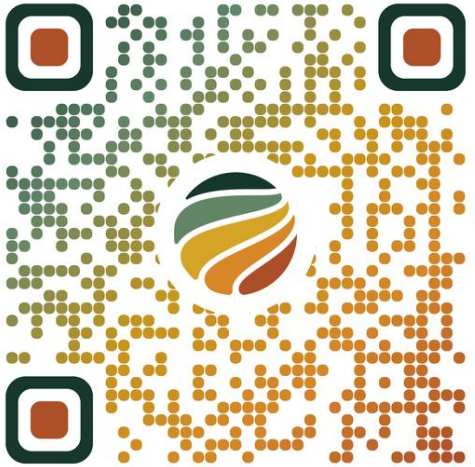
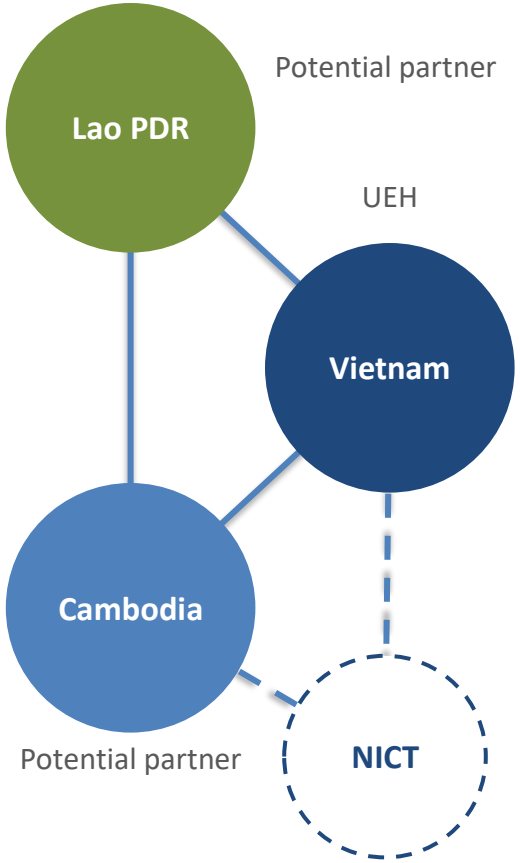
Title :

Low-Cost Federated AI for Transboundary Rice Pest and Disease Early Warning in the Lower Mekong Region





Share models, not raw data.
Dashed: potential advisor.

Full name of Speaker :

Duy-Dong Le

Institution :

University of Economics Ho Chi Minh City (UEH), Vietnam

Vietnam Principal Investigator (PI) and project lead. Seeking partners in Lao PDR and Cambodia; NICT as potential technical advisor.

Project Title: **Federated AI for Rice Pest & Disease Early Warning**

Background :

3 bn+ people depend on rice as a staple food

10–30% of the annual rice harvest is lost to rice blast

≈58 Mt paddy produced in 2021 by Viet Nam, Cambodia and Lao PDR

Pests and diseases do not stop at borders

Brown planthopper (*Nilaparvata lugens*) migrates long distances on the wind; rice blast (*Pyricularia oryzae*) spreads by airborne spores and thrives in favorable weather.

Observations stay in local silos

Agricultural data are managed locally or nationally in disparate formats, so cross-border responses are slow and uncoordinated.

Pooling raw data is difficult

Differences in data ownership, privacy practice, quality and connectivity make centralized sharing of raw data hard across three countries.

Sources: Skamnioti & Gurr (2009), Trends Biotechnol.; Otuka (2013), Front. Microbiol.; NARDT regional rice report, 2021 (Viet Nam 43.1, Cambodia 11.0, Lao PDR 3.8 Mt).

Project Title: **Federated AI for Rice Pest & Disease Early Warning**

Targets :

Goal: a low-cost, privacy-preserving, cross-border AI framework that turns farmer reports and public environmental data into early-warning risk information, without costly new sensors.

