

Scaling up climate-smart agriculture: lessons learned from South Asia and pathways for success

Henry Neufeldt, Christine Negra, Jim Hancock, Kristi Foster, Devashree Nayak, Pal Singh



**World
Agroforestry
Centre**

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EXECUTIVE SUMMARY & KEY MESSAGES

The world is changing rapidly. A burgeoning global population, with direct impacts on food insecurity, poverty, climate change and environmental degradation, is constantly changing the stakes. Climate-smart agriculture (CSA) can help overcome hunger while supporting rural populations adapt to climate change, managing natural resources sustainably and curbing rising temperatures. But as the challenges build and intensify, climate-smart solutions will need to be implemented on a much greater scale.

This paper aims to aid policy makers and rural development practitioners in strategically planning scaling up of successful CSA practices. We provide the context for scaling up CSA, identify practical elements to guide thinking and planning around scaling up and map pathways for taking CSA to scale. Building on a series of workshops and eight case studies from South Asia, we identify widely applicable ingredients for scaling up CSA and how they must be connected to achieve impact.

Key messages

- Scaling up CSA is complex because it involves more than scaling up technological innovations in agriculture. Envisioning, implementing and monitoring CSA requires integrating biophysical, socioeconomic and institutional dimensions, with careful attention to the issues and interactions of these dimensions at different scales.
- Successfully scaling up CSA requires identifying and promoting appropriate practices, technologies or models (new, improved, adapted) within favourable enabling environments comprising supportive institutional arrangements, policies and financial investments at local to international levels. Anticipating potential opportunities and bottlenecks to scaling up CSA, such as market and policy drivers, will be central to implementing CSA at scale.
- Seven key elements provide practical guidance for thinking through challenges and opportunities in the process of scaling up CSA: (1) landscape analyses and approaches, (2) context-specific drivers and spaces, (3) partnerships and knowledge management, (4) strategic and adaptive participatory project management, (5) multi-dimensional monitoring and evaluation, (6) capacity development through co-learning within a research in development paradigm (7) focus on gender and other disadvantaged groups.
- Scaling up can occur horizontally (replicating promising or proven practices, technologies or models in new geographic areas or target groups), vertically (catalyzing institutional and policy change) and diagonally (adding project components, altering the project configuration or changing strategy in response to emergent reality). Scaling can occur directly, in which an organization, initiative or coalition is directly responsible for change, and indirectly, in which these actors influence others to implement key changes.
- Three major conceptual stages of scaling up – effectiveness, efficiency and expansion – represent a general sequence of investments, transitions and outcomes on the path to CSA adoption and impact at scale. CSA project leaders can anticipate and plan for

transitions across these major stages, while also adaptively adjusting or adding project components.

- Program managers, donors, investors, policy makers, researchers, practitioners and other actors are advised to think about scaling up as a long-term, non-linear process that will commonly require combining generalized and context-specific approaches and that leadership within CSA projects is likely to be complex.
- There is no blueprint for scaling up CSA. However, project leaders and partner institutions can pursue common visions and strategies including dynamically combining horizontal and vertical scaling approaches in response to specific project needs. This will depend on building strong knowledge networks and fostering learning.

As the global agricultural system confronts planetary boundaries and rapidly escalating demands, it is essential to implement climate-smart practices, technologies and models at scale, driven by shared leadership across sectors and scientific disciplines.

GLOSSARY

Action research: Research that aims to achieve action (implementing change, improving situations) and research (increasing understanding, generating knowledge) outcomes together, often while solving a specific problem.

Adaptive capacity: The ability or potential of a human or natural system to successfully respond to climate variability and change by adjusting behaviour and/or resources and technologies (Adger et al. 2007).

Agroecosystem/Agroecological: Pertaining to both agricultural production systems and ecological processes.

Clean Development Mechanism (CDM): One of three ‘flexibility mechanisms’ defined in the Kyoto Protocol which promotes sustainable development by allowing emissions reduction projects in developing countries to generate certified emission reduction credits. These credits can be used by developed countries to help meet their emission reduction targets (UNFCCC 2015).

CDM Afforestation/Reforestation (A/R): A project category under the CDM that allows projects to generate emission reduction offsets through carbon sequestration by forests from afforestation and reforestation activities. These activities convert non-forested land to forested land via seeding, planting and promotion of natural seed sources.

Climate risk: Risk associated with climate change and variability that has the potential to adversely affect human and natural systems.

Crowdsourcing: The process of soliciting contributions from a large online community of people to acquire services, content or ideas.

Economies of scale: The cost advantages that arise from increased size, output or scale of an operation, typically because fixed costs are shared over a larger number of goods.

