Smart Use of Non-Conventional Water and AI-Driven Agriculture for Food Production in the GCC

Dr. Kamel Mostafa Amer
Senior Water Resources Expert & Head of the Middle Regional Office
Arab Organization for Agricultural Development (AOAD)

Artificial Intelligence (AI) for Sustainable Water Resources Management (SWRM) in the GCC Countries, Kuwait Institute for Scientific Research (KISR)

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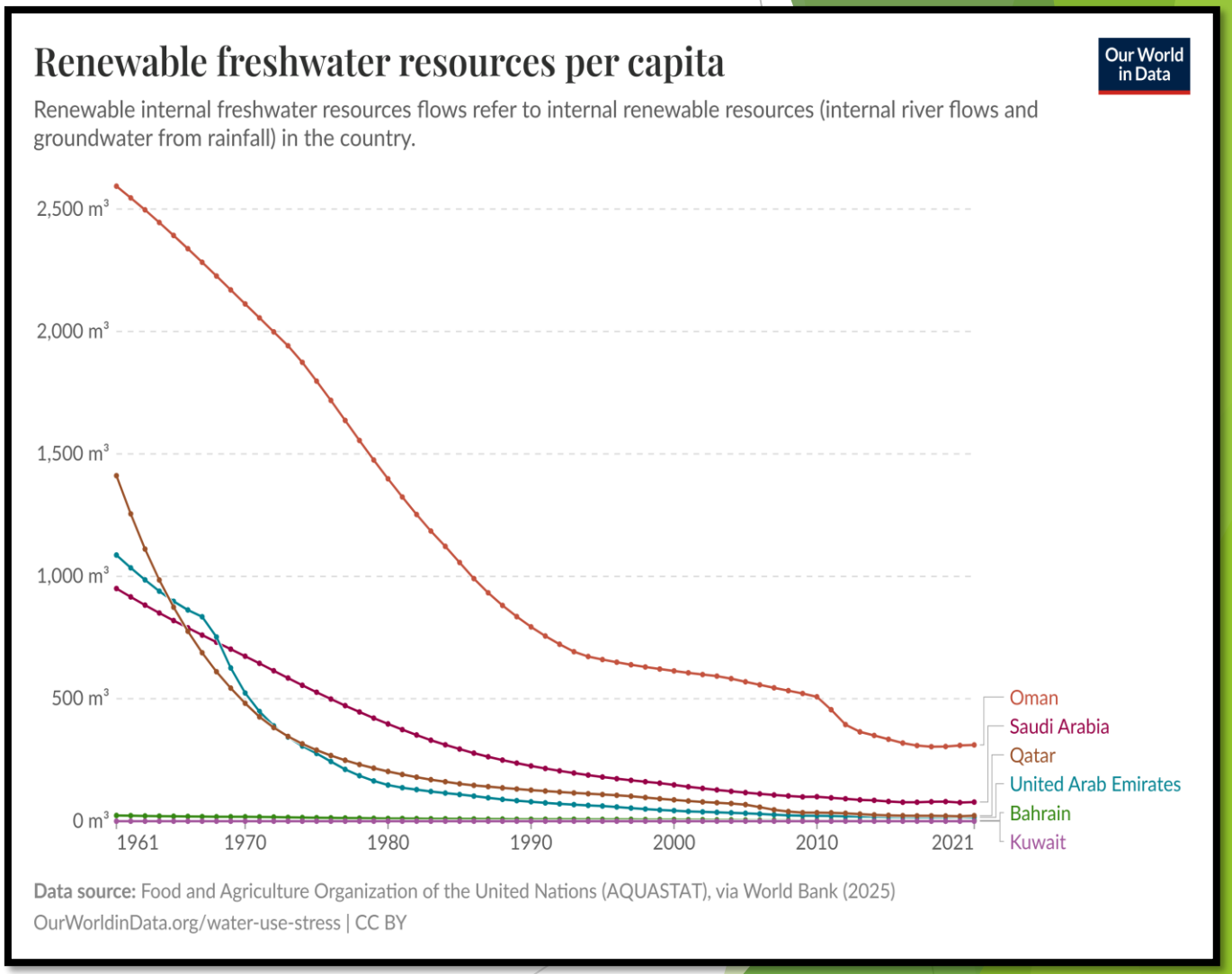
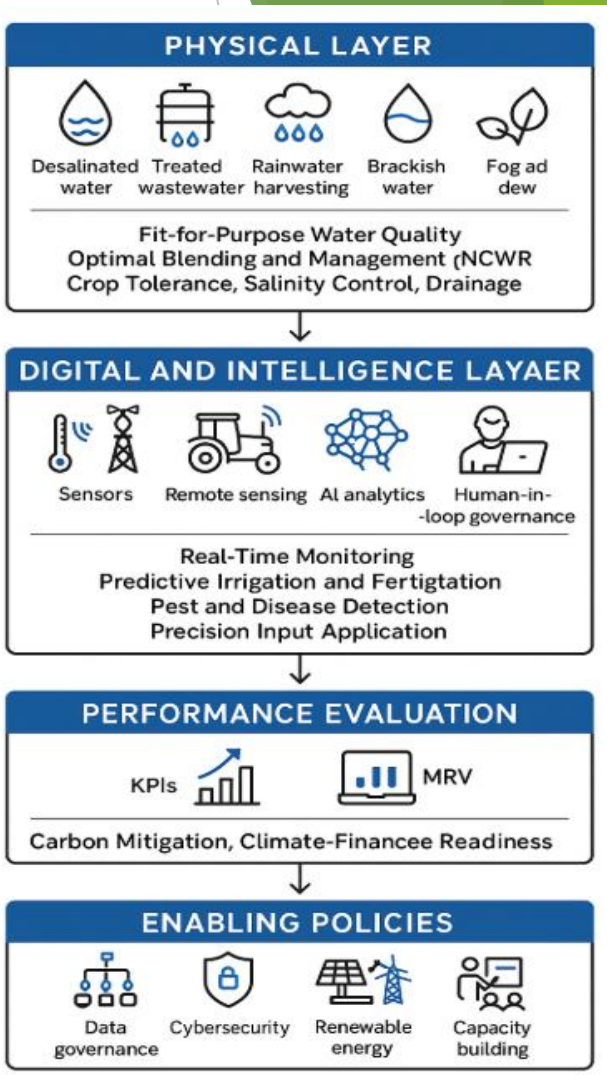
Problem Statement:

