From Ecosystem Functions to Investable Systems

The AIRE Framework

Agroecology-to-Investment Readiness for Ecosystem Services

A flow-based framework linking natural capital, ecosystem services, farmer incentives, and climate-resilient agrifood investment

CONCEPTUAL WORKING PAPER

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Positioning Note

This paper introduces the AIRE Framework (***Agroecology-to-Investment Readiness for Ecosystem Services***) as an author-led conceptual framework linking natural capital, agroecological and circular production, ecosystem-service value, evidence and assurance, farmer incentives, and investment readiness.

AIRE builds on earlier FlowScape and Circular VAC-R systems-design work and incorporates lessons from research, field practice, and regional agrifood-systems assignments, including work under ADB TA-9916. It is presented as an independent analytical contribution and is not an official ADB, SAFSP, or GMS framework.

The framework is intended for conceptual development, methodological discussion, and empirical testing across project design, preliminary readiness diagnostics, ecosystem-service incentives, and climate-resilient agrifood investment preparation. It does not replace specialized ecosystem valuation, MRV, certification, financial appraisal, or safeguard methodologies, nor does it establish investment eligibility.

This manuscript is prepared as a working paper for academic and professional discussion, including dissemination through SSRN. Subsequent versions may refine the framework, diagnostic criteria, figures, and illustrative applications following empirical testing and peer feedback.

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Abstract

Agroecological, circular, climate-smart and nature-based practices are increasingly available across agrifood systems, yet successful local practices do not automatically become scalable or investable models. A persistent gap lies between ecological performance and the evidentiary, institutional, market and financial conditions needed to recognize, reward and finance ecosystem-service benefits. The **Agroecology-to-Investment Readiness for Ecosystem Services (AIRE) Framework** addresses this gap through a flow-based systems architecture linking natural capital, agroecological and circular production, ecosystem services, investment readiness and resilient agrifood systems.

Building on the **FlowScape Framework**, **Circular VAC-R** and lessons from ADB TA-9916, AIRE integrates seven system flows, five cross-cutting readiness conditions and three investment-readiness pathways. Its **Practice–Proof–Prioritization–Payment** mechanism connects ecological outcomes with credible evidence, strategic targeting, appropriate incentives and financing. A preliminary six-dimension readiness diagnostic, supported by an indicative 0–3 scoring scale, identifies technical, evidentiary, institutional and financial bottlenecks without implying overall investment eligibility. An illustrative low-emission rice application demonstrates how the framework can inform intervention design, evidence requirements, prioritization and financing choices.

AIRE is proposed as a conceptual and methodological bridge rather than a validated assessment standard, ecosystem valuation method or financing instrument. Its potential application to the GMS 2030 agrifood transformation agenda illustrates opportunities to connect CSA/NbS, digital MRV, natural-capital prioritization and investment preparation. Further field testing and methodological validation are required to establish its operational reliability and broader applicability.

Keywords: agroecology; natural capital; ecosystem services; investment readiness; MRV; nature finance; PES; systems thinking; circular agriculture; scaling

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List of Abbreviations

Abbreviation	Meaning	Abbreviation	Meaning
ADB	Asian Development Bank	NbS	Nature-based Solutions
AIRE	Agroecology-to-Investment Readiness for Ecosystem Services	PES	Payment for Ecosystem Services
CRAFS	Climate-Resilient AgriFood Systems	QA/QC	Quality Assurance / Quality Control
CSA	Climate-Smart Agriculture	SOC	Soil Organic Carbon
FSF	FlowScape Framework	SOM	Soil Organic Matter
GHG	Greenhouse Gas	TA-9916	ADB Technical Assistance 9916-REG
GMS	Greater Mekong Subregion	VAC-R	Vietnam' Garden-Pond-Livestock-Forest integrated farming system
MRV	Monitoring, Reporting and Verification	VNUA	Vietnam National University of Agriculture

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1. Introduction: why good practices do not automatically become investable systems

Agrifood transformation is often discussed as if the central constraint were a shortage of technical solutions. In practice, many of the required solutions already exist: diversified agroecological production, conservation agriculture, integrated crop–livestock systems, agroforestry, circular nutrient management, residue recycling, water-saving irrigation, low-emission rice, digital advisory services and nature-based solutions. The more difficult question is why promising practices remain confined to pilots, project sites or isolated value chains rather than becoming durable and investable systems. Previous regional experience with climate-smart agriculture scaling in Southeast Asia also shows that scaling depends on institutional learning, local adaptation, farmer engagement and enabling systems rather than the transfer of technical packages alone (Barbon et al., 2021).

Experience across the Greater Mekong Subregion (GMS) suggests that scaling stalls less because a practice is technically weak than because the surrounding delivery architecture is incomplete. Farmers and small and medium-sized enterprises may face fragmented extension support, limited access to credible data, high verification costs, weak market incentives, thin service-provider networks, uncertain institutional responsibilities and finance that is poorly aligned with transition risks. Water and soil evidence generated under TA-9916 similarly shows that climate-smart agriculture (CSA) and nature-based solutions (NbS) are constrained by gaps in governance, data and MRV, last-mile services, finance and regional coordination rather than by a complete absence of workable practices (Bui, 2025a; Bui, 2025b).

This creates a translation problem. Agroecological practices can generate soil health, water regulation, biodiversity, carbon, resilience and livelihood benefits, but these benefits do not automatically become recognized ecosystem-service value. Even when benefits are real, they may remain difficult to measure, costly to verify, poorly connected to beneficiaries or markets, and therefore invisible to investors and public finance. The cost of proving sustainability can itself exclude smallholders. A system may therefore perform well ecologically while remaining weak institutionally or financially.

The AIRE Framework – **Agroecology-to-Investment Readiness for Ecosystem Services** – was developed to address this missing middle. It asks how the ecological and productive performance of agroecological systems can be made visible, measurable, rewardable and investable without reducing agroecology to a narrow carbon-accounting or financialization exercise. AIRE treats investment readiness as an emergent property of a well-connected agrifood system: one in which natural-capital functions, farm practices, ecosystem services, evidence systems, incentives, institutions and finance are sufficiently aligned.