TARGET 1

Open regional research network

Led by UEH (Vietnam), with potential partners in Lao PDR and Cambodia and NICT as potential advisor.

TARGET 2

Federated AI framework

Analyze data locally; share models instead of raw data.

TARGET 3

Integrate heterogeneous data

Pest reports, photos, weather, hydrology and crop calendars.

TARGET 4

Explainable regional risk

Pest and disease probabilities for neighboring areas.

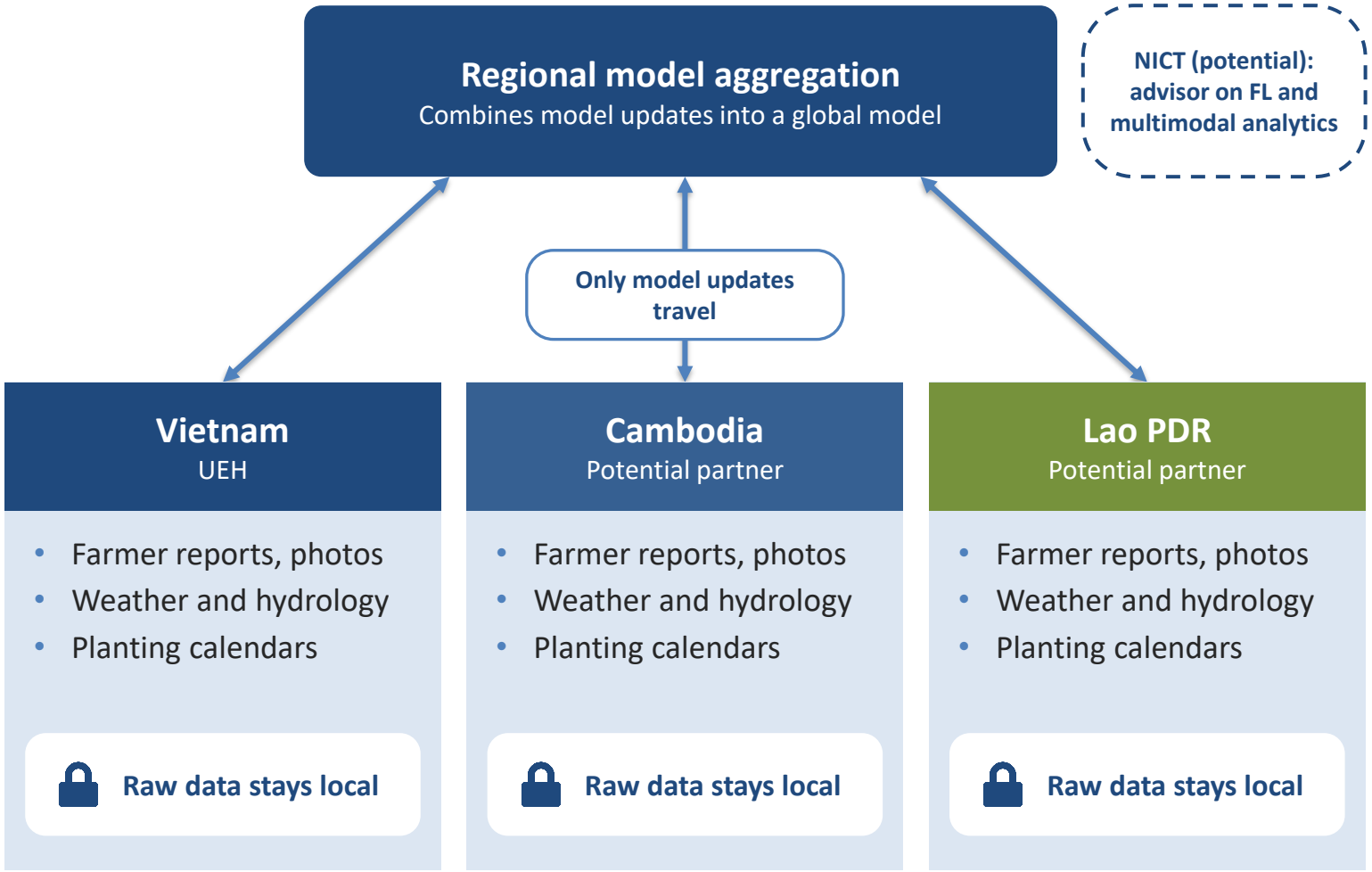
TARGET 5

Capacity building

Training and knowledge transfer in Lao PDR and Cambodia.

Proposed Method: **Federated Architecture Across Three Nodes (1/3)**

Point of view: **Scientific and technological**



Design principles

Share models, not data

Each site trains locally; a coordinator aggregates updates (baseline: FedAvg[1]).

Built to add nodes

A new institution joins by training locally; differences in data quality, privacy practice and connectivity are expected.

Low cost by design

Existing data, smartphone reports and light models; no new sensors.

[1] McMahan et al. (2017) Communication-efficient learning of deep networks from decentralized data. AISTATS.

Proposed Method: **Causal-Temporal Risk Assessment (2/3)**

Point of view: **Scientific and technological**

Multi-source inputs

Outbreak reports, photos, weather, wind, hydrology, crop calendars

Temporal signals

Lead–lag patterns that precede outbreaks in neighboring areas

Causal analysis

Links among weather, wind, water, crop stage and spread

Regional risk estimate

Pest and disease probabilities with the drivers behind each alert

ILLUSTRATIVE EARLY-WARNING CARD

RISK: HIGH

Brown planthopper, neighboring district

Top drivers

- Upwind planthopper reports (last 7 days)