- Severe renewable water scarcity in the GCC
- Rising food demand + climate stress
- Need for integrated (water + AI + governance) solutions



Core Idea: Proposed Framework:

- Integrated NCWR + AI as synergistic drivers
- Layered logic: Physical → Digital/AI → Performance → Enabling policies

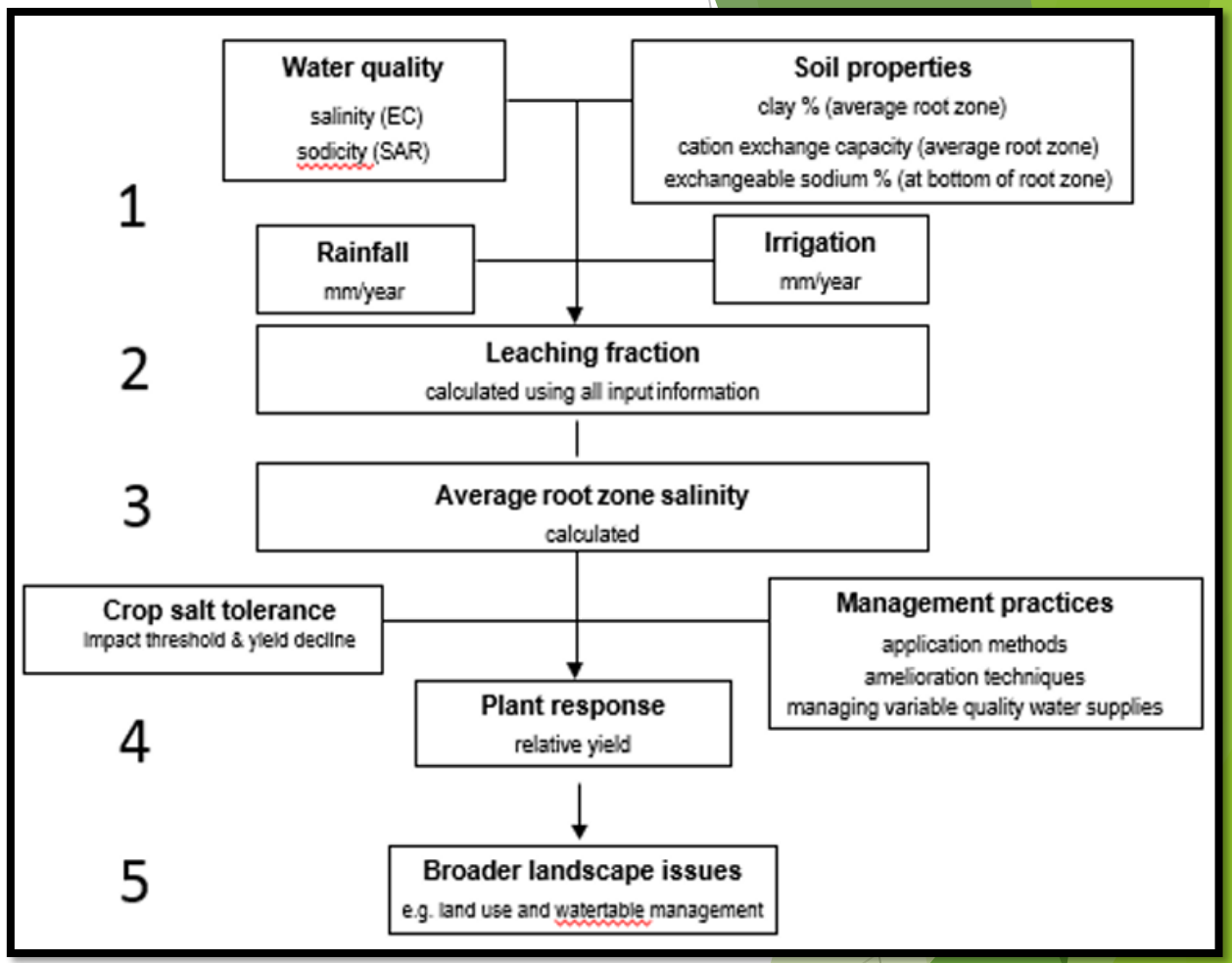


Non-Conventional Water Resources (NCWR) Portfolio for the GCC:

- Desalinated seawater/saline groundwater
- Treated wastewater/brackish groundwater/greywater
- Rainwater/fog/dew and humidity harvesting
- Artificial aquifer recharge

Fit-for-Purpose Water Quality:

