

Adaptive scaling to achieve system transformation in CGIAR

The challenge of scaling innovations

Two major challenges for stimulating economic and social development transformation are identifying which innovations fit and implementing effective strategies to accelerate scaling of these innovations to improve smallholder productivity and incomes and reduce trade-offs. The term scaling is gaining momentum and system-based scaling approaches like stage gating (a phased decision-making process with evidence-based checkpoints), the scaling scan (a diagnostic tool to assess enabling conditions for scaling), scaling readiness (an assessment of an innovation's technical, institutional, and financial maturity) are useful approaches to assess whether an innovation is "ready to scale" and which supportive functions are needed to go to scale. The use of a specific approach or bundle of approaches will depend on the objective of the actors involved in scaling efforts. For example, the scaling scan or scaling readiness lends itself to evaluate, manage and report on the scalability of an innovation or supporting processes and actors to achieve scaling success.

However, these approaches define 'success' as widespread adoption of a specific innovation. This overlooks, the deeper, systemic processes that have emerged in recent literature and that are required to achieve meaningful and sustained development outcomes. Simply saturating a market with a new seed variety, solar pump or advisory service, for example, is insufficient to generate broad improvements in production, food security, greenhouse gas reduction or water security unless underlying structures, incentives and institutional arrangements also change. Large-scale impact requires changes in the system that enable access to information, services, resources, and markets, and transform how actors interact across value chains, institutions and environments. Therefore, we must shift our focus toward addressing systemic barriers and treat scaling as a dynamic, interconnected and co-evolutionary *systemic change process* embedded within complex food systems, and essential to meet the Sustainable Development Goals. This means that along with bundling technology, social and institutional

innovations, we must acknowledge that scaling processes are non-linear, adaptive, and shaped by continuous feedback, boundary shifts and evolving actor networks.

In this technical brief, we draw on the growing academic literature on system-based scaling (e.g., Cooley and Linn 2014; Wigboldus et al. 2016; Frake and Messina 2018; Sartas et al. 2020) as well as more practical guides to scaling of agricultural innovations (e.g., IDIA 2017; Kohl and Foy 2019; Jacobs et al. 2018), to outline how adaptive scaling enables system transformation, and we reflect upon lessons learned from operationalizing such approaches in action-oriented research-for-development programs.



Vegetable farmers selling their produce in Siraha district, Nepal (photo: Nabin Baral/IWMI).

Defining the agricultural innovation scaling systems

Scaling agricultural innovations, including agricultural water management solutions, is embedded in complex socio-economic-ecological-political and market environments. These environments consist of multiple interconnected subsystems, including farming and household systems, value chains, financial systems, natural resources, and policy and institutional settings, the existence of effective agricultural value chains (or lack thereof), both markets making inputs including

technologies available and output markets for the resulting products, availability of reasonably priced capital for investment and equal access to resources (e.g., information, water, land, seeds, as illustrated in Figure 1).

Contemporary scaling requires viewing these subsystems as part of a broader innovation ecosystem: a multi-layered network of actors, institutions, relationships, governance arrangements, and resources that evolves over time. Innovation ecosystems are characterized by fluid boundaries, cross-scale interactions, competition and cooperation among heterogeneous actors, and the coevolution of technologies, markets, policies, and user practices.