> *The central proposition of AIRE is that good practices become investable only when ecosystem-service value, credible evidence, incentives and institutions are connected as part of the same system.*

The framework is organized around three questions:

- How do agroecological and circular production systems generate ecosystem-service value?
- What makes that value sufficiently visible, measurable and rewardable for farmers and other service providers?
- What readiness conditions allow successful local systems to become fundable, bankable or scalable through public, blended or private investment?

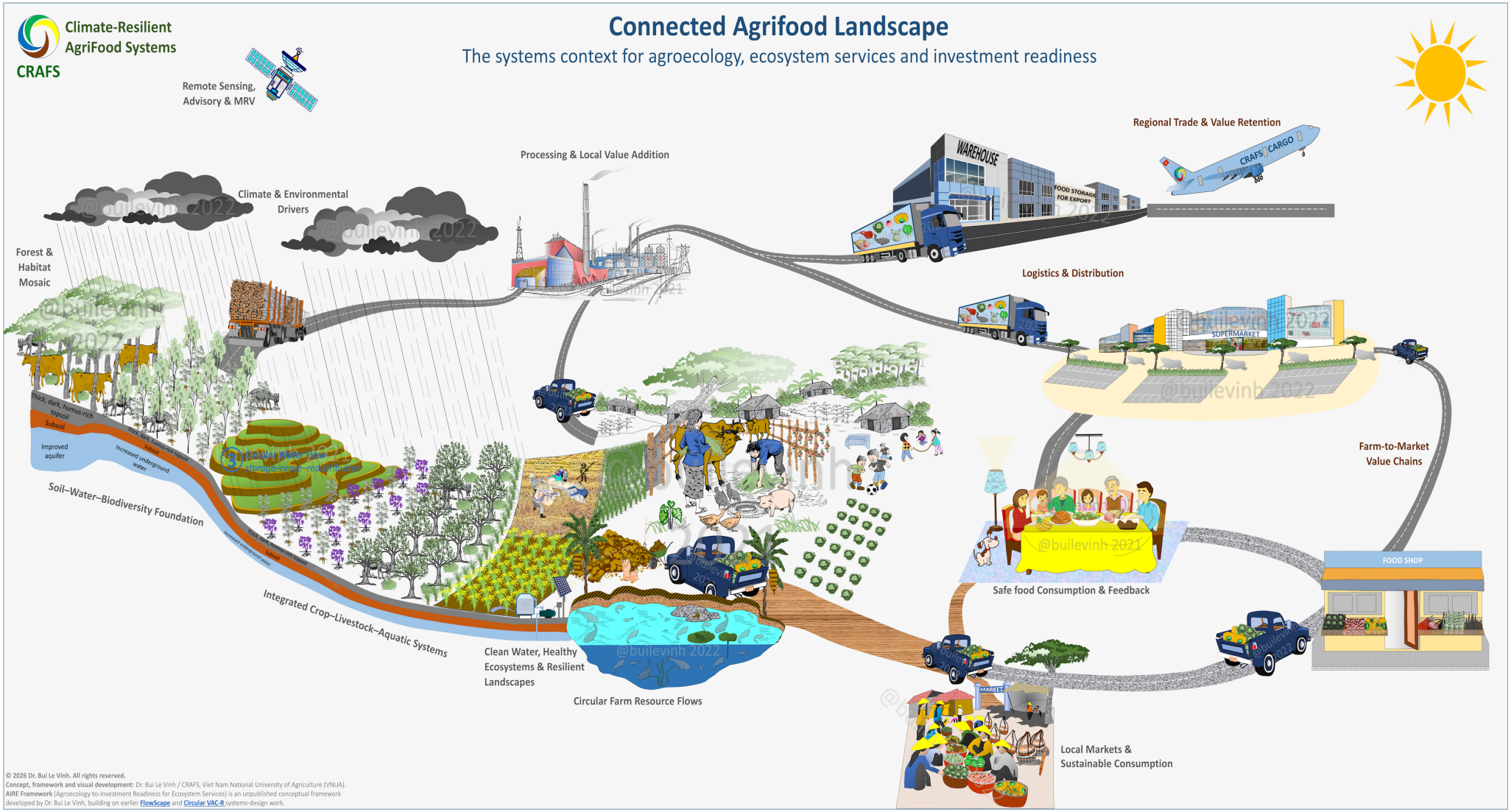


Figure 1. Connected agrifood landscape as the systems context for AIRE: farms, natural resources, value chains, markets and information systems before the analytical flows and readiness pathways are overlaid.

2. From a connected agrifood landscape to an analytical investment-readiness framework

2.1 The connected landscape as the starting point

AIRE starts from a simple observation: agrifood systems are already connected before any framework is applied. Farms sit within landscapes shaped by soils, water, biodiversity and climate. They exchange biomass, nutrients, energy, information and value with households, processors, markets and institutions. Production links to storage, logistics, processing, retail and consumption; information moves back through advisory systems, traceability and consumer demand. The analytical challenge is not to create these connections on paper, but to reveal which connections are functioning, which are broken, and which determine whether environmental performance can translate into wider value.

For this reason, the first visual in AIRE is deliberately a connected agrifood landscape without the full analytical overlay. **Figure 1** illustrates the ecological foundations, integrated production systems, farm-to-market value chains, processing, logistics, local markets, consumption, and digital advisory elements that constitute this landscape. While these interconnected components provide the systems context, the figure remains descriptive rather than diagnostic. It reveals the complexity of agrifood interactions without yet identifying which relationships are critical for ecosystem-service generation, value creation, or investment readiness.

2.2 Conceptual lineage: FlowScape, Circular VAC-R and the TA-9916 scaling agenda

AIRE builds on a sequence of systems-design work rather than starting as an isolated framework. The FlowScape Framework (FSF) reframes fragmented agricultural interventions around flows and alignment. Its central argument is that systems underperform not necessarily because individual components are absent, but because flows of water, biomass, nutrients, energy, information and value are poorly connected across scales. Scaling therefore depends on alignment rather than simple replication (Bui, 2026a).

Circular VAC-R applies this flow logic at farm level. It uses flow diagnosis to identify broken loops and to redesign integrated garden–pond–livestock and related production systems around circular resource use, soil and water functions, biomass recycling, energy, livelihoods and local value. In this sense, Circular VAC-R demonstrates how flow-based systems thinking can move from a conceptual architecture to an operational farm-design approach (Bui et al., 2026).

