1. System Overview & Operational Scope

CropEye is a dedicated agritech mobile diagnostic instrument engineered for on-field identification, symptom localization, and severity classification of foliar diseases in tomato crops (*Solanum lycopersicum*). The system replaces subjective visual inspection with high-precision computer vision algorithms executed natively on commercial Android hardware.

> **AUTONOMOUS EDGE PROCESSING ARCHITECTURE**
> CropEye operates with complete autonomy in remote fields with zero internet or cellular connectivity. The underlying neural network runs directly on the device using a quantized TensorFlow Lite engine, guaranteeing low latency (<300 ms inference) without sending crop imagery to external servers.

2. Hardware & System Requirements

System Component	Minimum Specification	Recommended Operational Specification
Operating System	Android 8.0 (Oreo, API Level 26)	Android 11.0 (API Level 30) or higher
Processor (CPU)	Quad-Core 1.8 GHz (ARMv7 / ARM64)	Octa-Core 2.0 GHz+ (ARM64-v8a with NEON support)
Memory (RAM)	2.0 GB System RAM	4.0 GB System RAM or higher
Camera Module	8.0 Megapixels with Autofocus	12.0+ Megapixels with PDAF & Macro capability
Storage Capacity	150 MB available internal storage	500 MB available (for continuous diagnostic history cache)
Connectivity	None (100% Offline Diagnosis)	Optional Wi-Fi / LTE (for cloud telemetry synchronization)

3. Installation & Sideloading Procedure

Because CropEye Beta is deployed directly to field evaluators prior to Google Play Store listing, the application is packaged as a signed standalone Android Application Package (APK).

1. **Obtain the Package:** Download `CropEye-release.apk` via the distribution portal (`https://larp.reydian.tech/downloads/CropEye-release.apk`) or by scanning the official field evaluation QR sheet.
2. **Authorize Sideloading:** If prompted by Google Chrome with *"File might be harmful"*, tap **Download anyway**. When prompted during launch, enable *"Allow from this source"* in Android Settings.
3. **Execute Package Installer:** Open the downloaded file from the notification tray or Files app and confirm the installation.

> **IMPORTANT: RESOLVING "APP NOT INSTALLED" ERRORS**
> If Android reports *"App not installed as package appears to be invalid or conflicting"*, an older development build signed with a different key is present on the device. Completely uninstall any previous CropEye installation before running the installer.

> **APPLICATION PERMISSIONS REQUIREMENT**
> Upon first launch, CropEye requests access to the **Camera** (mandatory for real-time symptom analysis) and **Location** (optional for GIS spatial outbreak mapping). Grant *"While using the app"* for seamless operation.

4. User Interface Navigation & Module Architecture

CropEye features a streamlined bottom navigation bar providing instant access to five core functional modules:

Home Dashboard

Central operational overview displaying quick-scan action triggers, recent diagnostic summaries, local microclimate disease risk indices, and rapid access to farm logs.

Diagnostic History

Comprehensive chronological registry of all recorded field scans. Supports search filtering by crop disease type, severity score, date range, or farm plot identifier.

Field GIS Map

Geospatial visualization displaying geographic pins for every recorded scan. Identifies emerging localized disease clusters and pathogen dispersion vectors across fields.

Farm Management & Profile

Configuration portal for managing field boundaries, operator accounts, language localization (English / Filipino), offline model status, and diagnostic data exports.

5. Standard Operating Procedure: Targeted Crop Scanning

To achieve optimal diagnostic accuracy (>95% model precision), field operators must adhere to the standardized 4-step specimen capture procedure:

1. **Specimen Selection:** Identify tomato foliage displaying distinct, active symptom lesions (e.g., chlorotic halos, necrotic concentric spots, fungal sporulation, or foliar curling). Avoid dried, dead leaf fragments where primary fungal structures have decayed.
2. **Lighting & Distance Optimization:** Position the device **15 cm to 25 cm** from the target leaf surface. Ensure the leaf is illuminated under diffused, indirect ambient daylight. Avoid heavy leaf shadows, backlight glare, or strong flash reflections.
3. **Reticle Alignment:** Launch the Scanner by tapping the center camera button. Center the affected leaf region within the on-screen framing reticle. Keep the mobile device steady until the autofocus indicator confirms image sharpness.
4. **Trigger & Rapid Analysis:** Tap the shutter trigger. The native TensorFlow Lite neural network processes the frame locally, completing foliar classification and severity estimation in under 300 ms.

FIELD INSPECTION RULES TO PREVENT OPERATOR ERROR

- **Do not obstruct lesions:** Avoid placing fingers, tools, or foreign objects directly over or adjacent to the symptomatic area.
- **Avoid compound focal points:** Keep the background clear of surrounding soil or unrelated weeds; frame only tomato foliage.
- **Clean camera lens:** Field dust and moisture on the camera lens degrade high-frequency texture features critical for fungal identification.

MULTI-LANGUAGE SWITCHING (ENGLISH / FILIPINO)

CropEye includes complete Filipino (Tagalog) localization tailored for local growers and field technicians. Operators can toggle the display language at any time in *Profile > Settings > Language (Wika)*.

