

**Delivering AI for Climate Action in Developing Countries**

# **SAFIR: Smart AI-based Farming Irrigation for Climate Resilience**

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# Laos: Agricultural Climate Vulnerability

70%+

Population dependent on agriculture

<20%

Irrigation coverage countrywide

>90%

Underutilized paddy fields during the dry season (VTE)



## Main problem in agriculture



Climate is suitable for two-crop cycles, but low dry-season rainfall prevents double-cropping without irrigation.

### Infra

#### Infrastructure Constraint

- Fewer than 20% of farming households have access to irrigation infrastructure.



### DSS

#### Lack of Decision Support System(DSS)

- Small-scale irrigation is in place; but farmers are lack of DSS framework to support operational decision-making system.

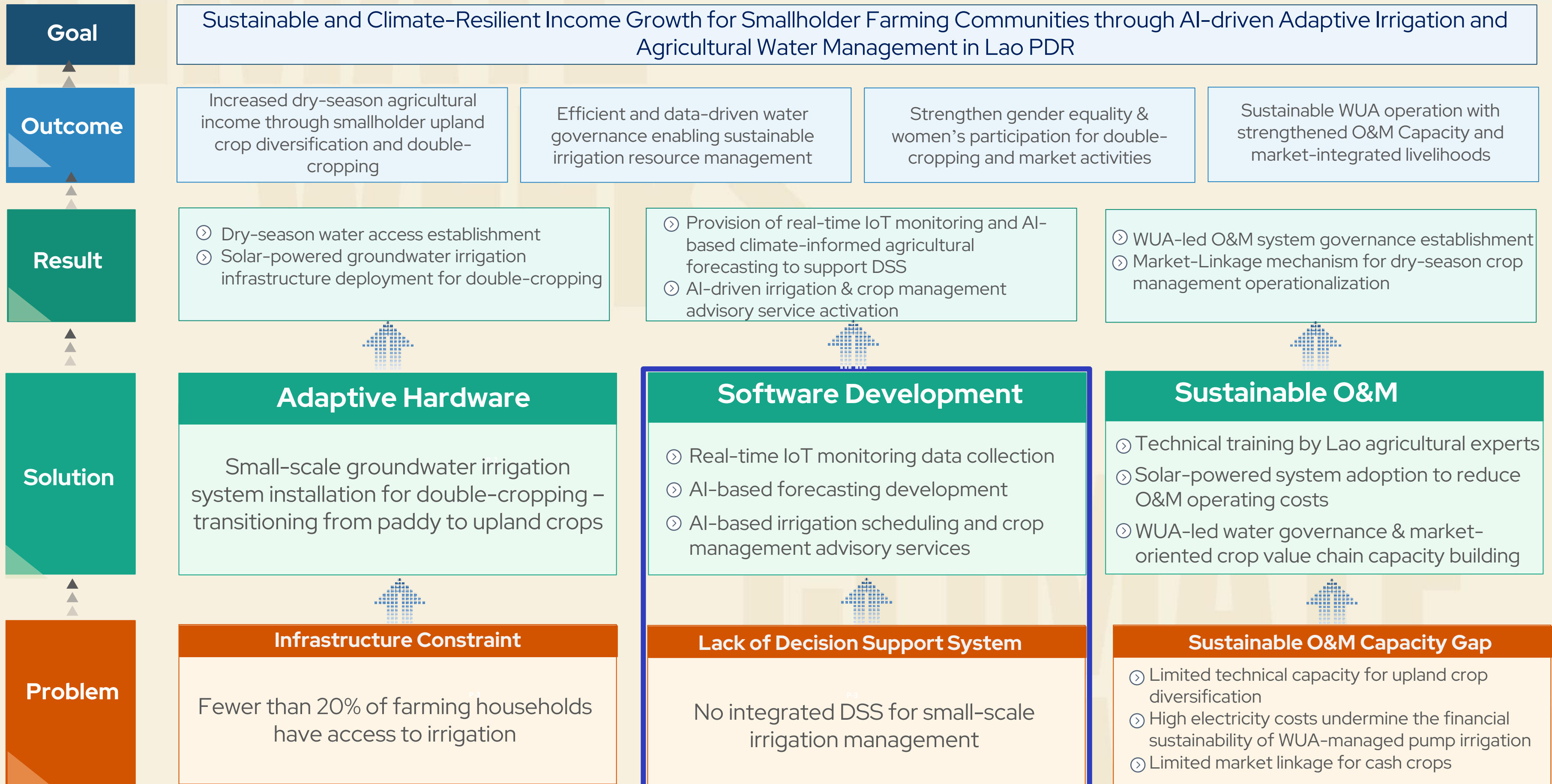


### O&M

#### Sustainable O&M Capacity Gap

- Farmers lack agronomic capacity to transition from paddy to crop.
- Water User Association (WUA)-managed pump systems face chronic shutdowns due to accumulated electricity bill.
- Smallholders have no market linkage for upland crops.