The TA-9916 work adds the next step: why technically good packages still fail to achieve system-wide scale. The program's knowledge products, policy work and closing communications increasingly converged on the need to connect CSA/NbS practices with digital MRV and traceability, natural-capital prioritization, market signals and finance (Bui, 2025c). The blog and video storyline developed for the close-out phase summarized this scaling logic through four levers–**Practice, Proof, Prioritization and Payment**–and emphasized that scaling becomes a system outcome only when these functions are connected (Bui, 2026b).

AIRE combines these three strands. FSF explains how systems are structured through flows; Circular VAC-R demonstrates how flows can be diagnosed and redesigned at farm level; the TA-9916 scaling work explains why evidence, incentives, market access, governance and finance determine whether those redesigned systems can move beyond pilots. AIRE therefore extends flow-based systems design into the domain of ecosystem-service value and investment readiness.

2.3 What AIRE adds

AIRE does not propose another package of agricultural practices or replace established methods of ecosystem-service assessment, natural-capital accounting, MRV, PES design, or investment appraisal. Its contribution is to connect these

approaches within a flow-based architecture that traces how agroecological performance can progress towards investment readiness while retaining ecological integrity and farmer livelihoods.

The framework integrates five domains that are often addressed separately: (i) agroecology and circular production; (ii) natural capital and ecosystem services; (iii) evidence, digital tools and MRV; (iv) incentives, markets and environmental finance; and (v) investment preparation and scaling. Its distinguishing feature is the explicit treatment of evidence, prioritization, incentives and institutional readiness as interconnected conditions rather than isolated technical or financing requirements.

AIRE is therefore best understood as a translation and diagnostic architecture. It helps identify where the transition from ecological functions to credible value signals and appropriate financing pathways is constrained, without assuming that all ecosystem services are monetizable or that investment is necessarily the preferred outcome.

3. The AIRE Framework architecture

3.1 The five-stage backbone

The full AIRE Framework is organized around a five-stage backbone:

Natural Capital – the soil, water, biodiversity, carbon and landscape functions that form the productive and ecological asset base;

Agroecological Production – diversified, circular and resource-efficient production systems that mobilize and regenerate that natural-capital base;

Ecosystem Services – the soil, water, biodiversity, carbon and livelihood/resilience functions generated or strengthened by those production systems;

Investment Readiness – the condition in which services, evidence, actors, incentives and institutions are sufficiently organized to support funding, finance or scaling; and

Resilient Agrifood Systems – the broader system outcome in which ecological integrity, livelihood resilience, market functionality and investment capacity reinforce one another.

This sequence is not intended as a rigid linear pipeline. Feedbacks occur in both directions: market demand and finance influence production decisions; evidence informs management; institutions shape ecosystem-service delivery; and ecological degradation can undermine value chains. **Figure 2** integrates the five-stage backbone with the seven system flows, five cross-cutting readiness conditions, and three investment-readiness pathways, illustrating how ecological functions, evidence, incentives, institutions, and finance interact to enable investment readiness and resilient agrifood systems.

3.2 Seven system flows: how value is generated

Within the landscape, AIRE identifies seven interrelated flows. The flows are not separate interventions; they are analytical lenses for understanding how a functioning agroecological system creates ecological and livelihood value.

1. Biodiversity and Ecological Functions

Forest patches, habitats, pollinators, biological control and landscape diversity support ecological regulation, production stability and resilience. Biodiversity is treated as a functional asset rather than as a background conservation variable.

2. Biomass Resources and Bioeconomy

Crops, residues, by-products and other biological materials move through production, processing, reuse and local value addition. The quality of these flows determines whether biomass becomes waste, externality or productive input.