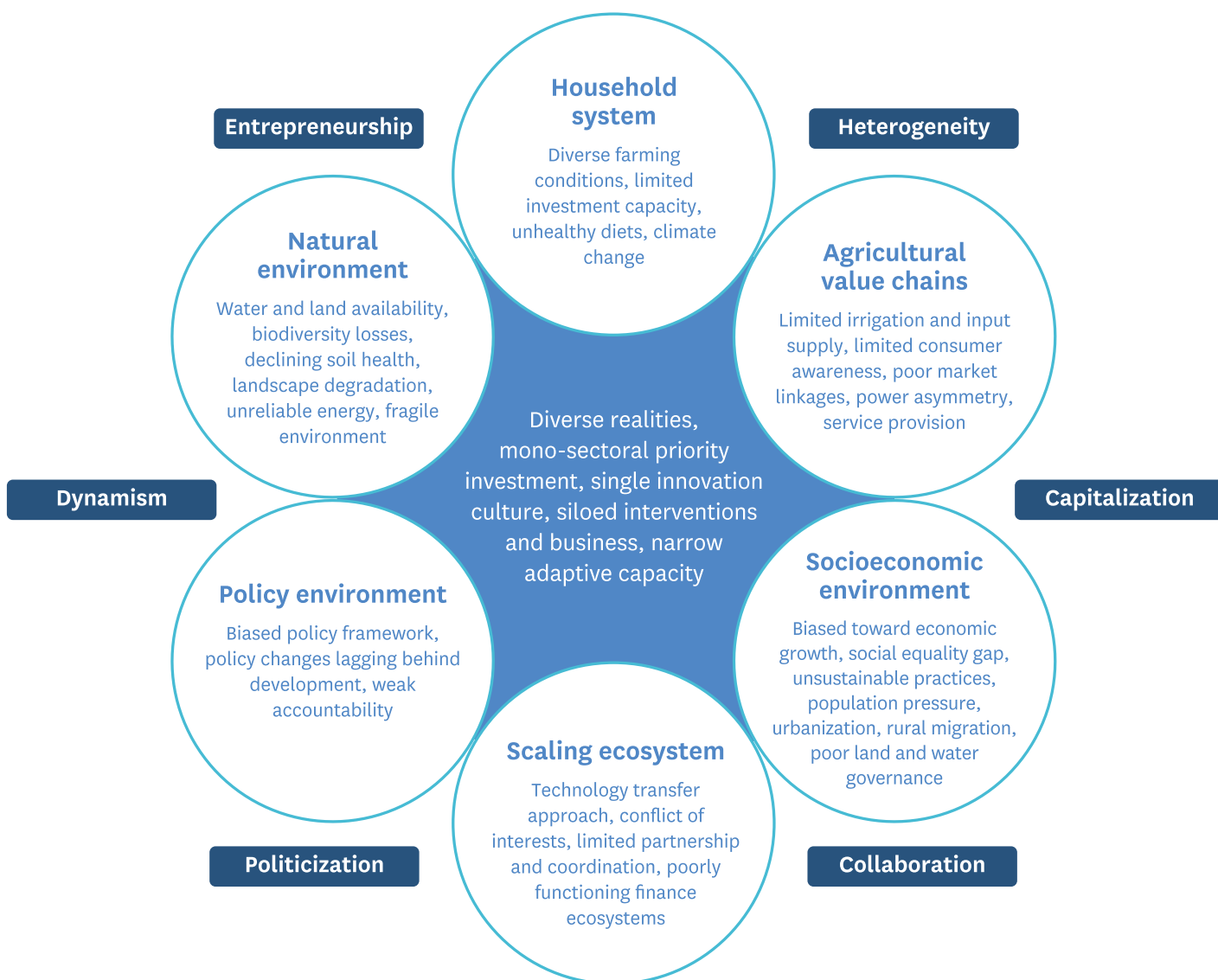


Figure 1. Scaling system: Context and attributes.

Some of the literature on scaling draws on innovation systems theory. This stresses that the key to innovative processes is the flow of technology and information among people and institutions. It also emphasizes the need for systematic interactions among actors and stakeholders to take a new idea or technology to scale. This is often achieved through ‘innovation platforms’ (sometimes referred to as ‘hubs’ or ‘clusters’), i.e., facilitated forums that bring together the full range of key stakeholders to learn, negotiate and coordinate efforts to make

new technologies or knowledge widely available. These are now common features of research-for-development programs (e.g., Dror et al. 2016; Schutt et al. 2019; Van Rooyen et al. 2017). A recent paper on innovation ecosystems broadens the agricultural innovation system concept by drawing on experiences in business to focus more on value creation. In addition, it recognizes that agricultural innovation scaling systems are embedded in and linked to a wider set of innovation systems. The purpose remains the same: to either enhance or create enabling environments

and foster innovation communities (Pigford et al. 2018). Another recent paper highlights the need for a mission or ‘vision’ to drive agricultural innovation system transformation (Klerkx and Begemann 2020).

The ASEco perspective builds upon this by integrating innovation ecosystem theory directly into scaling practice. It highlights that scaling requires attention to ecosystem boundaries (what is included, excluded, or reconfigured), subsystem interactions, actor incentives, and the coevolution of markets, institutions, and technologies. Rather than viewing scaling systems as static structures, ASEco treats them as flexible, adaptive, and continuously negotiated spaces shaped by ambiguity, agility and shifting governance arrangements.

What is adaptive scaling?

We define adaptive scaling as the many processes by which diverse actors and actants cooperate, feed off, adapt to, support, compete and interact with each other, forming different multi-actor networks and corresponding collective actions to undertake various functions in the scaling ecosystem [PI3.1] [TM3.2]. In the published 2025 framework, this is formalized as the Adaptive Scaling Ecosystem (ASEco), which integrates system-based scaling with innovation ecosystem thinking

to enable system change. ASEco conceptualizes scaling as a dynamic, interconnected process guided by adaptability, responsiveness, reflectiveness, inclusiveness, and flexibility.