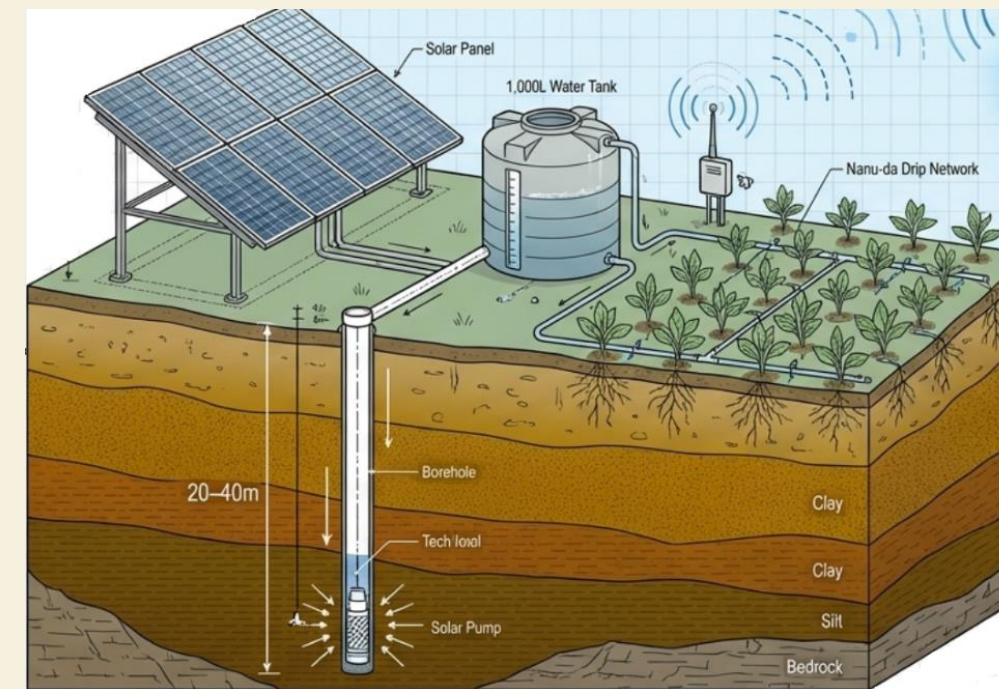
# SAFIR

**Smart AI –based Farming & Irrigation for Climate Resilience (SAFIR)** was originally designed as a Decision Support System (DSS) for climate-vulnerable smallholder farming communities in Lao PDR. The system comprises real-time IoT monitoring of soil moisture, groundwater levels, and weather conditions, combined with AI-based forecasting to enable smart irrigation scheduling and crop advisory services delivered through a mobile application in the Lao language. The platform will be released under open-source Digital Public Good (DPG) licenses to support for scale-up projects across Least Developed Countries (LDCs).



# OASIS

**On-farm Adaptive Smart Irrigation System for smallholder farmers (OASIS)** focuses on WUA-led governance and sustainable O&M capacity, built upon small-scale groundwater irrigation infrastructure to enable double-cropping — transitioning from paddy to upland (non-paddy) crops — during the dry season. The project integrates AI-based forecasting to deliver adaptive irrigation scheduling and crop advisory services directly to smallholder farming communities.



# Hardware: Small-Scale Groundwater Irrigation Infrastructure



## Pilot Project Simulation: Scalable Groundwater (GW) Irrigation Blueprint

- A scalable, village-level model designed to consolidate fragmented smallholder plots to a high-efficiency, jointly managed irrigation zone.

### Isolated GW Infra

- Household-level installations constructed separately
- Fragmented operations with limited collective management
- **Result:** High unit costs per household

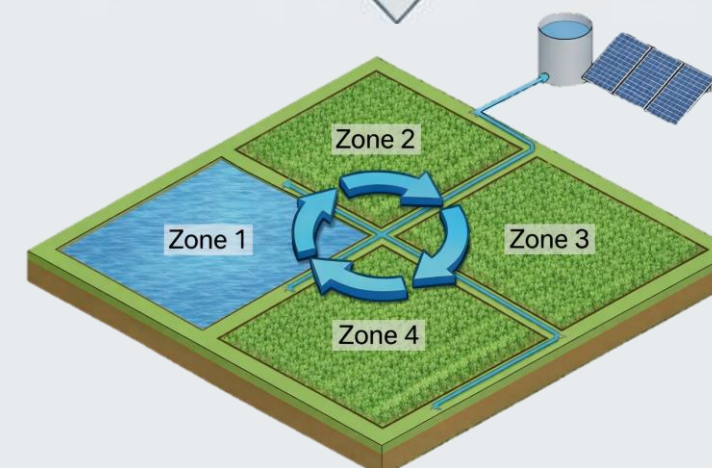
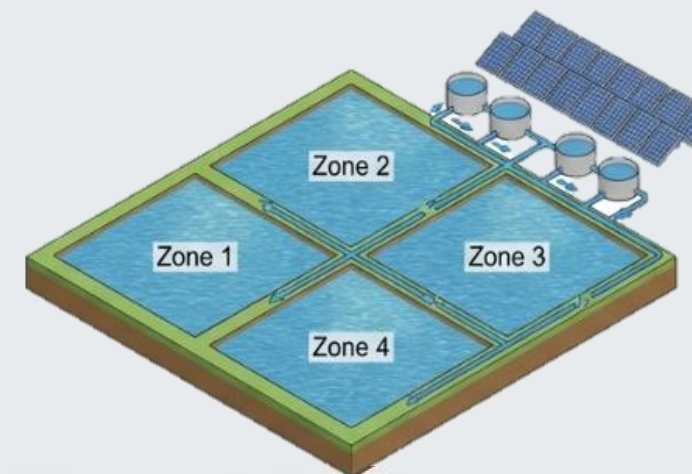
### Consolidated GW Infra