6. Disease Classification Catalog & Diagnostic Interpretation

The CropEye diagnostic screen provides three primary analytical metrics upon capture:

1. Classification:
Specific pathology or condition identified by the neural network.

2. Confidence Level (%):
Model statistical certainty. Confidences ≥75% represent verified diagnostic matches.

3. Severity Rating:
Quantified canopy damage: Low (<15%), Moderate (15–40%), High (41–70%), Severe (>70%).

The table below documents the 10 detectable classes and corresponding agronomic intervention protocols:

Condition / Class	Causative Agent	Characteristic Visual Symptoms	Recommended Action Protocol
Early Blight	*Alternaria solani* (Fungus)	Dark brown to black necrotic spots with concentric "target" rings surrounded by yellow chlorotic halos on older leaves.	Prune affected lower leaves; apply copper-based fungicide; shift from overhead to drip irrigation.
Late Blight	*Phytophthora infestans* (Oomycete)	Large, irregular water-soaked pale-green to brown lesions rapidly expanding; white fungal growth on undersides in humid conditions.	Immediate preventive application of chlorothalonil or mancozeb; eradicate heavily infected plants to stop spore drift.
Bacterial Spot	*Xanthomonas* spp. (Bacteria)	Small (<3 mm), circular water-soaked lesions turning dark brown to black with greasy appearance and yellow halos.	Apply fixed copper sprays combined with mancozeb; avoid handling plants while foliage is wet.
Septoria Leaf Spot	*Septoria lycopersici* (Fungus)	Numerous small circular spots (2–4 mm) with dark brown margins and gray centers containing tiny black speck pycnidia.	Apply protective fungicides; remove crop debris post-harvest; implement minimum 2-year crop rotation.
Leaf Mold	*Passalora fulva* (Fungus)	Diffuse pale-green to yellowish spots on upper leaf surface; corresponding velvety olive-green to brown mold on underside.	Increase greenhouse ventilation; reduce relative humidity below 85%; apply targeted bio-fungicides.
Target Spot	*Corynespora cassiicola* (Fungus)	Pinpoint lesions expanding into circular necrotic spots with light brown centers and dark concentric rings resembling early blight.	Apply registered strobilurin or carboxamide fungicides; optimize row spacing to accelerate canopy drying.
Spider Mites	*Tetranychus urticae* (Arachnid)	Fine chlorotic stippling (yellow speckling) on upper leaf surface, delicate webbing on undersides, progressing to bronzed leaves.	Apply insecticidal soaps or horticultural oils; release predatory beneficial mites (*Phytoseiulus persimilis*).
Tomato Mosaic Virus	ToMV (Tobamovirus)	Mottling with alternating light and dark green mosaic patterns, blistering, leaf distortion, and "fern-leaf" malformation.	No chemical cure; rogue and burn infected plants; sanitize tools with 10% trisodium phosphate (TSP).
Yellow Leaf Curl	TYLCV (Begomovirus)	Severe stunting, upward curling and cupping of leaflet margins, pronounced interveinal chlorosis, and aborted flowering.	Control vector populations of silverleaf whitefly (*Bemisia tabaci*) using yellow sticky cards and systemic insecticides.
Healthy Foliage	Non-pathogenic (Normal)	Uniform vibrant green coloration, intact turgid tissue, and complete absence of necrotic spotting or marginal curling.	Continue routine balanced N-P-K fertilization, baseline integrated pest management (IPM), and weekly surveillance.

7. Data Management, GIS Mapping & Offline Synchronization

Local Data Persistence

Diagnostic scans are committed immediately to the on-device transactional database (WatermelonDB/SQLite). Records store high-precision UTC timestamps, device hardware IDs, GPS coordinates (if permitted), diagnostic confidence percentages, and estimated severity scores.

Autonomous Cloud Synchronization

When cellular data or Wi-Fi becomes available, the application background synchronization engine securely pushes queued diagnostic telemetry to the centralized Supabase repository. Users can trigger immediate sync in *Profile > Sync Settings*.

8. Operational Troubleshooting Matrix

Operational Symptom	Probable Root Cause	Corrective Operator Action
"App not installed" error during APK setup	Cryptographic signature collision with a previously installed development or EAS preview build.	Uninstall any existing CropEye application from device settings. Restart device and reinstall `CropEye-release.apk`.
Camera viewfinder remains black or fails to initialize	Camera hardware permissions denied, or another camera app is locking the hardware sensor.	Navigate to Android *Settings > Apps > CropEye > Permissions* and set Camera to *"Allow only while using the app"*. Force close background apps.
Low diagnostic confidence (<60%) or fluctuating results	Improper focal distance (<15 cm or >30 cm), motion blur, harsh lens flare, or dirty lens cover.	Wipe camera lens with a microfiber cloth; stabilize device; ensure indirect natural sunlight; tap viewfinder to force autofocus lock.
Scans do not appear on the Field GIS Map	Location permission was denied during first launch, or GPS hardware is disabled in system tray.	Enable device GPS/Location toggle. In Android App Permissions, verify that CropEye has *Precise Location* permission enabled.
Excessive battery drain during extended field surveys	Camera sensor and continuous hardware preview held active without timeout.	Navigate back to the Home tab between plant inspections to allow the camera hardware to enter low-power sleep mode.

9. System Attribution & Technical Support

Research & Development Initiative: CropEye Edge-AI Precision Agriculture Project
Lead Developer & Contact: Reydian (reydian04@gmail.com)
Software Release: Version 1.0.0-Beta (Production Standalone Build)

Official APK Distribution Portal: `https://larp.reydian.tech/downloads/CropEye-release.apk`
Document Status: Official Technical Documentation