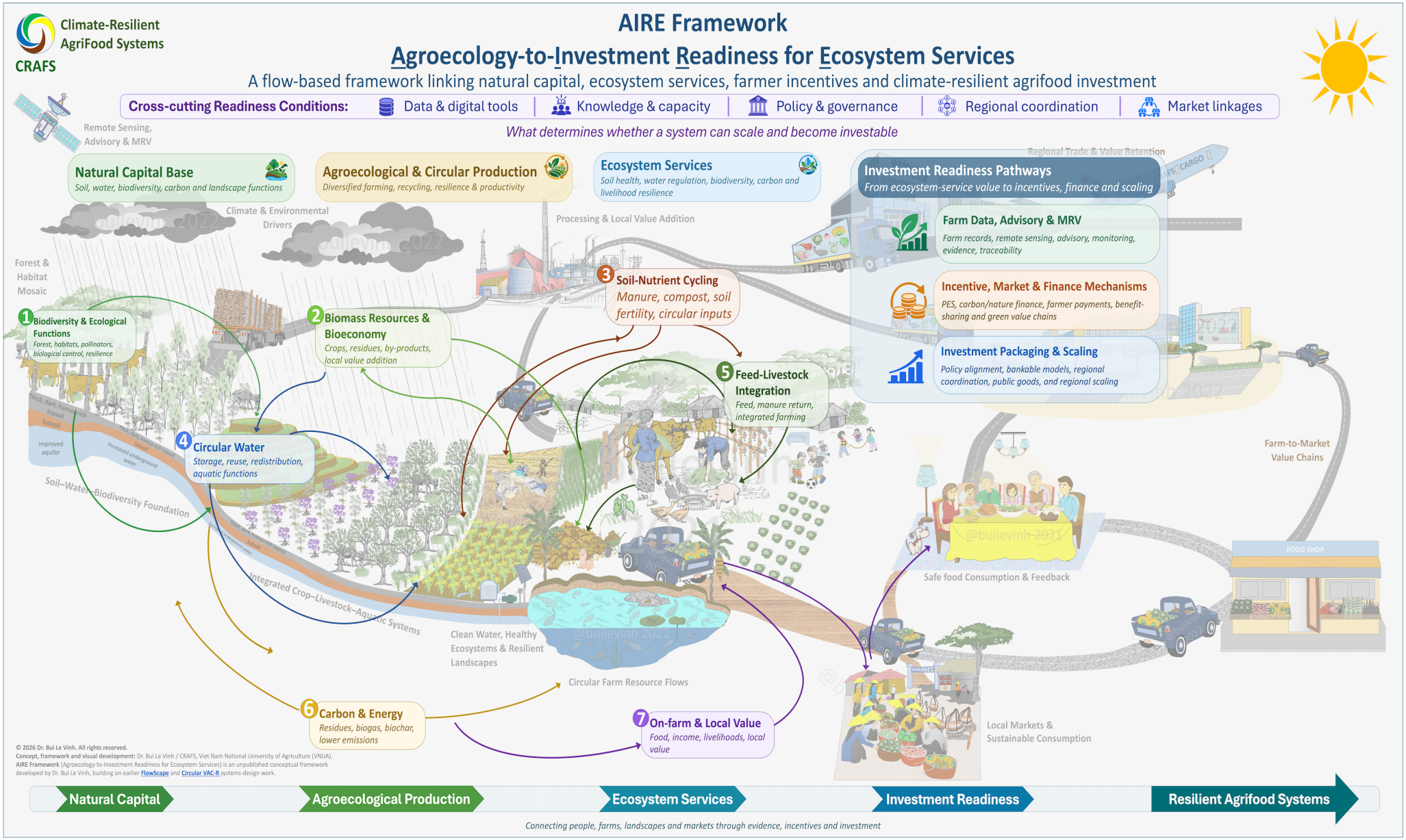


Figure 2. AIRE Framework–Agroecology-to-Investment Readiness for Ecosystem Services: a flow-based framework linking natural capital, agroecological and circular production, ecosystem-service value, cross-cutting readiness conditions and investment pathways.

3. Soil–Nutrient Cycling

Manure, compost, crop residues and biological inputs return nutrients and organic matter to soils, supporting fertility, soil structure, carbon and long-term productivity. This flow connects circularity directly to natural-capital maintenance.

4. Circular Water

Water storage, reuse, redistribution, soil-water retention and aquatic functions connect production with wider hydrological resilience. Water is treated not only as an input but also as a landscape function and ecosystem service.

5. Feed–Livestock Integration

Feed production, livestock, manure return and integrated farm design link crop and animal systems, creating opportunities for nutrient recirculation, diversified income and reduced waste.

6. Carbon and Energy

Residues, biogas, biochar, renewable energy and reduced-emission practices connect circular resource management with mitigation, energy efficiency and potentially measurable carbon value.

7. On-farm and Local Value

Food, income, livelihoods, local enterprise and retained value capture the socio-economic return from improved ecological and production-system performance. This flow is essential because ecosystem-service generation that does not improve or protect livelihood value is unlikely to sustain adoption.

The seven flows provide the ecological and socio-economic foundations for ecosystem-service generation. In operational application, each flow can be examined through four questions: What system function is being strengthened? What observable outcome is generated? What evidence is available? And what form of value could be recognized by farmers, beneficiaries, markets, or public institutions? **Table 1** illustrates these relationships through selected system flows, associated evidence, and potential value signals, demonstrating how flow-based diagnosis can inform ecosystem-service assessment and subsequent investment-readiness decisions. These examples are illustrative rather than standardized valuation metrics.

Table 1. Illustrative flow-to-value translation in AIRE

Flow	System function	Illustrative evidence	Potential value signal
Soil–nutrient cycling	Nutrient recycling, soil fertility, SOC	SOC/SOM, nutrient balance, fertilizer reduction	Soil-health outcome, input savings, carbon benefit
Circular water	Storage, retention, reuse, water regulation	Water use, soil moisture, irrigation efficiency, water quality	Resilience, avoided loss, water-service value
Biodiversity & ecological functions	Pollination, biological regulation, habitat function	Habitat indicators, diversity, pest pressure	Risk reduction, biodiversity/nature value
Carbon & energy	Emission reduction, carbon retention, energy substitution	GHG estimates, biochar/biogas records, energy use	Carbon value, energy savings, climate-finance eligibility
On-farm & local value	Income, food, livelihood resilience, local value retention	Income mix, avoided costs, local sales, enterprise performance	Commercial viability, benefit sharing, adoption incentive

3.3 Five cross-cutting readiness conditions

The seven flows explain what the system does. The cross-cutting readiness conditions explain whether the value generated by that system can be recognized, trusted and scaled. AIRE therefore distinguishes five conditions that operate across the full pathway.

Data and digital tools

Farm records, remote sensing, sensors, traceability, digital advisory and MRV help convert activities and outcomes into usable evidence. Their value lies not in digitization alone but in reducing information gaps and verification costs.

Knowledge and capacity

Farmers, cooperatives, extension agents, service providers and institutions need the capacity to implement practices, interpret evidence, maintain quality and adapt solutions to local conditions.

Policy and governance

Rules, mandates, safeguards, standards, land and resource rights, verification arrangements and public budgets shape whether ecosystem-service value can be recognized and whether incentives can be delivered credibly. Evidence from Viet Nam similarly shows that agricultural climate-policy implementation is shaped by institutional coordination, enabling-environment conditions and governance barriers, not only by the availability of technical options (Giles et al., 2021).

Regional coordination

Shared indicators, interoperable protocols, transboundary information and learning platforms become important where risks, value chains, watersheds and markets cross administrative boundaries.

Market linkages

Buyers, processors, cooperatives, service providers and green-value-chain mechanisms create demand signals and channels through which environmental performance can translate into retained value or investment.

These conditions should not be interpreted as a checklist to be completed after technical design. They are part of design itself. A technically effective practice may remain non-investable if evidence is not credible, if providers and beneficiaries are not identifiable, if institutions cannot verify or transfer incentives, or if markets do not recognize the value created.

3.4 Three investment-readiness pathways

Pathway 1: Farm Data, Advisory and MRV

This pathway converts practice into evidence. Farm records, remote sensing, advisory services, activity tracking, monitoring and verification make farm-level action visible and improve both management and credibility. The key design principle is affordable assurance: evidence must be sufficiently robust for the intended decision without imposing transaction costs that exclude smallholders.

Pathway 2: Incentive, Market and Finance Mechanisms

This pathway converts credible value into rewards. Potential mechanisms include PES, carbon and nature finance, price premiums, results-based payments, cost savings, benefit-sharing arrangements, green procurement and value-chain incentives. The appropriate mechanism depends on who provides the service, who benefits, how outcomes are measured and which institution can manage the transaction.