- A centralized, jointly operated GW irrigation system managed by WUA
- **Result:** Improved governance and enhanced financial sustainability through WUA management

### Infrastructure Layout



### Operational Design



### High-investment Design

- Simultaneous irrigation across the entire consolidated area
- Requires multiple storage tanks & massively oversized solar arrays.
- **Result:** Multi tanks and oversized solar panel installation

### Cost-Efficient Zone-Based Rotation

- A consolidated irrigation area subdivided into zones aligned with crop growth stages.
- Zone-based rotational irrigation reduces pumping energy demand
- **Result:** Minimize storage and solar capacity requirement

# Hardware: Small-Scale Groundwater Irrigation Infrastructure

## Farm Area Analysis for Pilot Project



- The average agricultural landholding per household (hh) in Laos is estimated at approximately 1–2 hectares (ha).
- Smallholder farmers engaged solely in single-season paddy rice cultivation during the rainy season earn an **average monthly income of approx. \$ 35–65**, equivalent to an annual income of **\$ 420–780**.
- Based on agronomic assessment, optimal crops for dry season double-cropping with viable income potential include watermelon, peanut, mung bean, sesame, and chili.

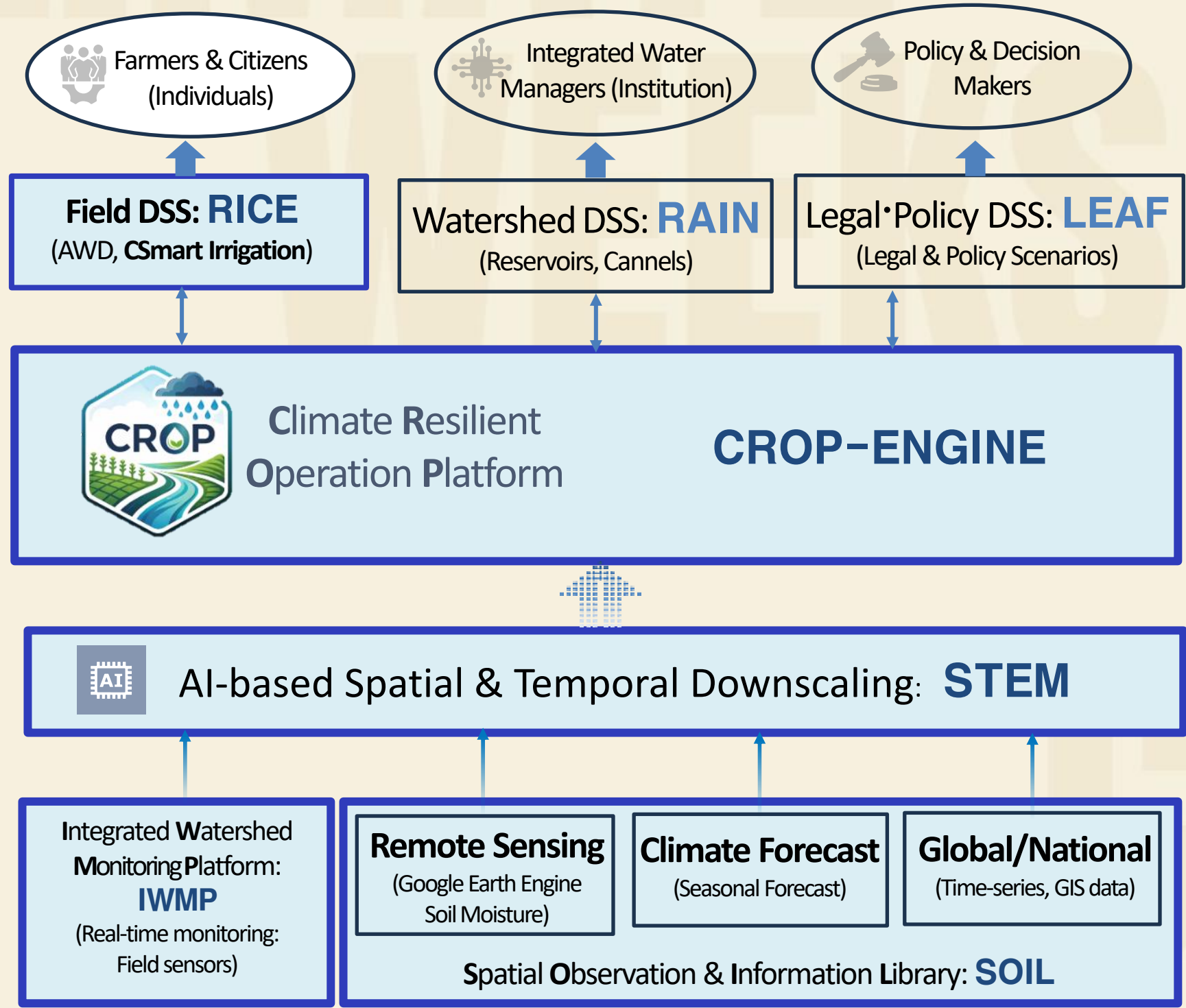
Parameter	Water Melon	Peanut	Mung Bean	Sesame	Chili
Min. Income Area (ha)	0.1–0.3	0.3–0.5	0.5–1.0	0.3–0.5	0.2–0.4
Yield (t/ha)	20–40	2–3	0.8–1.2	0.5–1.0	5–10
Local Market Price (\$/kg)	0.20–0.30	0.50–0.80	0.40–0.70	1.0–2.0	0.30–0.60
Est. Income/Season (\$)	400–900	300–600	320–560	300–700	300–600

