# EcoBloom: Project Documentation

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EcoBloom is a farmer's ecosystem designed to provide affordable, real-time pest and heat risk monitoring. Initially launched in English, the system will expand to Arabic and other languages to better support regional farmers.

The basic package includes one solar-charged camera with a built-in $CO_2$ sensor, 10 sticky traps for pest monitoring, a QR code for device registration and app connection, and a personalized video demo showing farmers how to set up the camera and sensor.

To get started, farmers complete a simple 3-minute Smart Farm Setup on our website. They answer a few visual questions about their crops, farm type, size, and main challenges (no technical knowledge needed).

**See sample survey questions on last page of the document*

The system immediately analyzes their situation and provides:

- Personalized camera quantity and placement recommendations
- Risk assessment for pests and heat based on their location and crops
- Interactive farm map showing exactly where to install cameras
- Instant cost estimate for their customized package

Farmers then provide their email, phone number, and confirm their location. They receive a notification requesting location access, which enables personalized setup video configuration and optional local farmer networking features. After purchasing the package, they receive a confirmation with a PDF placement guide and set up video links.

When the package arrives, each device includes a QR code that instantly connects the camera to their account and displays a personalized video demo showing exactly where to place that specific camera based on their farm profile. The app remembers their survey answers, so every recommendation is tailored to their crops, climate, and setup.

### Optional Feature: Local Farmer Network (P2P)

All farmers use WiFi/5G for core EcoBloom functionality (camera uploads, dashboard, Community Q&A). Farmers can optionally enable the Local Farmer Network (P2P) for free, which adds a LoRa mesh layer for direct neighbor-to-neighbor communication within 5-10km. The key advantage: when one farm detects HIGH severity pests, P2P instantly broadcasts alerts to neighboring farms without cloud routing which is critical since pests migrate between adjacent fields. This creates a faster, decentralized early warning system where neighbors receive alerts within seconds, even if the internet weakens or cloud servers experience delays.

P2P also enables privacy-first messaging (device-to-device, not stored on servers), zero additional data costs (LoRa operates independently), backup connectivity during sandstorms/power outages when WiFi/5G drops, and real-time local collaboration for equipment sharing or bulk orders. Farmers choosing WiFi/5G-only get full EcoBloom functionality; those enabling P2P gain an extra layer of speed, resilience, and hyperlocal coordination.

## The Ecobloom App

The **EcoBloom app** is the central hub, bringing together four modules:

1. The **Farmer's Dashboard**, which shows pest levels and heat risk based on sensor data. It also provides auto-recommendations. Farmers receive free access for one month, after which they can subscribe for $10/month. Subscriptions can include sticky traps that the farmer requested.

2. The **Networkless Q&A (P2P System)**, where farmers help each other with responses within 2–24 hours. The system leverages LoRa and distributed networking to encourage resilient peer-to-peer and B2B relationships.

3. The **AI Chatbot**, which gives instant, automated responses using open-source technologies and integrated databases. It acts as the first contact before queries escalate to human experts.

4. The **International Forum**, which connects farmers to NGOs, experts, and officials. It provides human responses when the chatbot is insufficient, usually within a few days. Discussions are structured from local to regional to global levels.

The **hardware prototype** uses a Raspberry Pi Zero 2 W as the hub, ESP32-CAM modules for image capture, a DHT22 sensor for temperature/humidity, a capacitive soil moisture sensor, and an Ra-02 LoRa module for communication. Power comes from a 10W solar panel with a battery, while a 32GB microSD card stores data. Everything is protected in a weatherproof enclosure. The total system cost is around $125.

On the software side, EcoBloom currently uses a **custom classification model** (AI) for pest detection and a **Random Forest model** (AI) trained on a CSV dataset for heat risk assessment. Together, these provide farmers with early warnings and practical insights. Looking ahead, EcoBloom will enhance accuracy and scalability by integrating two open-source tools: the Yellow Sticky Traps Dataset, which provides labeled pest images, and CVAT (Computer Vision Annotation Tool), which supports annotation and training for computer vision models. These resources will form the backbone of EcoBloom's AI pipeline in the future.

**Sample Questions for the Quick Survey**

Q1: "What are you growing?" (Select all that apply)

- 🍅 Tomatoes
- 🥒 Cucumbers
- 🌶️ Peppers
- 🥬 Leafy Greens
- 🌿 Herbs
- 🌾 Other crops

Q2: "What kind of farm do you have?" (Visual icons)

- 🏚️ Open Field (outdoor)
- 🏠 Greenhouse (enclosed)
- 🪴 Shade House (partial cover)
- 🌳 Mix of both

Q3: "How big is your growing area?" (Simple slider)

- 📏 Small: Under 500m² (visual: small plot)
- 📏 Medium: 500-2,000m² (visual: medium field)
- 📏 Large: Over 2,000m² (visual: large farm)

Q4: "What's your biggest challenge?" (Icons with text)

- 🐛 Pests eating my crops
- 🌡️ Plants dying from heat
- 💧 Water/irrigation issues
- 🤷 Not sure yet

Q5: "Enable location for personalized setup?"

- 📍 Yes, use my GPS (recommended)
- ⌨️ Or type location manually