Pathway 3: Investment Packaging and Scaling

This pathway converts a functioning and rewardable model into a fundable proposition. It brings together policy alignment, risk allocation, institutional responsibilities, technical assistance, public goods, concessional finance, blended finance and private investment. The objective is not to force all ecosystem services into commercial finance, but to identify the appropriate mix of public, market and financial instruments for each context.

4. The AIRE transition mechanism: Practice, Proof, Prioritization and Payment

AIRE uses a four-part mechanism—Practice, Proof, Prioritization and Payment—to explain the transition from promising interventions to investment-ready systems. This logic emerged from TA-9916 work on agrifood systems transformation and is retained because it provides a concise operational bridge between the ecological and financial sides of the framework.

Practice

Agroecological, circular, climate-smart and nature-based solutions must work under real farm and landscape conditions. Practice is the point at which natural capital is managed and ecosystem services are generated. It includes not only technologies but also service delivery, farmer organization and context-specific management.

Proof

Outcomes must be made visible through an assurance layer that combines farm records, monitoring, digital tools, MRV, traceability and QA/QC. Proof is not synonymous with maximum measurement. The appropriate level of assurance depends on the decision and the financing mechanism. For smallholders, the design challenge is to increase credibility while keeping verification affordable.

Prioritization

Evidence becomes more valuable when it informs where investment should go. Natural-capital conditions, land and water risks, ecosystem-service potential, vulnerability and market opportunity can be used to target interventions rather than distribute resources uniformly. Prioritization links environmental performance to investment planning.

Payment

Adoption becomes durable when value is returned to the actors who create or maintain it. Payment is used broadly to include market incentives, farmer payments, cost savings, performance-based grants, carbon or nature finance, concessional support, risk sharing and other benefit-sharing mechanisms.

> *Practice creates the outcome; Proof establishes credibility; Prioritization directs resources; Payment makes sustained adoption economically viable.*

4.1 The assurance layer as the bridge between ecosystem services and investment

One of the most important additions from the TA-9916 experience is the explicit recognition of an assurance layer. Agrifood transformation requires more than better production; it requires evidence systems that create trust between farmers, buyers, regulators, funders and investors. This layer includes data standards, field records, MRV, traceability, QA/QC, registries, verification procedures and, where useful, remote sensing and digital analytics.

The assurance layer performs two functions. First, it improves management by turning field conditions into actionable advice. Second, it reduces information asymmetry by providing credible evidence of environmental and production outcomes. These functions are related but not identical. A farmer may need a simple advisory indicator, while a results-based finance mechanism may require a stronger verification protocol. AIRE therefore encourages fit-for-purpose assurance rather than a single universal MRV standard.

This distinction is particularly important for inclusion. If the cost of proof is too high, smallholders and local enterprises may be excluded from premium markets, carbon programs or nature finance even when their practices generate real benefits. Investment readiness therefore depends not only on measurability but also on the affordability and institutional accessibility of measurement.

4.2 From ecosystem-service value to an investment package

AIRE treats ecosystem-service value as a sequence of relationships rather than as a price tag. Before a service can support an incentive or financing mechanism, the following questions need to be answered:

- Service: What ecosystem function or service is being generated or protected?
- Provider: Who creates, maintains or improves that service?
- Beneficiary: Who receives the value or avoided cost?
- Evidence / assurance: Can the outcome be measured or verified credibly and affordably?
- Value signal: How is the benefit recognized—through avoided cost, productivity, resilience, market demand, carbon/nature value or public benefit?
- Incentive mechanism: What mechanism can return part of that value to the provider?
- Institutional arrangement: Who sets the rules, verifies performance, transfers benefits and manages safeguards?
- Investment package: What combination of grants, public investment, concessional finance, blended finance, lending, private capital or results-based finance is appropriate?

This sequence extends beyond PES and does not presume that every ecosystem service can generate a marketable revenue stream. The appropriate financing pathway depends on who benefits, whether outcomes can be credibly demonstrated, the existence of a willing payer or viable revenue source, institutional capacity, and the distribution of risks and benefits.

Public investment or grants may be appropriate where benefits are predominantly collective and commercial returns are limited. PES or results-based payments require identifiable beneficiaries or funding sources, credible performance evidence, and workable payment arrangements. Blended finance may help address specific risks or financing gaps where a plausible long-term financing model exists, while commercial investment requires sufficiently predictable revenues, manageable risks, and financial viability. These pathways may be combined, but environmental value alone does not establish bankability.

5. Operationalizing AIRE as a readiness diagnostic

AIRE can be operationalized as a preliminary, evidence-informed readiness diagnostic to identify strengths, bottlenecks, and missing connections between agroecological performance and investment preparation. **Table 2** presents six complementary readiness dimensions, each assessed on an indicative four-level scale (0–3). Scores represent the maturity of individual dimensions rather than overall investment eligibility. The assessment should document supporting evidence, information gaps, and priority actions for each dimension. It is intended to guide further technical preparation and stakeholder dialogue, not to substitute for financial due diligence, safeguards assessment, or independent verification.

The five cross-cutting readiness conditions described in Section 3.3 represent enabling factors that operate across the AIRE system, whereas the six diagnostic dimensions in **Table 2** provide an assessment structure for examining intervention-specific readiness. The two sets are complementary rather than directly equivalent: each diagnostic dimension may depend on multiple enabling conditions, and each condition may influence several dimensions.

Table 2. AIRE readiness diagnostic matrix: dimensions, guiding questions and indicative scoring

Readiness dimension	Core question	Scoring reference
Technical and system functionality	Does the production system function technically, and are key resource flows connected rather than dependent on isolated practices?	Common 0–3 scale

Readiness dimension	Core question	Scoring reference
Ecosystem-service materiality	Are meaningful soil, water, biodiversity, carbon or resilience services generated at a scale relevant to farmers or beneficiaries?	Common 0–3 scale
Measurability and assurance	Can outcomes be monitored credibly, at an appropriate cost and with a clear data/verification workflow?	Common 0–3 scale
Rewardability and market linkage	Is there a realistic pathway for value to return to service providers through markets, payments, savings or finance?	Common 0–3 scale
Institutional readiness	Are responsibilities, safeguards, standards and benefit-sharing arrangements sufficiently clear?	Common 0–3 scale
Investment and scaling readiness	Can the model be packaged with an appropriate financing structure, risk allocation, technical assistance and scaling pathway?	Common 0–3 scale

Common readiness scoring scale

Score	Interpretation
0 – Not established	The relevant function or arrangement is absent, or available evidence demonstrates that it is not functioning.
1 – Emerging	Initial practices or arrangements exist, but evidence and implementation capacity remain limited.
2 – Developing	Core elements are functioning and supported by preliminary evidence, although material gaps remain.
3 – Established	Core elements are operational, supported by credible evidence, and sufficiently developed to inform the next stage of preparation.