- For **watermelon crop**, the minimum viable cultivation area generating meaningful crop income is **0.3ha per hh**.
- Applying this to the pilot cohort of **30 households** (one WUA): **0.3ha x 30 hh = 9ha** as a single consolidated, jointly operated irrigation unit.

Parameter	Watermelon	Peanut	Mung Bean	Sesame	Chili
Growing Period (days)	130	90	65	100	90
Zone-Based Rotation (no.)	4	3	4	3	3→4
Peak Irrigation Interval (days)	4	8	4	10	3
Peak Daily Demand (m <sup>3</sup> )	675	585	612	648	612
Pump Capacity Q (m <sup>3</sup> /hr)	84	73	77	81	77
Solar panel (KWp)	24	28	24	26	14
Amount of large-size solar panel(panel)	44	51	44	47	44

However, hardware alone is insufficient to support farmers in making informed crop and irrigation decisions. A Decision Support System (DSS) is essential tool for farm-level management guidance.

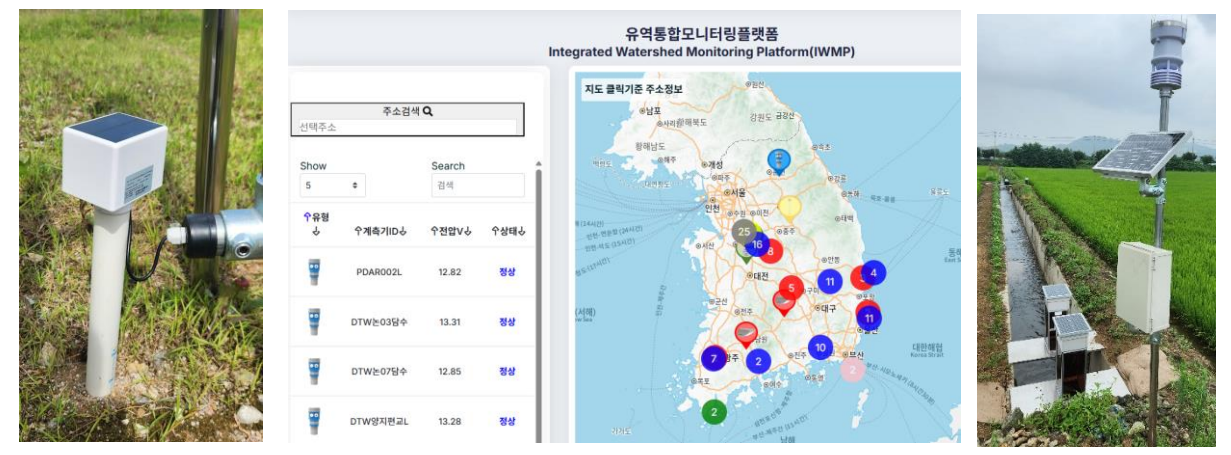
# Software: Real-time Monitoring and Forecasting for DSS



	BMI v2.0-compliant modular orchestration engine powering all hydrological and agronomic models across the ecosystem
	<b>Spatial Observation &amp; Information Library</b> Unified geospatial data infrastructure — integrating remote sensing, climate reanalysis, and national datasets via standardized APIs
	<b>Integrated Watershed Monitoring Platform</b> Real-time IoT telemetry platform delivering continuous in-situ hydrological observations as ground-truth input to CROP services
	<b>Spatial &amp; Temporal Enhancement Models</b> AI-driven spatial & temporal downscaling layer translating coarse global forecasts into high-resolution field-scale climate inputs
	<b>Realtime Irrigation &amp; Climate-responsive Engine</b> Field-scale irrigation DSS enabling AWD, plot-level water balance, and carbon MRV for farmers and irrigation managers
	<b>Realtime Analysis of Integrated Nexus-forecasting</b> Watershed-scale DSS integrating drought forecasting, flood early warning, and water quality assessment for water authorities
	<b>Legal Evaluation &amp; Availability Framework</b> Policy-grade DSS quantifying legally available water supply through filter models to support allocation and dispute resolution