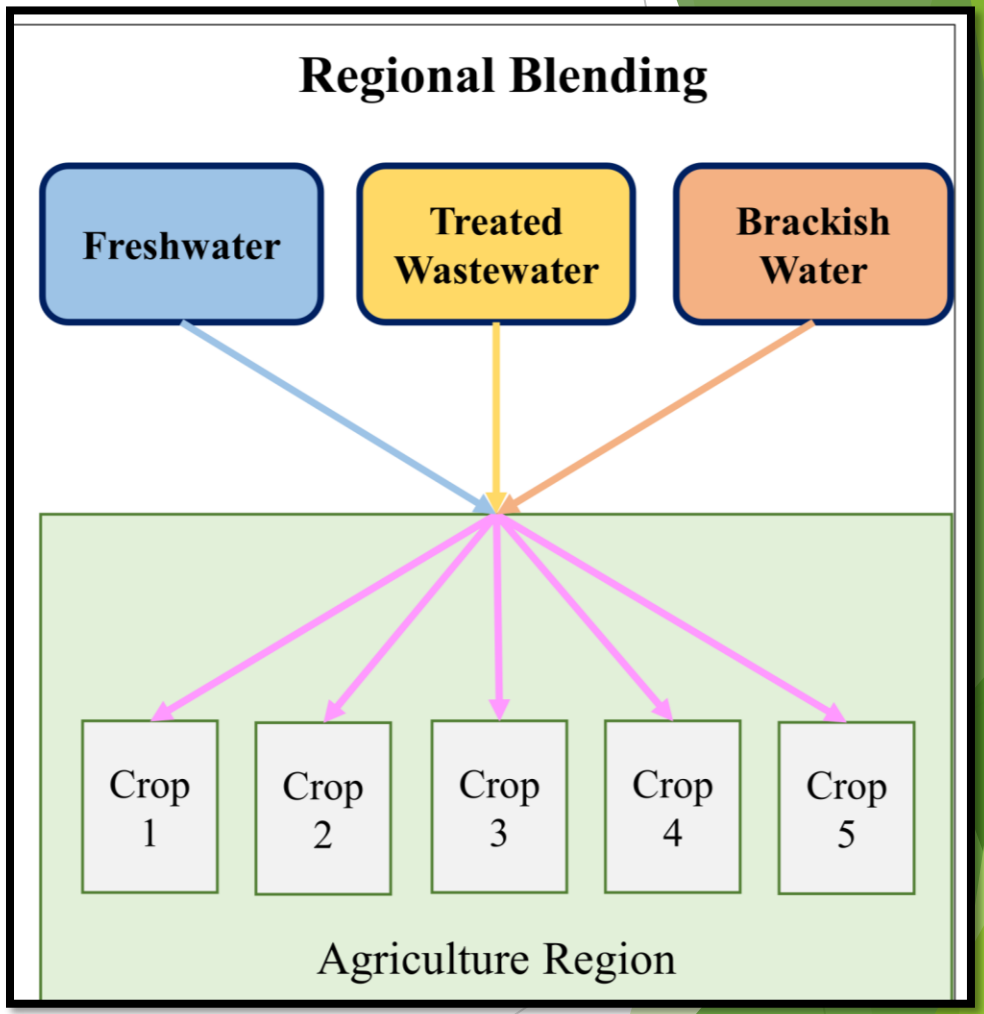
- Fit-for-purpose + matching quality to use
- Quality indicators ↔ crop tolerance ↔ irrigation requirements
- Blending as a cost–quality tool



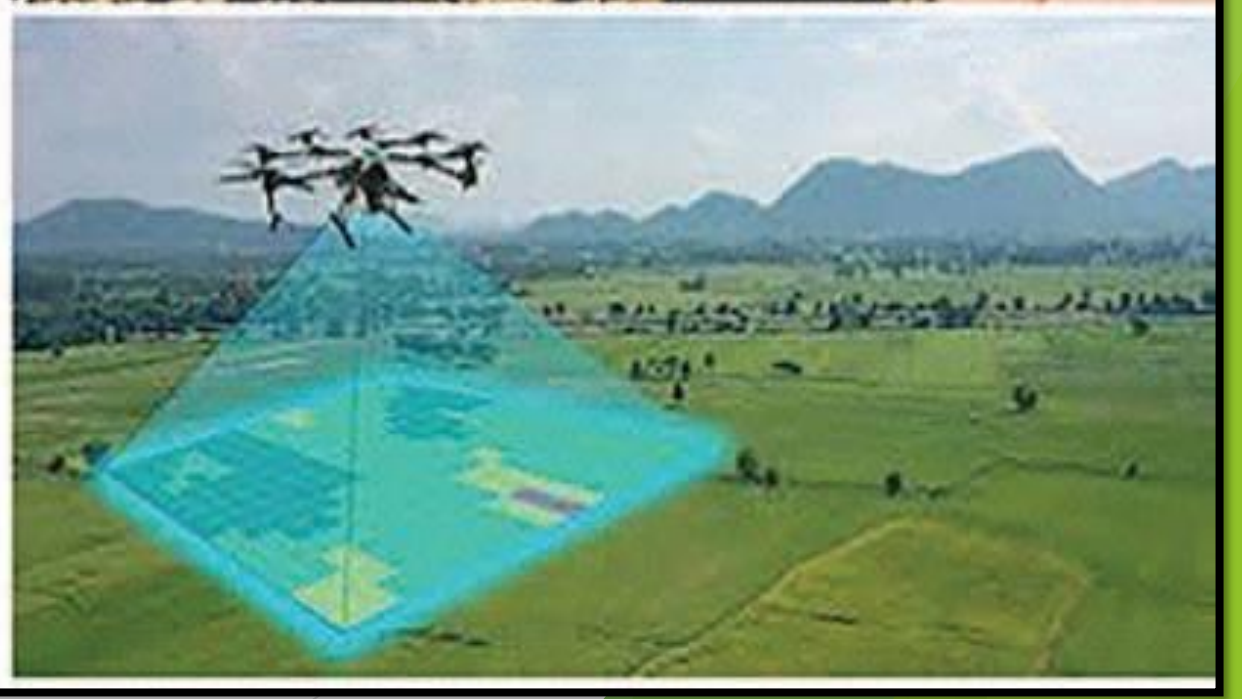
Fit-for-purpose irrigation water quality: linking EC/SAR (water quality) with soil properties, irrigation/rainfall, leaching fraction, crop salt tolerance, and management practices to predict plant response

Blending, Irrigation & Salinity Control:

- Optimized blending
- Closed-loop irrigation/fertigation + nutrient recovery
- Leaching + gypsum/organic matter
- Drainage as a requirement