We identify four interconnected scaling functions for adaptive scaling: niche, reach, accelerate and transform. These are processes that are guided by adaptability, responsiveness, reflectiveness, inclusiveness and flexibility:

1. Adaptability (foundational principle), enables continuous adjustment and enhancing organization and resilience as conditions evolve
2. Responsiveness, addresses systemic barriers, enablers, drivers, and negative aspects or emergent properties associated with system transformation, and helps ASEco anticipate and manage ambitions, risks, and trade-offs
3. Reflectiveness, encouraging ongoing sensemaking, learning and recalibration of goals and processes
4. Inclusiveness, ensuring equitable participation, benefit-sharing and attention to diverse needs
5. Flexibility, allowing rapid reconfiguration of networks, roles, and pathways as contexts shift

These principles provide feedback loops between the various scaling functions. Figure 2 illustrates the adaptive scaling functions and guiding principles supporting the scaling processes.

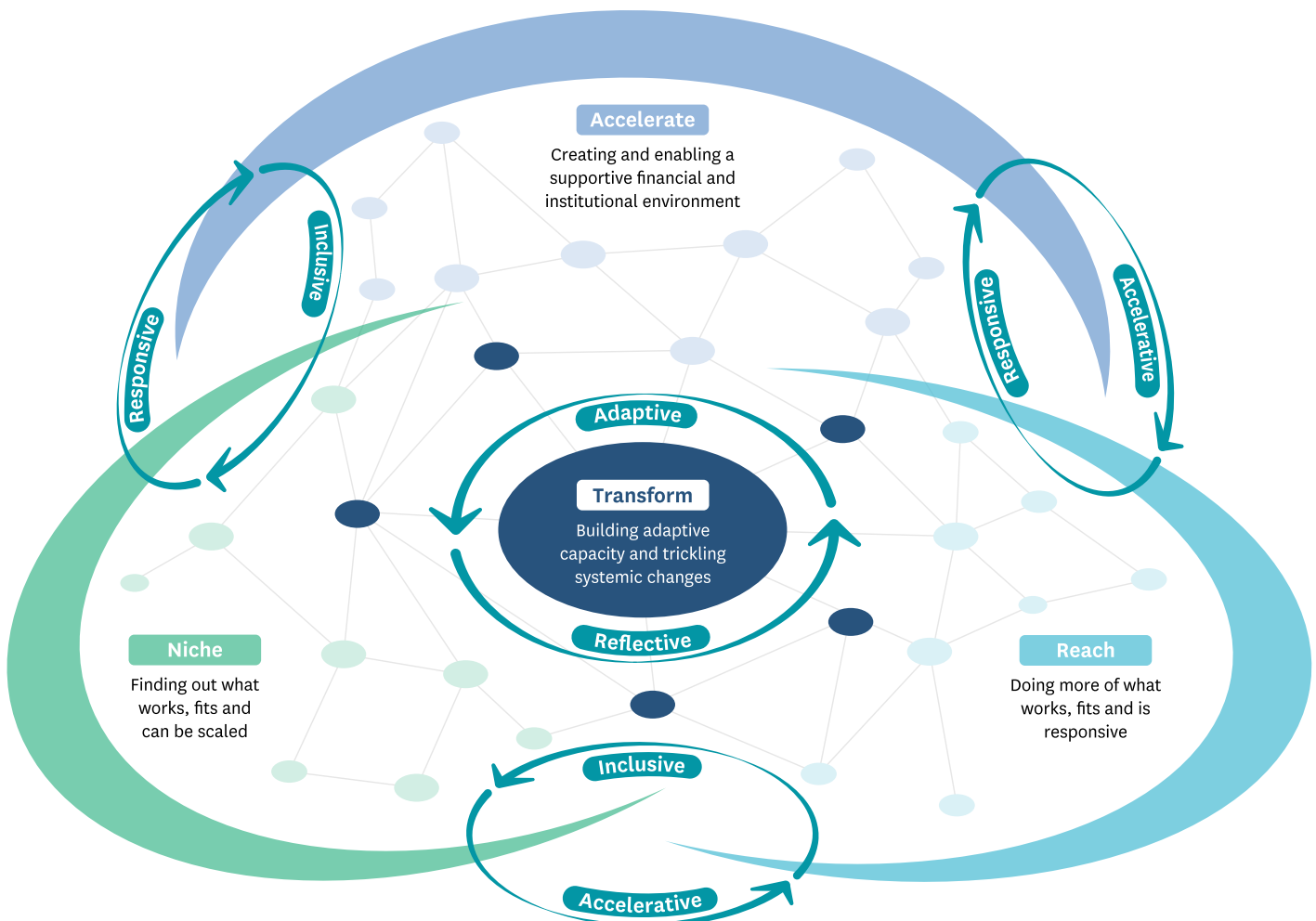


Figure 2. Adaptive scaling ecosystem: Structure, functions, and principles (Source: Minh and Schmitter 2025).