## Integrated Watershed Monitoring Platform : IWMP

Soil Moisture Sensor    Groundwater Sensor    Weather Station

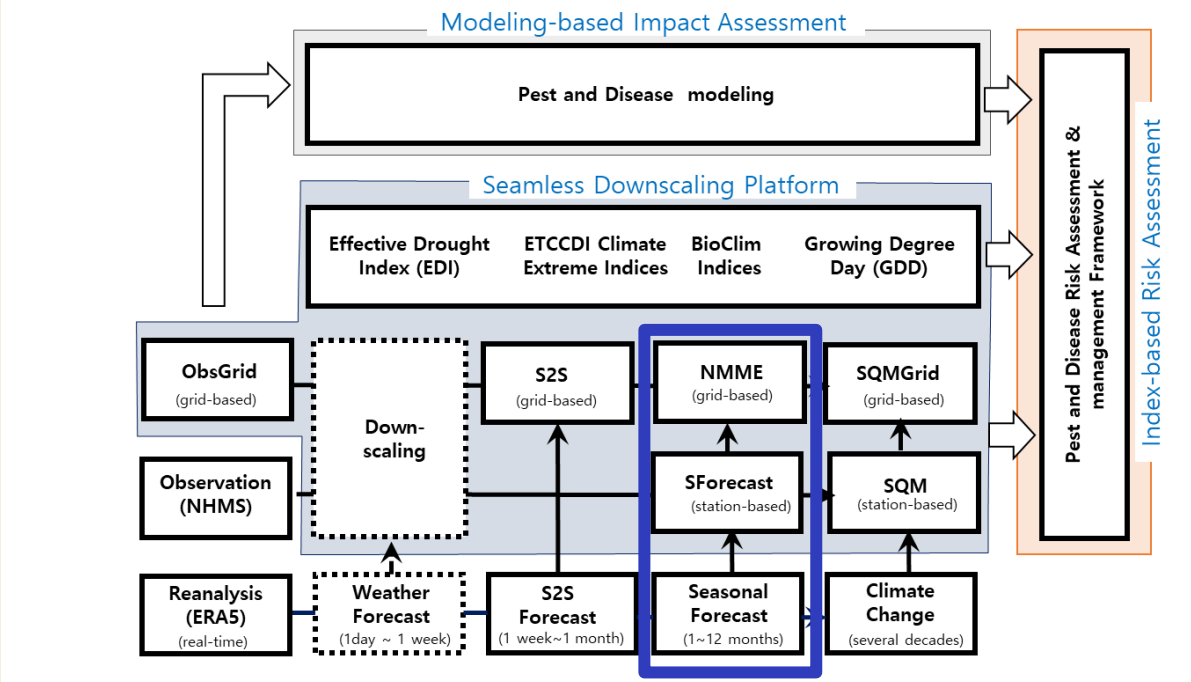


- Ⓞ **Safe pump operation check**  
7-day forecast alerts farmer when water levels approaches minimum pump intake — preventing pump damage and mid-season crop failure
- Ⓞ **Seasonal extraction limit setting**  
Dry-season groundwater level trend forecasts are used to set zone-based daily extraction limits, safeguarding aquifer sustainability across the target farmland

Farmer

WUA

## AI-based Spatial & Temporal Downscaling: STEM



### R-Packages

**Sforecast(station-based)**

- Hybrid seasonal forecasting based on APCC forecast, reanalysis, and climate indices.
- Deterministic forecast information are provided for each weather stations.

**SQM**

- Weather station-based statistical downscaling package for CMIP6 (SSP scenarios)

**ObsGrid**

- Creating long-term grid-based observation data
- ERAS: 1979-present; 6 variables(rainfall, temperatures, Wind speed, humidity, solar radiation); 25 km resolution

**SQM-Grid**

- Same downscaling method as SQM is used.
- Same GCMs, SSP scenarios, and variables as SQM
- Bias-corrected data is created based on the same resolution of ObsGrid output.
- ETCCDI and Bioclim indices are calculated based on downscaled data.

**NMME (grid-based)**

- North American MME is used as input
- Creating downscaled seasonal forecast data based on same resolution of ObsGrid output.
- Probabilistic drought (EDI) and heat wave forecast information is provided.