- Humid, rainy weather forecast
- Crop at a susceptible growth stage

Decision support, not replacement

Interpretable estimates assist agricultural extension officers, who stay in charge of every decision.

Proposed Method: **Implementation and Field Testing (3/3)**

Point of view: **Implementation · Experiments including field testing**

Phase 1 · Year 1: Build the foundation

- Partner coordination
- Data collection and harmonization
- Federated-learning infrastructure
- Baseline models
- Initial knowledge-transfer workshops

Phase 2 · Year 2: Integrate and demonstrate

- Cross-country model integration
- Causal and temporal risk assessment
- Prototype demonstrations
- Stakeholder evaluation
- Capacity building and joint research outputs

Experiments and field testing

Back-testing

Replay historical outbreak records against the models

Pilot season

Run the prototype with extension officers in real cropping seasons

Stakeholder evaluation

Gather officer and farmer feedback on usefulness and timeliness

~US$80,000

over 24 months, with no new sensing infrastructure

Impact: **New Methods for Cross-Border Agricultural AI (1/3)**

Point of view: **Scientific and technological**

Federated learning for heterogeneous agricultural data

Shows how institutions with different formats, quality and privacy rules can learn jointly by sharing models, not raw data.

Causal and temporal early-warning signals

Links outbreaks to weather, wind, hydrology and crop calendars to detect advance warning across neighboring regions.

Explainable regional risk

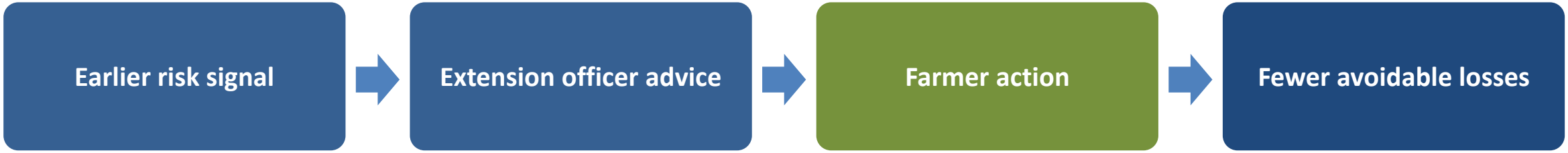
Interpretable pest and disease probabilities that officers can examine, question and act on.