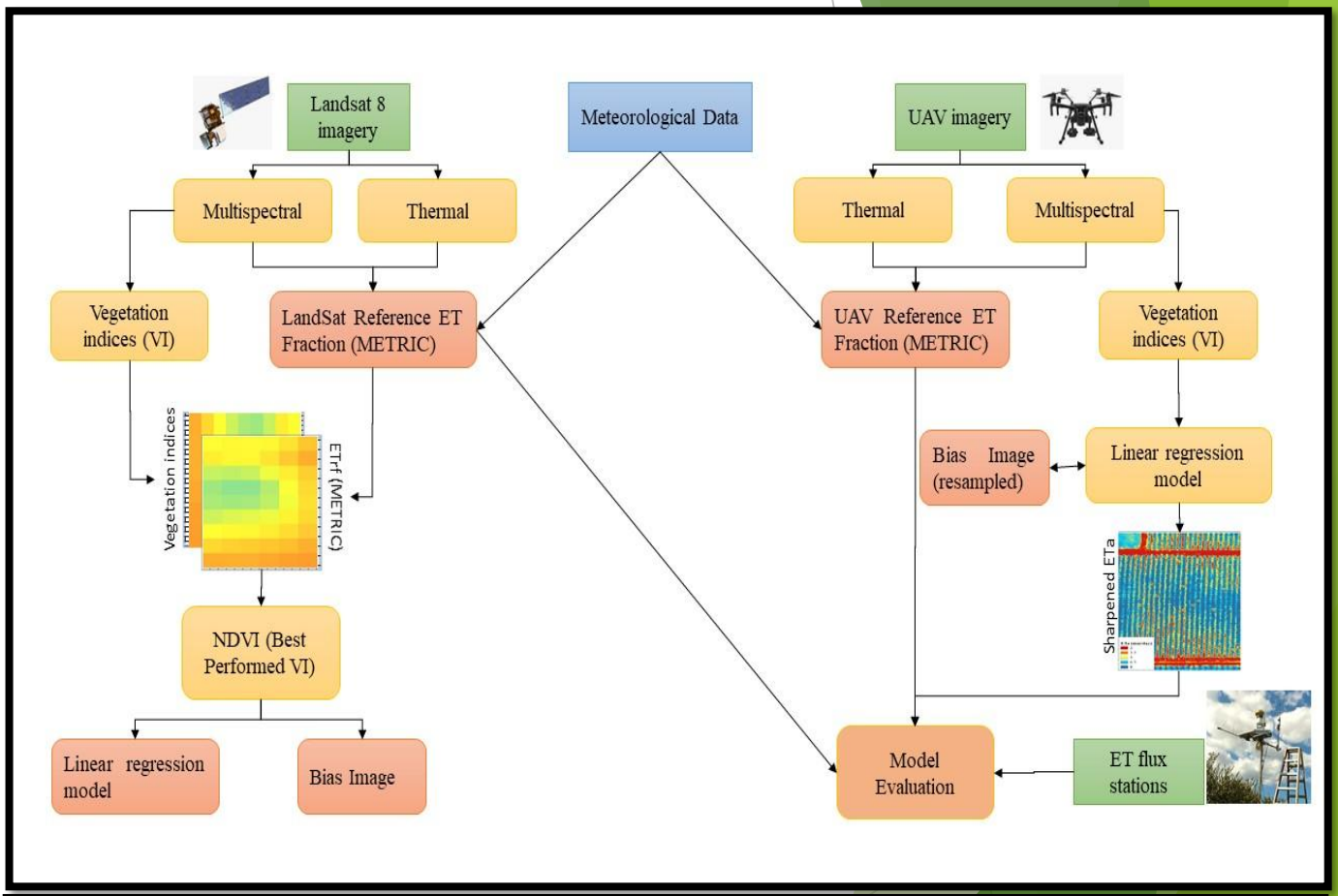


Optimized blending of multiple irrigation water sources (fresh, treated wastewater, brackish) to match crop salinity tolerance.

