partners & investors**.
- Collect feedback & iterate based on usage.