Low-cost AI, demonstrated

Practical proof that useful AI can run on existing data and smartphone reports, without new sensing infrastructure.

Impact: Earlier, Better-Targeted Crop Protection (2/3)

Point of view: **Societal**



Farmers

Timely, understandable alerts reach farmers through low-cost smartphones, lowering the digital-divide barrier.

Extension services

Regional risk estimates help officers decide where and when to inspect and advise.

Food security and environment

Better-timed action helps protect rice supply and can reduce reliance on blanket insecticide use, a known trigger of planthopper resurgence[2].

[2] Bottrell & Schoenly (2012) J. Asia-Pac. Entomol. 15(1):122–140.

Impact: ASEAN Collaboration and Alignment (3/3)

Point of view: **Collaborative**

1 TOPIC 1 · PRIMARY

ICT for food

AI for food availability in rice-producing ASEAN countries

2 TOPIC 2 · SECONDARY

Environment and disaster prevention

Early warning of climate-related agricultural risks

5 TOPIC 5 · ALSO RELEVANT

Inclusive digital services

Low-cost smartphones and existing data narrow the digital divide

6 TOPIC 6 · ALSO RELEVANT

Advanced technologies

Federated learning, explainable AI and causal assessment in a deployable prototype

Planned network: partners being confirmed

Vietnam
UEH

Cambodia
Potential partner

Lao PDR
Potential partner

NICT
Potential advisor

Capacity building in Lao PDR and Cambodia helps narrow development gaps.

VISION

Mekong Regional Agricultural Intelligence Network

Extends to other crops, regions and transboundary threats, with continued collaboration with institutions such as NICT.

Output/Outcome: **Reusable Tools, Data and Prototype (1/2)**

Point of view: **Scientific and societal**

Reusable cross-border data and AI framework

Minimizes raw-data exchange and can be adapted to other crops, regions and threats.

Scientific

Prototype rice pest and disease early-warning system

Designed for agricultural extension services and farmers.

Societal

Datasets, software components and technical reports

Reusable building blocks, shared where data agreements allow.

Scientific

Peer-reviewed publications

Joint research outputs of the three-country team.

Scientific

Demonstration of low-cost AI using existing data

Evidence that regional AI is feasible within a modest budget.

Societal

Output/Outcome: **Network and Regional Capacity (2/2)**

Point of view: **Collaborative**

From project to regional network

During the project

Three-country network formed; prototype and joint outputs delivered

After the project

Trained researchers in Lao PDR and Cambodia continue development

Long-term vision

Mekong Regional Agricultural Intelligence Network, extended to other crops, regions and threats

Capacity building in Lao PDR and Cambodia

Training

Federated learning, AI and multimodal data integration

Knowledge transfer

Joint workshops and shared software components with partner researchers

Future services

Multilingual, farmer-facing services as a longer-term step

Conclusion: Join Us to Build Regional Early Warning

A low-cost federated AI approach to transboundary rice pest and disease early warning: starting in the Lower Mekong, open to partners across ASEAN and Japan.

What we bring

- Vietnam lead: UEH (project PI)
- Share-models-not-data design
- 24-month plan with pilot seasons
- Aligned with ASEAN IVO Topic 1

Who we are looking for

- A partner institution in Lao PDR
- A partner institution in Cambodia
- NICT as technical advisor (FL and multimodal data analytics)
- Plant-protection and extension agencies

What partners gain

- A co-led pilot site in your country
- Joint datasets, software and papers
- Training in federated, explainable AI
- A role in the December 2026 proposal

Thank you. Talk to me today about joining the consortium.

Duy-Dong Le [dongld@ueh.edu.vn]
Deputy Head of Department of Science Technology and Innovation
UEH Mekong