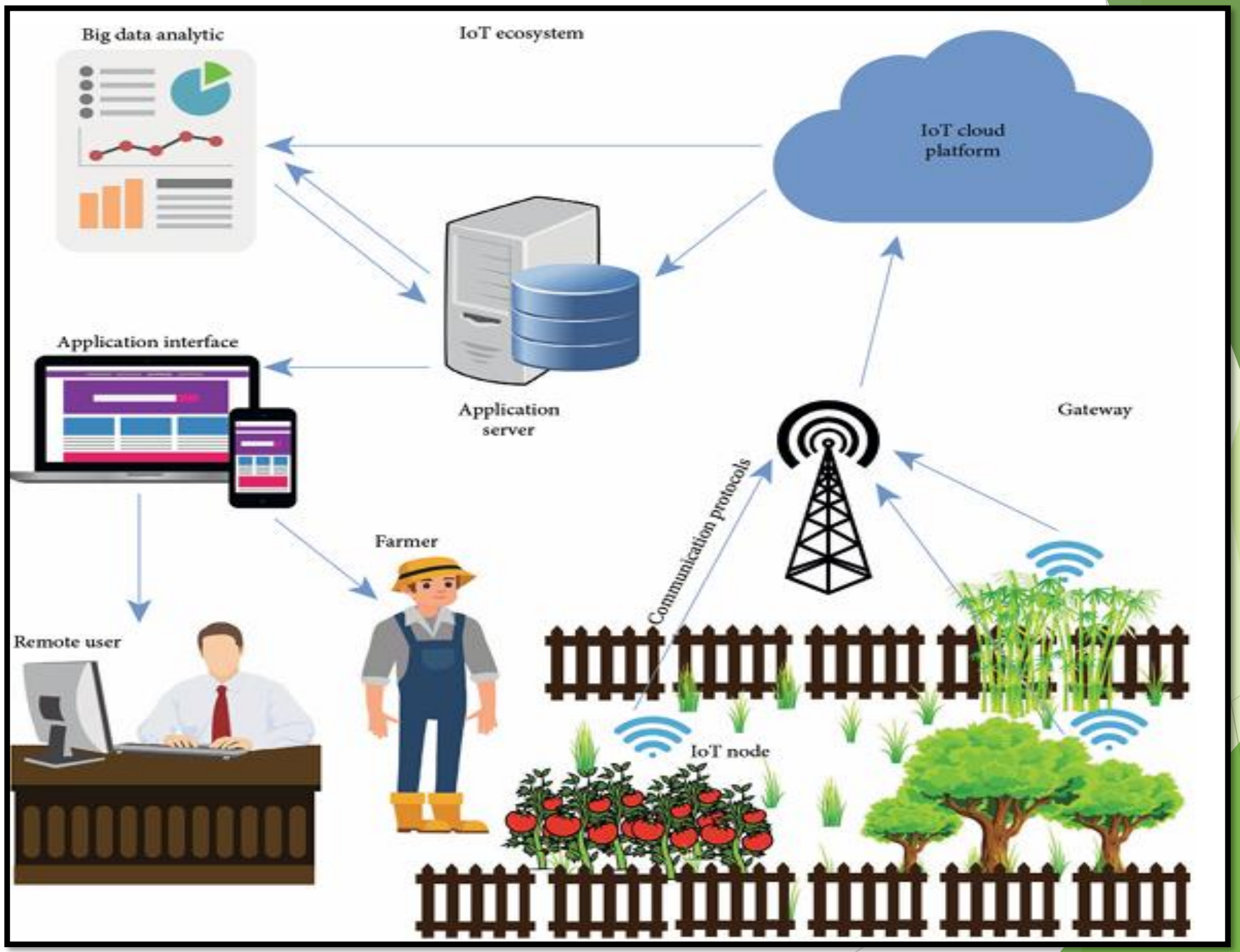


Sensing & Data Acquisition:

- Sensors: moisture/EC, pressure/flow
- Micro-weather stations
- Satellite + UAV
- NDVI + ET indices



Multi-source data acquisition for irrigation intelligence: satellite (Landsat), meteorological data, and UAV imagery are integrated via vegetation indices (NDVI) to support ET estimation and model evaluation.


Big data analytic
IoT ecosystem
IoT cloud platform
Application interface
Application server
Gateway
Communication protocols
Farmer
Remote user
IoT node

AI Analytics & Decision Engine:

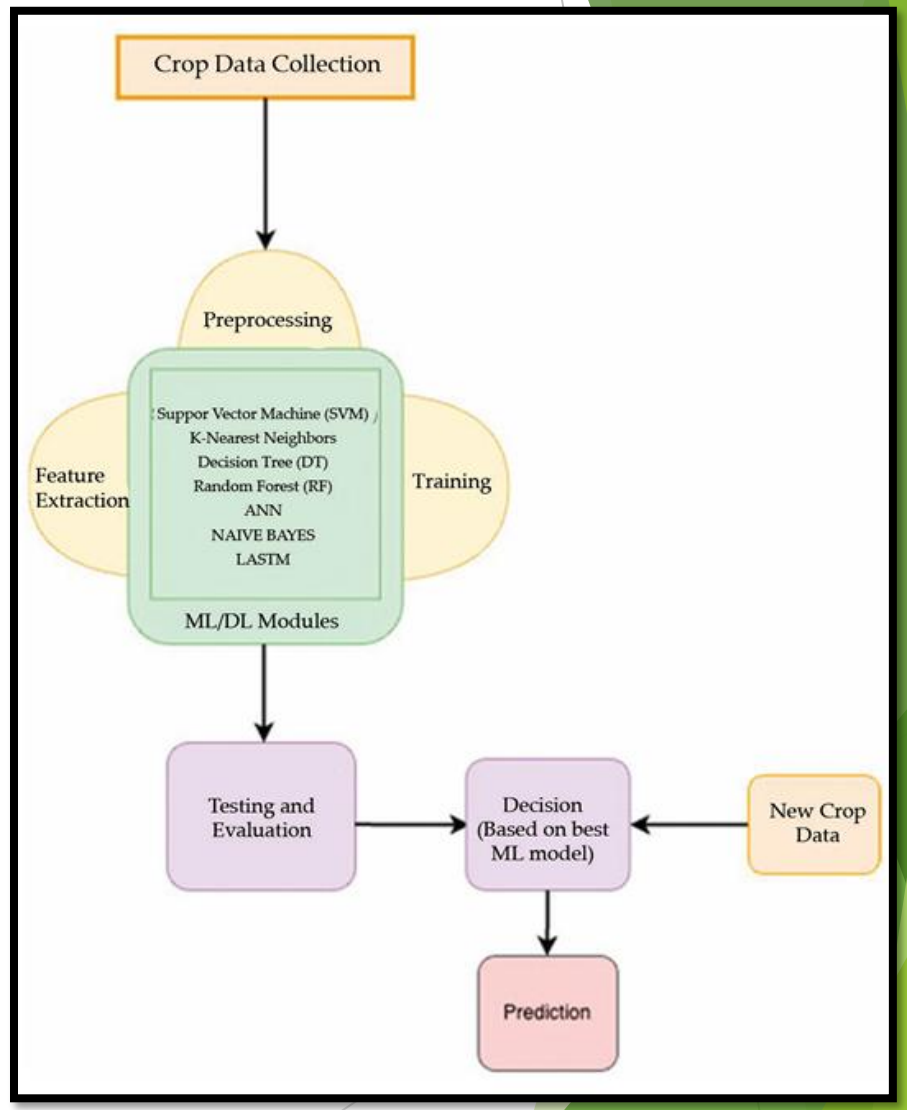
- Forecast crop water requirements
- Optimize water-source mix (quality + cost)
- Predictive irrigation/fertigation scheduling
- Fault/leak detection
- Dashboards (farm→program→national)

Human-in-the-Loop Governance:

- Farmer remains decision-maker
- Manual review in early adoption
- Training + skill development
- Reduce reliance risk

AI Agronomy Applications:

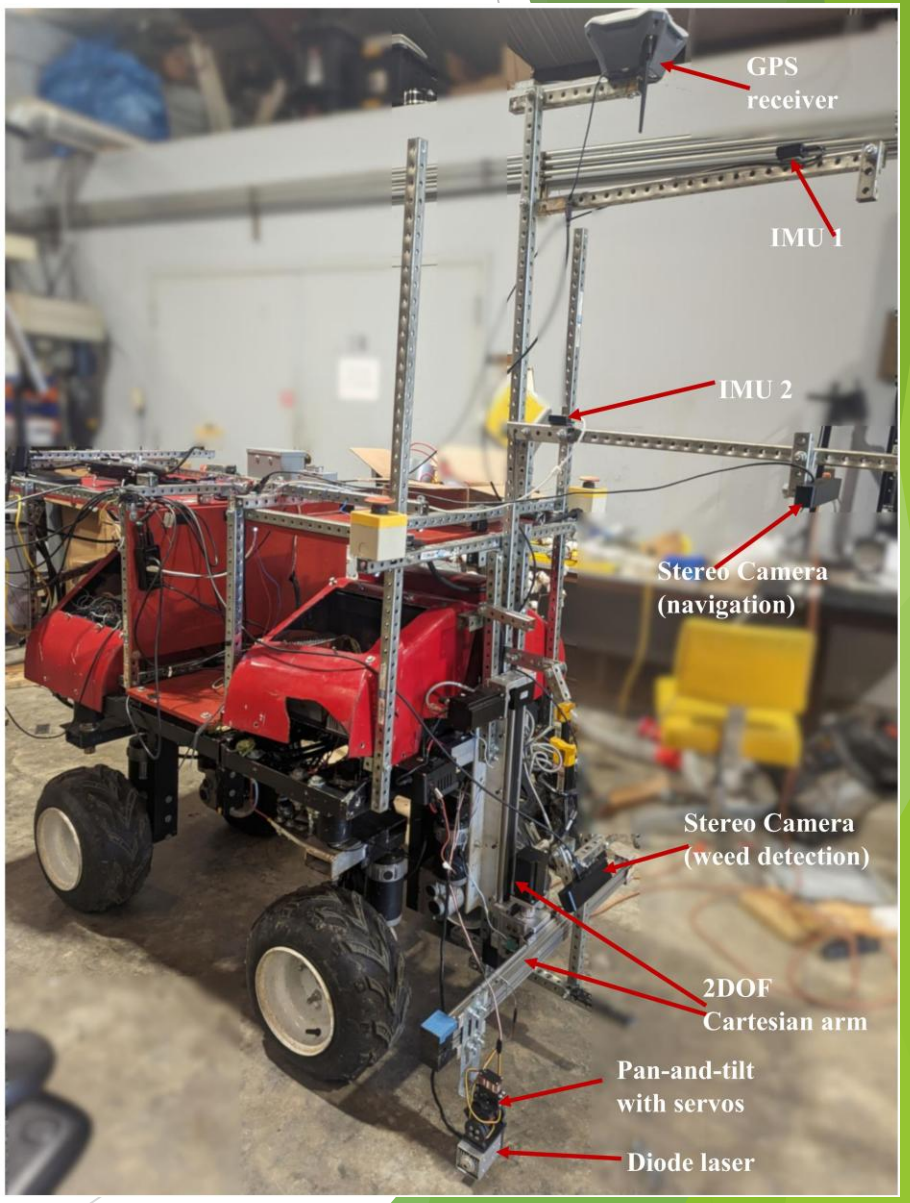
- Pest & disease detection (multi-source imagery)
- Crop stress monitoring
- Yield prediction
- Planning: inputs, harvest, supply chain, finance



AI-based crop analysis and prediction

Illustrative Case: AI Weed Control:

- Computer vision distinguishes crop vs weed
- Laser weeding (chemical-free)
- Lower labor cost + supports regenerative farming



Enabling Environment Requirements:

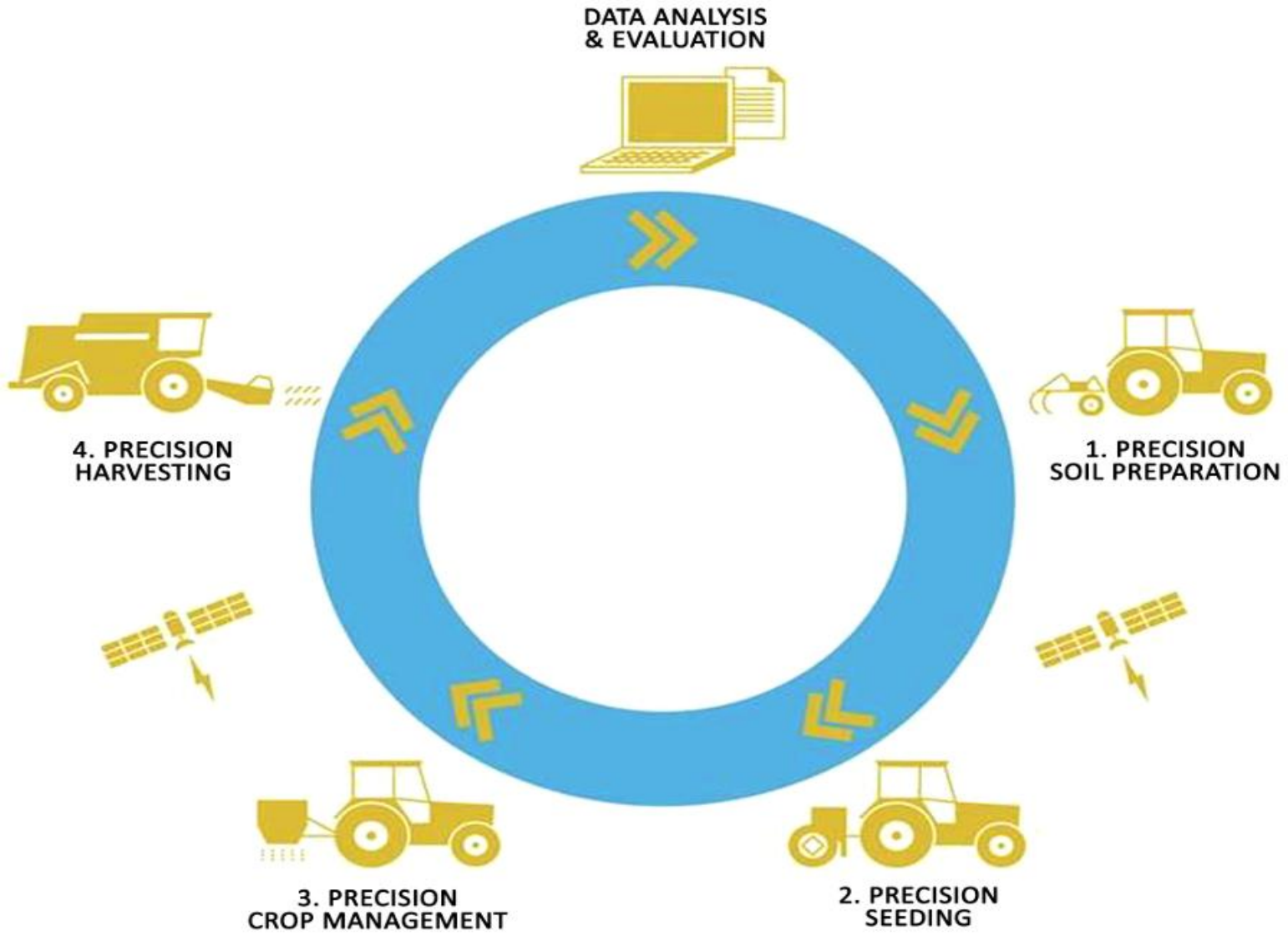
- Infrastructure readiness
- Reliable high-quality data
- Training + technical assistance
- Three bottlenecks for scale

Data Governance & Cybersecurity:

- Secure data-sharing protocols
- Privacy and legal responsibilities
- Cyber threats (breaches/attacks)
- Staff training for restricted systems

Unified Platform & Farmer Tools:

- Unified platform: sensors + weather + machinery + imagery
- Recommendations: crop/planting, irrigation, pest response
- Mobile apps + chatbots (weather, disease, markets)


DATA ANALYSIS
& EVALUATION
1. PRECISION
SOIL PREPARATION
2. PRECISION
SEEDING
3. PRECISION
CROP MANAGEMENT
4. PRECISION
HARVESTING

Precision Operations & Reliability:

- Variable-rate irrigation/fertilization/seeding
- Management zones (soil/topography)
- Real-time leak/failure detection
- Alerts to reduce crop stress

Performance Evaluation (KPIs):

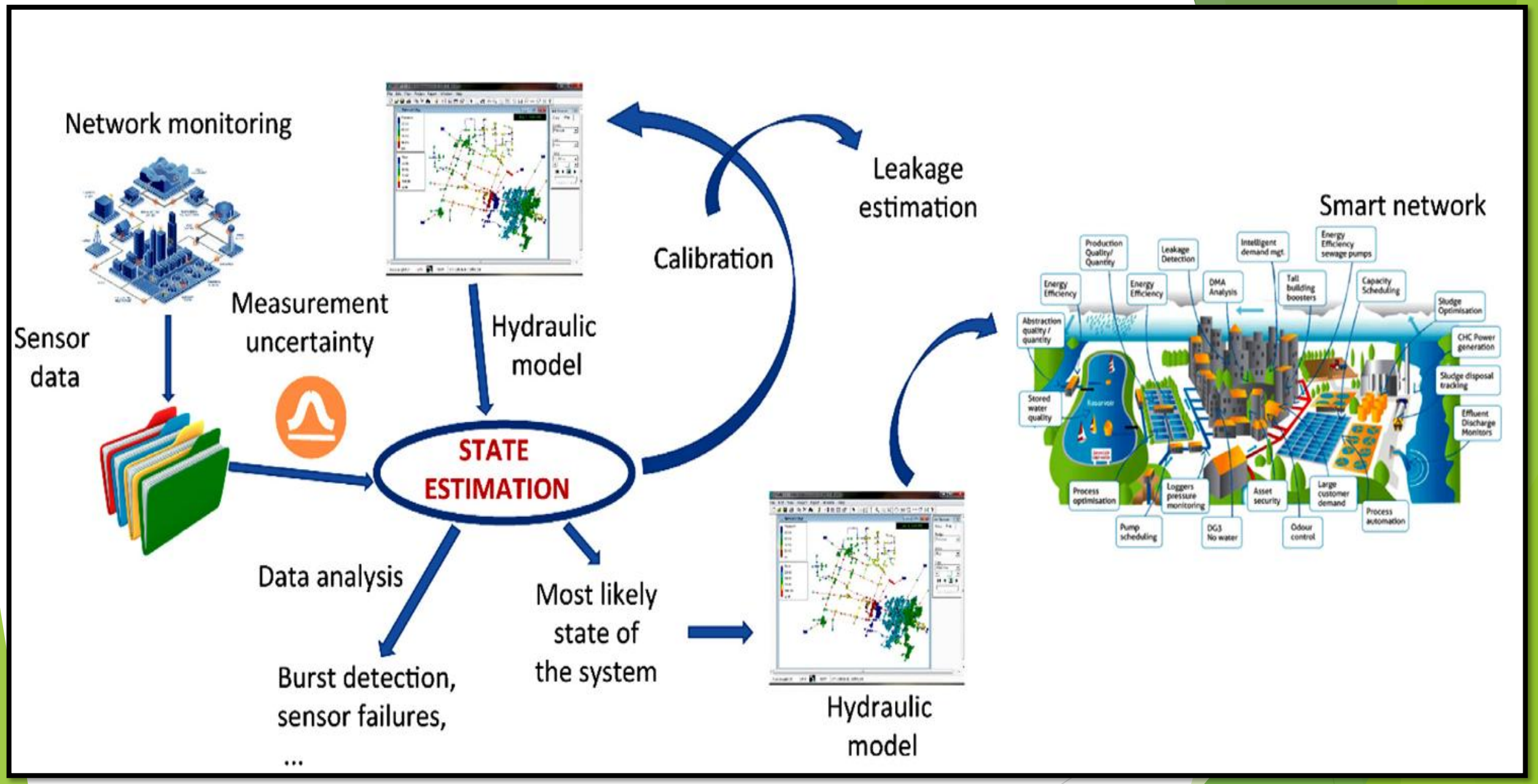
- Water productivity (kg/m³)
- Energy intensity (kWh/kg; kWh/m³)
- Nutrient-use efficiency (%)
- Stability under heat/salinity + soil ECe trends
- Cost of agricultural water