Farmers growing vegetables using drip irrigation in Kathmandu, Nepal (photo: Sharad Maharjan/IWMI).

Niche serves as an experimental and learning space where innovations—whether technical, social, institutional, financial, or organizational—are developed, tested, and refined over time. Niche builds and strengthens networks that are essential for creating strategies, incentive structures, and investment mechanisms, considering the political, socioeconomic, and environmental interests of actors involved in scaling. Niche-related networks may start small, but can grow over time, ultimately supporting the reach function. The innovations, networks, and scaling materials generated within these networks are crucial for disrupting established scaling processes and practices, and vitally enable more extensive system changes, especially when they align with larger global trends such as sustainability and digital transformation.

Reach accelerates the widespread adoption of innovation to achieve sustainable, large-scale impact. Reach integrates contextual enablers and drivers into scaling investments and tailors innovation to meet the diverse needs of different regions, cultures, and systems. It encourages actors to speed up scaling efforts, brings new participants into dynamic networks, and fosters interconnections that enhance scaling initiatives. It translates into business opportunities and profits for those involved, through various investment strategies including results-based financing, debt, or equity for market development. In underserved regions and vulnerable populations, it improves iterative learning and user feedback, facilitating innovation adoption in broader geographical areas and bottom-of-the-pyramid markets.

Accelerate reinforces both niche and reach functions by creating an environment conducive to sustainable, inclusive, and large-scale impact. It builds and strengthens networks that support the development of the knowledge and financial infrastructure needed for innovation and scaling investments. It expands these networks and strengthens their connections,

ensuring they remain informed and inclusive. Government and policymakers, together with development organizations, banks, and impact investors, mobilize resources, align institutional incentives and policies, and provide essential support such as catalytic funding, capacity building, digital platforms, and technical assistance for innovation investments.

Transform fosters interactions across networks and processes to reshape governance systems, norms, operational mechanisms, practices, and technologies within broader food systems. It integrates innovation and scaling networks, processes, pathways, and mechanisms into new food system configurations, encouraging adaptive behaviors and practices. It also supports ASEco-level actors in developing their capabilities for adaptive management and facilitating positive change, allowing them to initiate transformation across contexts. It cultivates and facilitates long-term, self-organized multi-actor processes and internal momentum to sustain interventions as conditions evolve.

The effectiveness of each of the four functions is a product of the effectiveness of the others: they are interlinked in many ways, impacting each other through feedback mechanisms. Some scaling ecosystems are already effective, enabling a fairly rapid scaling process. But in many developing countries, scaling ecosystems are not very effective, or may have some relatively strong components (for example, research institutions) but others that are less conducive (for example, a lack of access to affordable finance). However, even weak scaling ecosystems have bright spots, such as actors committed to reform. It is important to identify them and support their efforts to create a more effective system.

Adaptive scaling demands integration of these principles and their embeddedness in the scaling ecosystem functions.

Scaling principles and functions, therefore, do not float freely but must be integrated into a scaling ecosystem with reinforcement loops. There are multiple pathways to scaling. They may be driven by the private sector (commercialization), the public sector, NGOs or civil society organizations, or some combination thereof. The type of scaling pathways will be based on the priorities of actors, stakeholders and researchers in action-oriented research-for-development programs to achieve one or multiple of CGIAR's five impact areas:

- Nutrition, health and food security
- Poverty reduction, livelihoods and jobs
- Gender equality, youth and social inclusion
- Climate adaptation and GHG reduction
- Environmental health and biodiversity.

For example, NGOs may place greater emphasis on achieving gender and social inclusion, while private irrigation technology firms may emphasize business development. These are not mutually exclusive: we are aware of NGOs that promote inclusive businesses for women and youth; and policymakers are likely to have multiple objectives. The adaptive scaling approach requires all relevant actors to take on their core roles aligned with institutional mandate and priorities. Hence, the scaling is not driven by scaling practitioners or managers but by actors and stakeholders themselves.

Implementation of the scaling framework

Table 1 illustrates how the adaptive scaling framework has been implemented in two USAID-funded projects – the Feed the Future Innovation Lab for Small-Scale Irrigation and the Africa Research in Sustainable Intensification for the Next Generation – over the past five years in Ghana and Ethiopia.