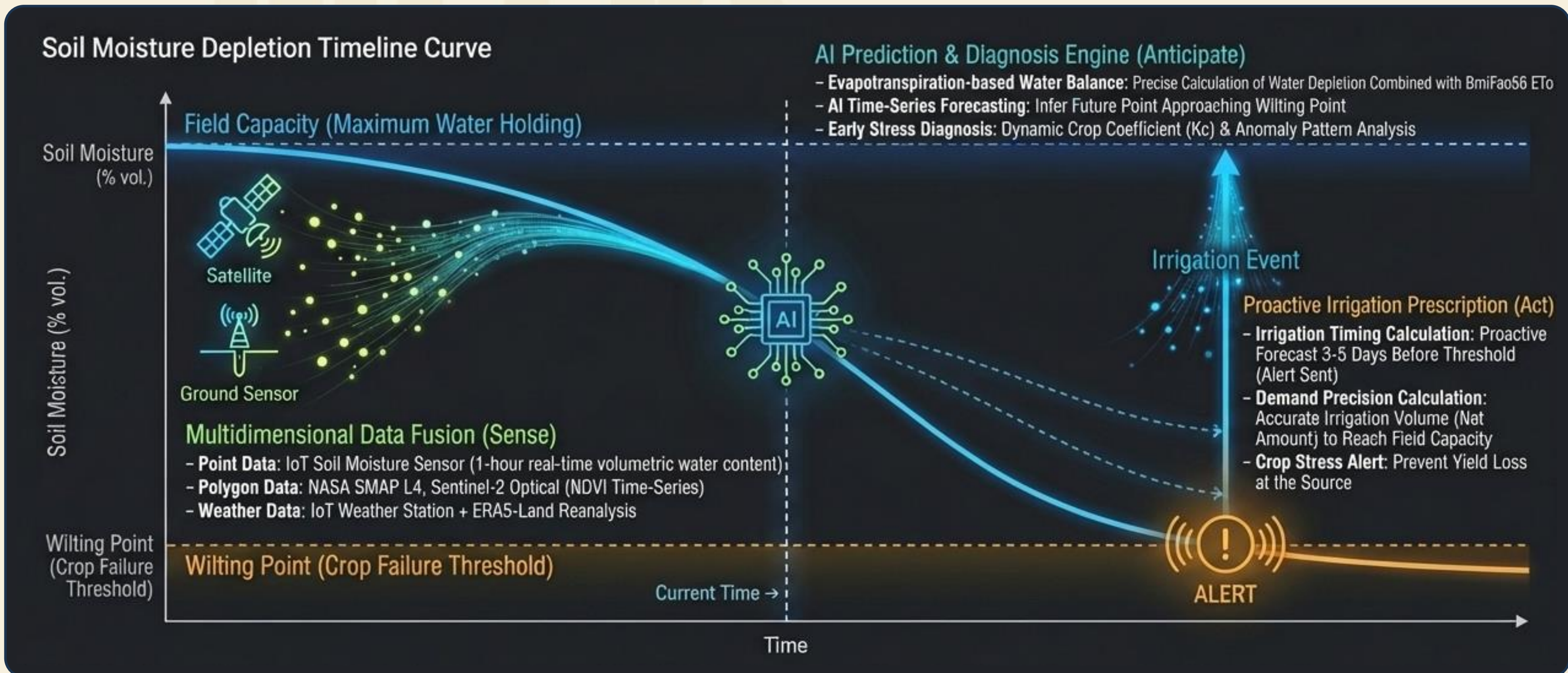


- Ⓞ **Crop selection guidance**  
Dry-season rainfall outlook (below/above normal) used to recommend crop mix planting timing, and crop type, reducing seasonal risk
- Ⓞ **Annual irrigation infrastructure plan**  
Wet/dry season outlooks inform irrigation scheduling, double-cropping area planning, and emergency water reserve management.

## CROP Engine

### Smart Irrigation Optimization for Field Crops: From Data to Proactive Decision-Making

Predicts optimal irrigation timing and required volume before water depletion using satellite & IoT fusion data and AI algorithms.



# Software: Rice Service for User Interface

## RICE (Mobile APP) for Farmer

**F** Farmer  
RICE Smartphone App

### 1 Farm diary — easy field logging (Farmer data input)

Register parcels by land ID code, log crop type, planting date, fertiliser inputs, and harvest yield directly from the app — data feeds back into the AI to improve prediction accuracy.