Carbon Mitigation & MRV:

- Renewables in desalination/pumping
- Reduced losses via precision control
- Soil/biomass carbon enhancement
- MRV: baselines, boundaries, uncertainty, audit trails

Deployment Models & Scaling:

- Bundling multiple sites to reduce transaction cost
- Service contracts and commercialization
- Financing to accelerate adoption



Main Components of a Network Analysis System

Beyond the Farm Gate (Value Chain):

- Demand prediction and storage optimization
- Reduce postharvest losses and food waste
- End-to-end traceability (blockchain)

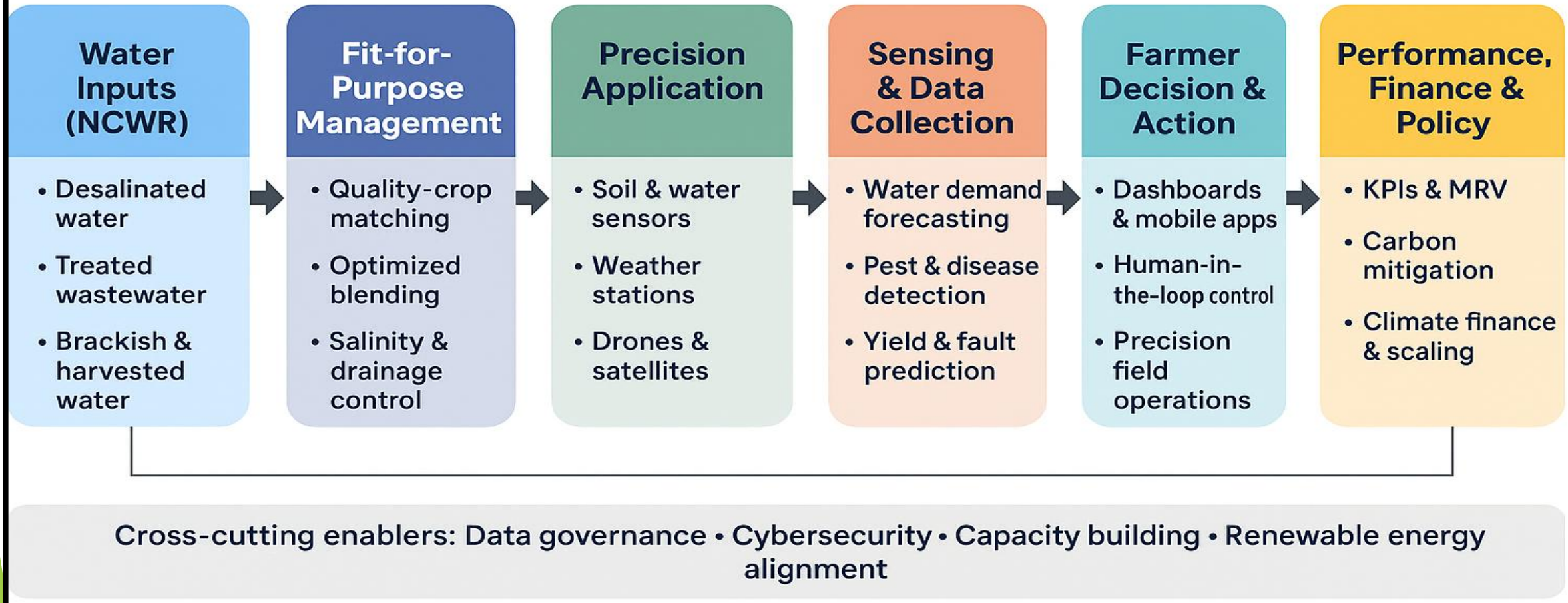
Enabling Policies for GCC:

- Update reuse standards (fit-for-purpose)
- Clear licensing for NCWR + drainage/salinity
- Mandate MRV + secure data sharing
- Align desalination/pumping with renewables
- Capacity building (farmers/operators/data specialists)

Closing: Value Proposition:

- Practical pathway for GCC agriculture
- Measurable outcomes (KPIs) + credible MRV
- Carbon mitigation + climate-finance readiness
- Scalable implementation

Integrated NCWR–AI Framework for Climate-Smart Agriculture in the GCC



Priority Recommendation:

- Mandate a unified MRV system (with secure data-sharing / governance) as the backbone of the GCC NCWR+AI program.

Recommendations:

- Update “fit-for-purpose” reuse standards (and harmonize them with safe agricultural use).
- Align desalination/pumping with renewables to cut emissions and improve system economics.
- Use scaling-friendly deployment and financing models (bundle sites + service contracts + adoption finance).

KISR
معهد الكويت للأبحاث العلمية
KUWAIT INSTITUTE FOR SCIENTIFIC RESEARCH

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Thank You