Scoring and interpretation. Each dimension should be assessed separately using the common 0–3 scale, supported by documentation, field observations, stakeholder consultations, or other relevant evidence. Where information is insufficient, the assessor should record the dimension as not assessed (NA) and identify the evidence gap rather than assigning a zero score. Results should be presented as a six-dimension readiness profile, highlighting critical bottlenecks and priority actions. No composite score, weighting system, or investment-readiness threshold is proposed at this stage. The scoring criteria and their inter-assessor consistency require validation through practical applications.

6. Scaling: from replication to alignment

Flow-based systems thinking reframes scaling beyond replicating techniques across locations. Replication may increase adoption without reproducing the conditions for success. FSF therefore defines scaling as alignment: connecting functions, actors and flows across levels to sustain performance in wider systems (Bui, 2026a). AIRE extends this principle to investment readiness. From an AIRE perspective, scaling requires alignment across at least six domains: ecological flows, delivery services, evidence systems, incentives, institutions and finance. A practice that works at one farm may fail at provincial scale if service providers are absent, data are incompatible, verification is too costly, markets do not recognize the outcome, or finance does not match the transition period.

The TA-9916 scaling storyline provides a practical three-step pathway: build the rails, prove at scale, then regionalize (Bui, 2026b). First, systems need interoperable data standards, workable MRV/traceability, service-delivery models and institutional rules–the rails into which individual innovations can plug. Second, bundled solutions need to be tested at meaningful scale with affordable assurance and clear incentives. Third, where regional value chains or transboundary environmental risks justify it, countries can align standards, evidence and learning so that market access and investment do not reset at every border.

6.1 Regional public goods

AIRE also helps distinguish what should be financed as a regional or public good rather than expected to emerge from individual farm investments. This orientation is consistent with the GMS 2030 agrifood transformation agenda, which emphasizes regional cooperation, shared platforms and investment pathways for sustainable agrifood systems (ADB, 2024). Examples include:

- common indicator definitions and minimum MRV protocols;
- shared data dictionaries, interoperability standards and verification guidance;
- open or shared climate, soil, water and natural-capital information;
- readiness-assessment tools and investment templates;
- regional knowledge platforms, case libraries and training materials;
- cross-border early-warning, watershed and haze-management coordination; and
- learning mechanisms that allow countries and provinces to adapt rather than mechanically replicate models.

7. Illustrative applications of AIRE

7.1 Circular VAC-R and integrated farming systems

Circular VAC-R is the most direct operational precursor to AIRE. It shows how resource flows can be diagnosed and redesigned within integrated farming systems so that waste becomes input, soil and water functions improve, and livelihood value is retained locally. Through AIRE, these farm-level flows can be taken one step further by asking which ecosystem services are generated, what evidence can demonstrate them, whether incentives are available and what type of investment could support wider replication.

7.2 Low-emission rice and climate-smart water management

Low-emission rice illustrates how a well-established practice can sit at different levels of readiness. Alternate Wetting and Drying (AWD), improved nutrient management and related practices can reduce water use and emissions, but investment readiness depends on credible activity data, MRV, farmer organization, aggregation, risk management and a mechanism that values the verified outcome. AIRE helps distinguish the technical package from the assurance and financing architecture around it.

7.3 Soil, water and landscape restoration

The TA-9916 regional water-and-soil work demonstrates why natural capital must remain at the front of the AIRE pathway. Soil degradation, water scarcity, residue burning, weak carbon return to soils and fragmented watershed governance reduce the productive asset base on which agrifood systems depend. Investment in soil restoration, agroforestry, residue recycling, water storage, efficient irrigation and landscape restoration can therefore be assessed not only as technical expenditure but as investment in natural-capital functions that generate multiple services. The AIRE lens then asks how those services can be evidenced, prioritized and linked to public or private finance (Bui, 2025a; Bui, 2025b).

7.4 Digital advisory, MRV and traceability

Digital agriculture becomes most valuable in AIRE when it reduces the distance between action and credible evidence. Farm records, remote sensing, advisory systems, monitoring and traceability can support both better decisions and lower-cost assurance. The investment proposition is therefore not simply to finance more apps or sensors, but to finance a delivery and evidence infrastructure that makes environmental performance easier to manage and verify.

7.5 Provincial transformation as a practical unit of scaling

The TA-9916 blog and video use a province-level storyline to show how production, processing, market linkage, cooperative organization, digital standards and finance can be connected. A province can be a useful meso-scale for AIRE because it is large enough to include landscapes, value chains, institutions and service markets, but sufficiently grounded for implementation. The exact scale will vary by ecosystem service: watersheds, value-chain corridors or administrative regions may be more appropriate in other cases.

7.6 Illustrative worked example: Low-emission rice and climate-smart water management

Low-emission rice production provides a practical illustration of how AIRE can connect agroecological practices, ecosystem-service outcomes, evidence systems, and investment preparation. The example is hypothetical and is intended to demonstrate the framework's analytical sequence rather than report validated field results.

Practice – Establishing the ecological and production functions. A rice-growing landscape introduces improved water management, including alternate wetting and drying (AWD), alongside appropriate residue management and soil-health practices. These interventions may reduce methane emissions, improve water-use efficiency, and strengthen production resilience, depending on local conditions. AIRE first examines how water, soil, biomass, carbon, knowledge, and economic flows interact, rather than assessing each practice in isolation.

Proof – Establishing credible and affordable evidence. The next step is to identify the evidence required to demonstrate relevant outcomes. Potential indicators include irrigation practices, water-use patterns, crop yields, residue management, and estimated greenhouse gas emissions. Farm records, field monitoring, remote sensing, and appropriate emission-estimation methodologies may provide complementary evidence. AIRE considers the reliability, affordability, and institutional responsibilities of monitoring and verification. Claims concerning verified emission reductions or carbon credits would require compliance with applicable methodologies and standards.