### 2 Crop selection guidance (Seasonal forecast)

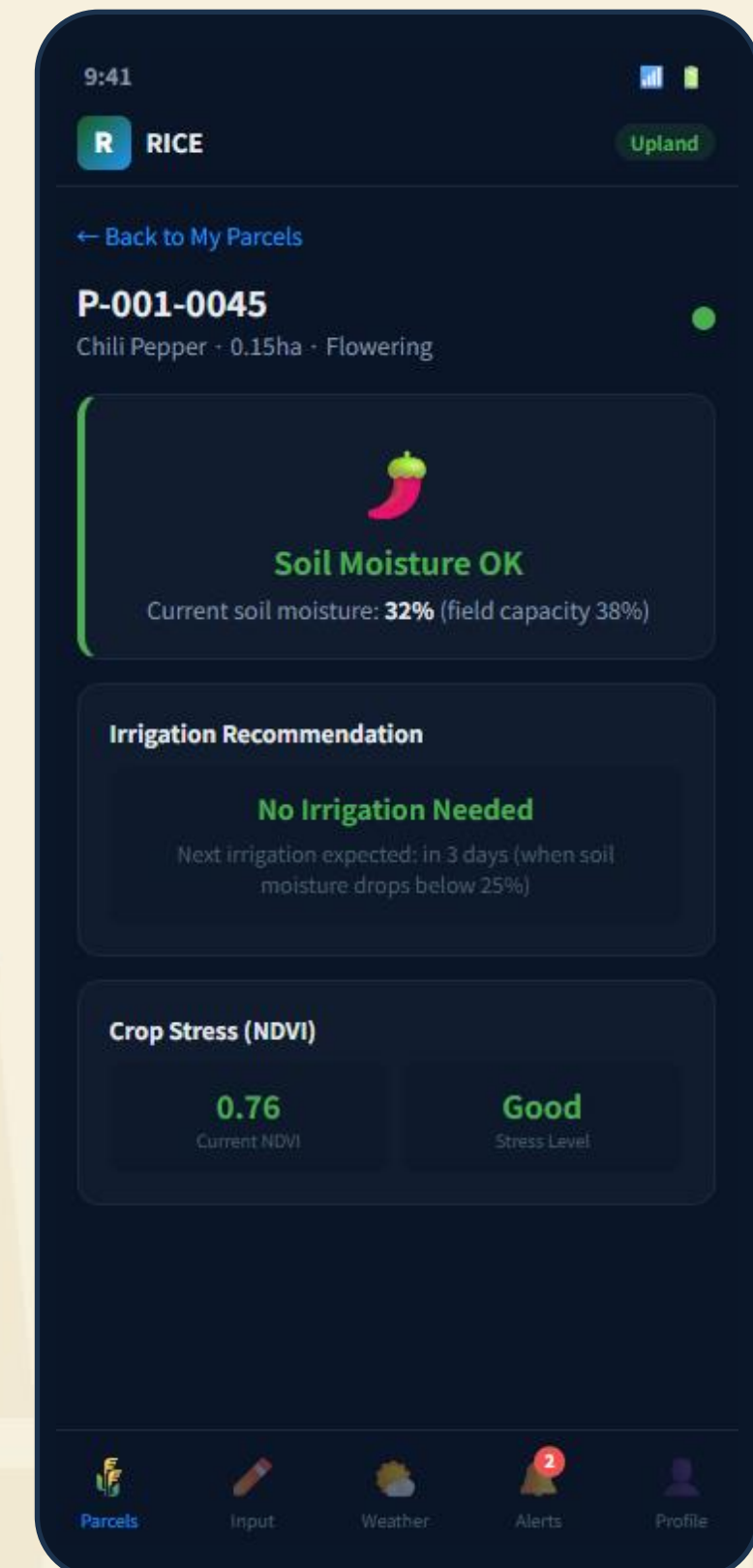
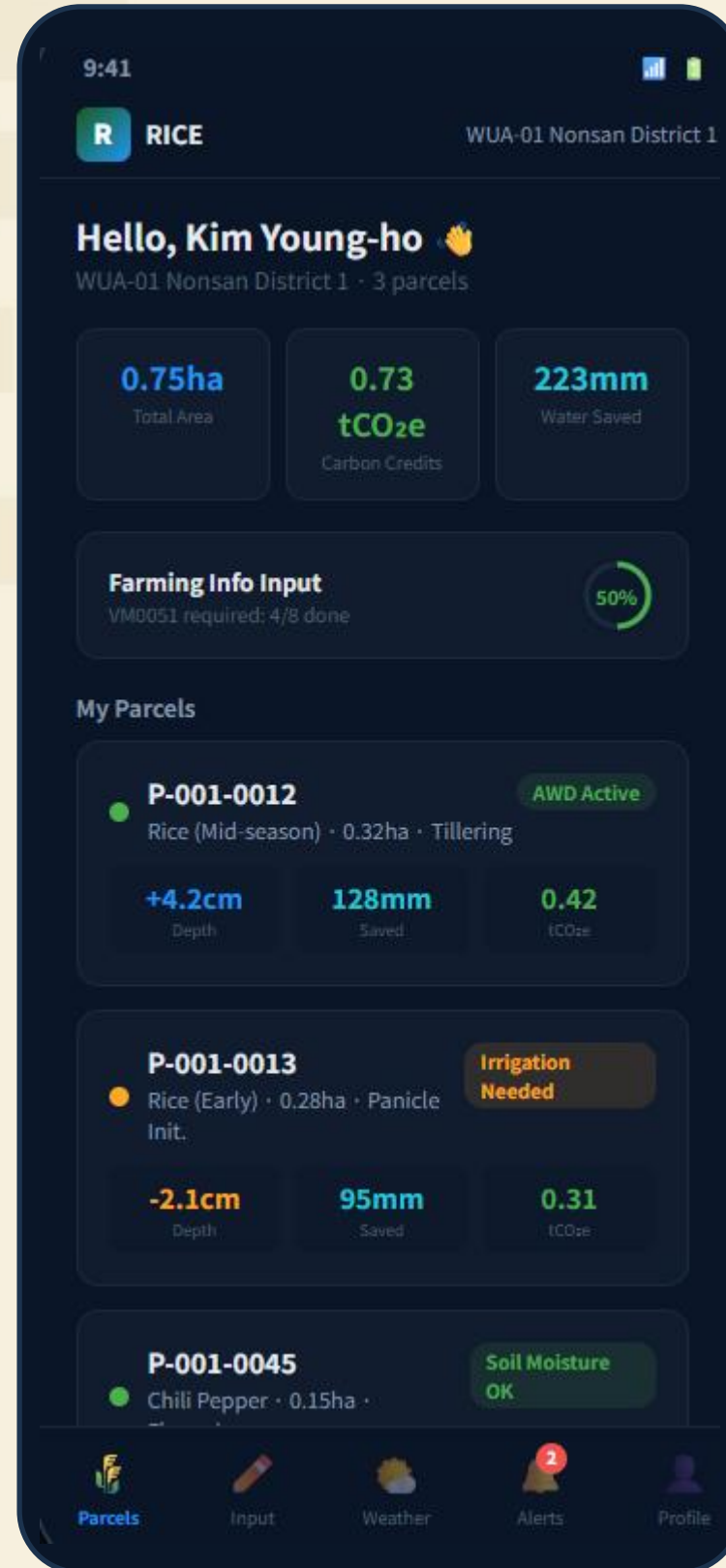
1-3 month seasonal rainfall and temperature forecast used to recommend crop type, planting ratio, and timing before the dry season begins — watermelon, peanut, mung bean trade-off.