Farmer using solar power to irrigate her crops in Zimbabwe (photo: David Brazier/IWMI).

Table 1. Operationalizing the adaptive scaling approach: illustrative example

Scaling function and activity	Scaling principle	Operational level and modality
Niche		
Improve consumptive water use by bundling solar pump, drip irrigation and conservation agriculture for vegetable production.	Responsiveness to water shortage and land resources as well as market demand for high-value crops.	<ul style="list-style-type: none"> - <i>Innovation bundle</i> - Multi-actor partnership - <i>Innovation bundle</i> - Researcher-farmer partnership
Test different agricultural water management scenarios for various genetic fodder varieties to improve the quality and quantity of milk production by hybrid cows.	Responsiveness to the market demand for irrigated fodder and milk while dealing with water scarcity.	<ul style="list-style-type: none"> - <i>Innovation bundle and scaling process</i> - Research-women-private sector partnership
Test the bundling of solar pump with pay-as-you-go or pay-as-you-own financial modality to lower the upfront investment cost. Address gender-related gaps in credit scoring.	Responsiveness to market segment demands and inclusive of resource-poor farmers in bottom-of-the-pyramid markets.	<ul style="list-style-type: none"> - <i>Innovation bundle and scaling process</i> - Research-household partnership - <i>Scaling process</i> - Research-private-public sector partnership
Identify gendered preferences for water-lifting technology and use for irrigation, domestic and livestock purposes.	Inclusiveness of women and intra-household needs to address water access and use in irrigated value chains, livestock and water, sanitation and hygiene (WASH).	<ul style="list-style-type: none"> - <i>Scaling process</i> - Research-private-public sector partnership
Identify solar-based irrigation potential at national and regional levels using integrated decision-support systems, multi-agent-based modeling, water accounting and suitability mapping to strengthen irrigation supply chains sustainably and reduce environmental trade-offs.	Responsiveness to the private sector's identified knowledge gaps to include water-relevant information into market segments and expansion analysis.	
Reach		
Co-design demand-supply linkages for solar pump and financing products by identifying the current irrigation situation and user demand, establishing irrigation supply chains/services and different market segments and associated pay-as-you-own financing.	Responsiveness to market segment demands and heterogeneity of farmers and their farming systems, while being inclusive of resource-poor farmers in bottom-of-the-pyramid markets.	<ul style="list-style-type: none"> - <i>Scaling process</i> - Research-farmer-private sector partnership
Capitalize on referral mechanisms to stimulate sales and customer acquisition (e.g., proportional to the total number of products sold by the sales and service partners).	Responsiveness to market demands and requirements to close prevailing market linkage gaps for farmer-agribusinesses and irrigation supply chains.	<ul style="list-style-type: none"> - <i>Scaling process</i> - Private sector investment
Facilitate demand-supply linkage pathways by creating awareness in the region and supporting actor networking at the regional level.	Responsiveness and flexibility by strengthening cross-actor connectivity, expanding networks, and enabling adaptive coordination across the scaling pathway.	<ul style="list-style-type: none"> - <i>Scaling process</i> - Multi-actor partnership

(continued)

(continued)

Scaling function and activity	Scaling principle	Operational level and modality
Accelerate		
Provide financial support to private sector companies to de-risk their expansion of financial end-user services to other regions in the country and/or different technology bundles.	Responsiveness and flexibility by enabling inclusive, risk-aware expansion of financial services across diverse market segments, and by supporting adaptive financing models that respond to evolving market conditions.	- <i>Innovation bundles and scaling process</i> - Development partner-private sector-research partnership
Influence the smallholder irrigation development component in the Agriculture and Rural Development Policy, as solution brokers to the Ethiopian Ministry of Agriculture.	Responsiveness to the high upfront investment cost, underdeveloped irrigation supply chains and suitable technical interventions.	- <i>Scaling process</i> - Multi-stakeholder dialogues
Transform		
Establish/strengthen national multi-stakeholder dialogues to support co-learning, collective action, collaboration and commitment to FLI development.	Inclusiveness of partners' interests and capability to support accelerated action, adaptive by identifying processes/tools/solutions for overcoming identified scaling barriers.	- <i>Scaling process</i> - Research-farmer-government-public-private sector collaboration
Establish innovation scholarships and internships with the private and public sectors to close the research-private sector divide, stimulate local innovation and job-readiness of the next generation of young professionals.	Reflectiveness by stimulating contextually relevant innovations in-country and by identifying the knowledge gaps and needs of the private sector.	- <i>Scaling process</i> - Research-private sector collaboration

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