Prioritization – Identifying where intervention creates the greatest value. AIRE then examines which production areas or farmer groups offer the strongest combination of ecological benefits, implementation feasibility, farmer participation, and institutional support. Prioritization should account for water availability, irrigation infrastructure, production risks, aggregation capacity, and the distribution of potential benefits. Areas with substantial public environmental benefits but limited commercial returns may warrant different support mechanisms from those with established market opportunities.

Payment and investment – Matching benefits with appropriate incentives. Potential financing pathways include public investment in irrigation and monitoring infrastructure, technical assistance for farmer organizations, sustainability-linked market arrangements, results-based payments, or blended finance. Carbon finance may be considered where additionality, monitoring, verification, ownership, and other eligibility requirements can be satisfied. AIRE does not presume that every ecological benefit can generate a commercial revenue stream. Instead, it identifies the most appropriate combination of incentives, institutional arrangements, and financing instruments.

Readiness assessment and next steps. The six dimensions in **Table 2** can be applied to identify remaining preparation gaps. A technically functioning rice system may demonstrate strong ecological potential but still face limitations in monitoring capacity, benefit-sharing arrangements, institutional coordination, or financing structures. The resulting readiness profile would guide targeted actions before investment preparation proceeds. A subsequent pilot could test the practicality of this assessment, the costs of evidence generation, and the consistency of results across different assessors.

This example demonstrates AIRE's central proposition: successful agroecological practices do not automatically constitute investment-ready interventions. Their progression towards scalable investment depends on the alignment of ecological performance, credible evidence, incentives, institutions, and appropriate financing pathways.

8. Applying AIRE to GMS 2030: strategic alignment and investment readiness

8.1 Purpose and scope of the GMS application

This section illustrates how the independently developed AIRE Framework could be used as an analytical bridge between the GMS 2030 Kunming Strategic Framework for Transformation of Agrifood Systems and the implementation-oriented priorities identified in Knowledge Product 13 (KP13) under ADB TA-9916. It is a proposed application, not an endorsed GMS, ADB or SAFSP methodology, and does not imply that the illustrative interventions or financing arrangements have been approved.

The Kunming Strategic Framework organizes transformation around three strategic focus areas: (A) green and climate-resilient agriculture, (B) safe and quality agrifood systems, and (C) food diversification and value-chain optimization. Its implementation pillars address policy and governance, knowledge-based solutions, market and behavior transformation, and infrastructure and investments. AIRE can contribute most directly to area A, while its assurance, market-linkage and investment functions can support selected aspects of areas B and C (ADB, 2024).

KP13 translates the regional transformation agenda into four mutually reinforcing rails: priority CSA/NbS packages; digital MRV and traceability; natural capital accounting and prioritization; and finance and MSME inclusion. AIRE complements, rather than duplicates, these rails by diagnosing whether ecological outcomes, evidence, institutions, incentives and financing arrangements are sufficiently aligned for a specific intervention to progress beyond a pilot (Bui, 2025c).

8.2 Strategic crosswalk: Kunming priorities, KP13 rails and AIRE functions

Green and climate-resilient agriculture → CSA/NbS packages → Practice. The seven AIRE system flows can help identify which soil, water, biodiversity, biomass, carbon and livelihood functions an intervention strengthens. Candidate interventions include low-emission rice, agroforestry, soil restoration and climate-smart water management. The relevant ecological performance and local context must be demonstrated rather than assumed.

Safe and quality agrifood systems → digital MRV and traceability → Proof. Farm records, monitoring and fit-for-purpose assurance can support credible claims and improve the quality of information flowing through value chains. AIRE is not an SPS certification system and cannot substitute for official food-safety or traceability requirements.

Regional planning and investment prioritization → natural capital accounting → Prioritization. AIRE can help interpret natural-capital and ecosystem-service evidence for selecting landscapes, production systems and investment packages. It does not itself produce national natural capital accounts, monetary ecosystem-service valuations or spatial suitability maps.

Inclusive markets and infrastructure investment → finance and MSME inclusion → Payment and investment packaging. AIRE helps distinguish public-good financing, results-based grants, PES, commercial value-chain incentives, concessional or blended finance, and private investment according to beneficiaries, verifiability, risk and institutional capacity. Environmental benefits alone do not establish commercial bankability.

The alignment is functional, not one-to-one: the Kunming focus areas set policy direction; KP13 proposes regional implementation rails; and AIRE offers a diagnostic method for identifying the missing links between practice, proof, prioritization and reward. The three documents operate at different levels and should not be presented as interchangeable frameworks.

8.3 An illustrative GMS application sequence

Step 1 — Select a relevant intervention and geography. Begin with a GMS country or province, watershed, or cross-border value-chain corridor where an identified CSA/NbS problem and credible implementing partners exist. Establish the natural-capital baseline, farmer livelihood objectives, and any cross-border externalities.

Step 2 — Diagnose the flows and services. Use AIRE's seven flows to specify the production-system changes and the ecosystem services plausibly generated. Separate observed outcomes from expected benefits, and identify who provides and who benefits from each service.

Step 3 — Design affordable proof. Select proportionate farm records, monitoring indicators, traceability and MRV arrangements based on the intended use of the evidence. For example, management learning, results-based public funding and carbon-credit issuance require different assurance standards and transaction costs.

Step 4 — Prioritize through regional and national planning. Consider ecological materiality, vulnerability, farmer inclusion, public-good value, market opportunities and institutional readiness. Shared definitions and compatible data systems may qualify as regional public goods where cross-border benefits justify joint action.

Step 5 — Match the incentive and financing pathway. Identify beneficiaries, potential payers, benefit-sharing arrangements, risks and institutional capacity. Match public funding, PES or results-based payments, blended finance, or commercial investment to the nature of benefits, revenue potential and verification requirements. Where no credible payer or revenue stream exists, prioritize public or concessional support rather than assuming commercial bankability.

Step 6 — Test, learn and scale by alignment. Pilot the diagnostic with partners, assess its six readiness dimensions, document the bottlenecks, and only then consider replication or regionalization through interoperable evidence, knowledge exchange and coordinated investment planning.