### 3 AI Irrigation Decision Support (Soil Moisture AI)

AI combines per-layer soil moisture (sensor + satellite fusion) + crop growth stage + ETC + weather forecast → delivers recommended irrigation timing and volume per parcel

### 4 AWD water saving + carbon income

On AWD participation (paddy field): view real-time water saved vs conventional and methane reduction / carbon credits earned



# Software: Rice Service for User Interface

## RICE (Web) for WUA

**W** **WUA**  
RICE Manager Web Dashboard

- 1 Optimal rotational irrigation scheduling (Zone moisture map)**  
Satellite zone moisture map + groundwater forecast with irrigation supply volume → AI recommends zone-by-zone irrigation and duration
- 2 Seasonal Forecast for Crop Selection & Irrigation Planning**  
seasonal forecast with AI bias correction provides precipitation and temperature probability distributions — enabling WUA leaders to select appropriate dry-season crops and plan water budgets before planting.
- 3 Water Supply Scenario Analysis**  
Multiple supply scenarios (100% / 80% ) are simulated through CROP-Engine to forecast yield impact, water savings, and carbon credit (for rice paddy) potential under each scenario.
- 4 Automated water balance report**  
Calculates rainfall, evapotranspiration, actual irrigation per WUA → delivers irrigation efficiency metrics

The screenshot displays the RICE (Web) for WUA dashboard for the Upland (Dry Season) project. The interface includes a sidebar with navigation options: Dashboard, Parcels, GIS Map, Forecast, Paddy, Upland (selected), and Reports. The main content area shows the following details:

- Project Info:** Upland (Dry Season) WUA-01, Vientiane Plain Irrigation Project.
- Service (WUA Scope):** DRY SEASON — UPLAND CROPS ON PADDY FIELDS. Solar-powered groundwater pumping + drip irrigation · Rotation by zone.
- Zone 1 (North):** Zone, Watermelon (Crop), 4.2 ha (Area), 2025-11-15 (Planted), Drip (Irrigation), Growing (Status).
- Irrigation Forecast — Zone 1 (North):** Next 10 days. AI-based irrigation scheduling using soil moisture sensor data, ETo calculation (BmiFao56), and weather forecast. Drip irrigation amounts are optimized per crop stage.
  - Today:** Irrigate (10mm). Soil moisture 22% (below 25% threshold).
  - Day+2:** No action. Soil moisture recovery expected.
  - Day+4:** Irrigate (8mm). ET demand + no rainfall forecast.
  - Day+6:** No action. Slight rainfall possible (5mm).
  - Day+8:** Irrigate (12mm). Fruit development stage, high demand.
- Soil Moisture Status:** 22% Current, 38% Field Capacity, 12% Wilting Point. Threshold 25%, FC 38%, 50%.
- Water Budget — Zone 1 (North):** 72mm Total Applied, 180mm Crop Water Need, 42% Water Saved, 92% Drip Efficiency.

User profile: Khamla S., WUA Leader.

# Result and Goal

## GOAL

Sustainable and Climate-Resilient Income Growth for Smallholder Farming Communities through AI-driven Adaptive Irrigation and Agricultural Water Management in Lao PDR

01



### Farmer Income & Crop Diversification

Increased dry-season agricultural income through crop diversification and expanded dry-season production, reducing reliance on single wet-season rice cultivation

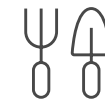
02



### Data-Driven Water Governance

Strengthened water governance through data-driven and efficient irrigation resource management

03



### Sustainable O&M & WUA Capacity

Strengthened WUA capacity for sustainable operation and maintenance of solar-powered irrigation systems, enabling low-cost operation and long-term financial self-sufficiency

04



### Gender Equity & Women's Empowerment

Enhanced gender equity through meaningful women's participation in water governance, agricultural production, and market activities, supported by gender disaggregated monitoring

**Thank you.**

**23 April 2026, Climate Week Yeosu**

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