8.4 Illustrative entry points for regional public goods and investment

Low-emission rice and water management. AIRE could connect farmer practice and irrigation outcomes to affordable activity data, methane and water indicators, farmer aggregation and appropriately verified incentives. Potential regional added value lies in comparable indicators, technical learning and market-facing evidence; carbon-finance eligibility would require separate methodology and additionality assessment.

Agroforestry, soil restoration and watershed resilience. AIRE could assess soil, water, biodiversity and livelihood co-benefits across landscapes and identify which functions warrant public watershed investment, PES-type arrangements or blended support. Transboundary cooperation is relevant only where shared watersheds, ecosystems or downstream benefits justify it.

Digital evidence and investment-readiness infrastructure. Regional guidance on minimum indicators, data dictionaries, interoperability, quality assurance, capacity building and readiness templates could reduce duplication and transaction costs across GMS projects. These are candidate regional public goods, not agreed programme outputs.

8.5 Implications for WGA–WGE cooperation and regional investment readiness

Session 4 of the 23rd GMS Working Group on Agriculture (WGA) Annual Meeting brought together perspectives on agroecology, ecosystem services, carbon markets, digital climate solutions, and national policy approaches to natural capital and Payments for Ecosystem Services (PES). These discussions illustrated the importance of connecting agricultural and environmental policy objectives with practical mechanisms for measuring ecosystem-service outcomes, strengthening farmer incentives, and mobilizing sustainable agrifood investment.

Within this context, AIRE offers a potential analytical approach for examining the transition from ecological performance to investment readiness. Its Practice–Proof–Prioritization–Payment mechanism can help identify gaps in evidence, institutional coordination, benefit-sharing arrangements, and financing pathways. Future WGA–WGE cooperation could explore whether such an approach supports the preparation of investment-ready CSA/NbS interventions and the development of regional public goods, particularly through shared indicators, interoperable evidence systems, and knowledge exchange. These applications remain illustrative and would require further testing and institutional validation; they do not represent formally endorsed outcomes of the meeting.

8.6 Boundaries and next steps

This GMS application remains illustrative until tested against specific country institutions, available baselines, financing instruments and safeguards. A next phase could validate the diagnostic with contrasting GMS cases, assess the costs of proof for smallholders, compare public versus commercial financing pathways, and evaluate whether shared indicators or tools deliver genuine regional added value. No readiness score, investment return, carbon revenue or programme endorsement is asserted here.

9. Discussion: contribution, boundaries and future development

9.1 What AIRE contributes

AIRE's conceptual contribution lies in connecting ecological system performance with the conditions required for credible investment preparation. Rather than treating ecosystem-service generation, measurement, incentives and finance as separate processes, it brings them into a common systems architecture. The framework retains physical and ecological flows as its starting point and positions resilient agrifood systems, rather than financial mobilization alone, as the intended outcome.

Methodologically, AIRE introduces an integrated diagnostic logic combining the five-stage backbone, seven system flows, cross-cutting readiness conditions, three investment-readiness pathways and the Practice–Proof–Prioritization–Payment mechanism. The six-dimension readiness assessment helps identify bottlenecks in technical functionality, ecosystem-service materiality, assurance, market incentives, institutional arrangements and investment preparation. These components are proposed as complementary analytical tools rather than validated assessment standards.

In practical terms, AIRE can support dialogue among farmers, technical specialists, policymakers and financing institutions by clarifying what evidence, incentives and institutional arrangements are needed before interventions can advance towards scaling. It also distinguishes commercially viable opportunities from ecosystem services requiring public investment, collective action or other non-market mechanisms. Its value therefore lies in improving the coherence of investment preparation while keeping ecological performance, inclusion and local benefits central to decision-making.

9.2 What AIRE does not replace

AIRE should not be overextended. It is an analytical and design framework, not a substitute for specialized methodologies. In particular, AIRE is not:

- an ecosystem-service valuation method;
- a carbon or biodiversity accounting standard;
- an MRV protocol or certification scheme;
- a financial appraisal or credit-scoring model;
- a safeguard system;
- a fixed agroecology technology package; or
- a guarantee that ecosystem-service value will be monetizable.

Instead, it helps identify where these specialized tools are required and how they should connect. This boundary is important because many ecosystem services have public-good characteristics and should not be forced into market mechanisms. In some contexts, public investment, regulation or collective action will be more appropriate than monetization.

9.3 Priorities for further development

The next stage of AIRE development should focus on empirical testing and methodological refinement across contrasting agrifood and landscape contexts. Priorities include validating the seven-flow classification and five readiness conditions; testing the six-dimension diagnostic and its indicative 0–3 scoring scale for consistency across assessors; assessing the feasibility and costs of evidence generation; and examining how the framework informs choices among public investment, PES, carbon/nature finance, green value chains and blended finance. The illustrative low-emission rice application provides a starting point for designing a field-based validation protocol, rather than evidence of demonstrated effectiveness. Case-based learning and refinement should precede any attempt to standardize AIRE as an operational assessment tool.

10. Conclusion

Agroecological, circular, climate-smart and nature-based interventions can generate substantial ecological and livelihood benefits, but these benefits do not automatically translate into scalable or investable systems. The AIRE Framework addresses this transition challenge by connecting natural capital, agroecological production, ecosystem services, investment readiness and resilient agrifood systems within a flow-based analytical architecture.

AIRE integrates seven system flows, five cross-cutting readiness conditions and three investment-readiness pathways through the Practice–Proof–Prioritization–Payment mechanism. Its preliminary six-dimension readiness diagnostic helps identify technical, evidentiary, institutional and financial bottlenecks, while the illustrative low-emission rice application demonstrates how these elements can inform intervention design and financing choices. Importantly, the framework recognizes that public investment, PES, blended finance or commercial investment may be appropriate under different conditions; ecological value alone does not establish bankability.

AIRE reframes investment readiness as an outcome of alignment among ecological performance, credible evidence, incentives, institutions and financing arrangements, rather than as a purely financial endpoint. Its proposed application to GMS 2030 offers opportunities for methodological testing and regional learning, but further empirical validation is needed before operational standardization. The ultimate objective remains resilient, inclusive agrifood systems that sustain natural capital and farmer livelihoods.

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