Emission intensity: The average emission rate of a pollutant from a source relative to the intensity of a specific activity or unit; for example, the amount of greenhouse gas emissions produced per unit product.

Landscape approach/integrated landscape (management) approach: A holistic approach to land management that aims to achieve social, economic and environmental objectives in areas of competing land uses.

Management Information Systems (MIS): The hardware and software systems that generate the information needed to run an enterprise, including information to improve efficiency and effectiveness of decision-making at all levels of management.

Payments for environmental services (PES): A market-based mechanism that offers incentives to farmers or landowners in exchange for managing their land to provide an ecological service (for example, watershed protection or carbon sequestration).

Political economy: The theory of the relationship between economics and politics and how public policy is created and implemented.

Profitability centres: A branch, division or unit of a company that is treated as a separate business and is responsible for its own revenues, costs and profits.

Resilience: The ability of a system to withstand changes, disturbances and shocks while maintaining important objectives such as sustainability, rural livelihoods and ecosystem services (O'Connell et al. 2015).

Safety nets: Services provided by the government or other institutions that prevent individuals from falling beyond a certain threshold of poverty; this includes financial (e.g. insurance) and non-financial services such as social safety nets.

Spatially explicit: A description for data that is associated with a location in geometrical space.

Social learning: Opportunities for stakeholders to learn by sharing information.

Sustainable Land Management (SLM): “A knowledge-based procedure that integrates land, water, biodiversity, and environmental management to meet rising food and fiber demands while sustaining livelihoods and the environment” (World Bank 2006).

Theory of Change (TOC): A methodology for promoting social and/or environmental change that uses critical thinking exercises to map the building blocks needed to achieve long-term goals.

Vulnerability: “The degree to which geophysical, biological and socio-economic systems are susceptible to, and unable to cope with, adverse impacts of climate change” (Parry et al. 2007).

ABBREVIATIONS

A/R	Afforestation/Reforestation
ACM	Adaptive Collaborative Management
CCA RAI	Climate Change Adaptation in Rural Areas in India
CDM	Clean Development Mechanism
CSA	Climate-smart Agriculture
CSISA	Cereal Systems Initiative for South Asia
DRR	Disaster Risk Reduction
FAO	Food and Agriculture Organization of the United Nations
GHG	Greenhouse Gases
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GoI	Government of India
HLPE	High Level Panel of Experts
IASSTD	International Assessment of Agricultural Knowledge, Science and Technology for Development
ICRAF	World Agroforestry Centre
ICT	Information and communications technology
IDRC	International Development Research Centre
IFES	Integrated food-energy systems
IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
IP	Innovation platforms
IPCC	Intergovernmental Panel on Climate Change
M&E	Monitoring and evaluation
MIS	Management Information Systems
NAC	National Advisory Council
NAIP	National Agricultural Innovation Project
NGO	Non-governmental organization
NICRA	National Initiative on Climate Resilient Agriculture
PES	Payments for environmental services
RATA	Resilience Adaptation Transformation Assessment
ROs	Relay organizations
RRC	Rural Resource Centre
SACC	Sustaining Agriculture in a Changing Climate
SAPCC	State Action Plans on Climate Change
SHARED	Stakeholder Approach to Risk-informed and Evidence-based Decision-making
SLM	Sustainable Land Management
TOC	Theory of Change

UN	United Nations
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar

SECTION 1: INTRODUCTION

In a world that is increasingly recognizing the limitations that accompany the benefits of the past decades of agricultural development, there is a dire need to manage natural resources more sustainably while improving food security in poor and rich countries alike (IASSTD, 2009). Alongside the environmental costs of feeding a growing number of people, global agriculture faces major issues associated with waste, perverse trade incentives and negative health implications, including malnutrition and overconsumption of food (Beddington et al. 2012). The challenge is to increase availability and access to nutritious food while restoring and sustaining land and water resources, helping rural populations adapt to climate change and contributing to greenhouse gas (GHG) mitigation. By reducing GHG emissions or improving energy efficiency through demonstrated technologies and practices, there is an opportunity to prevent between 1.3 and 4.2 Gigatonnes of carbon dioxide equivalent emissions per year from agriculture and forestry by 2020 (UNEP, 2013). Adaptation will be critical to reducing the largely negative impacts on food production and food security systems associated with local temperature increases.

Seventy percent of the global poor live in rural environments (World Bank, 2015). These populations, which typically lack functioning institutions, assets and technical capacity to innovate and adapt, are among the most vulnerable to climate-related shocks. Poor and food-insecure farming households have difficulty investing in their agricultural enterprise because they cannot shoulder the up-front costs needed for longer-term returns (Thorlakson and Neufeldt, 2012). It is critical to recognize the context of poverty, vulnerability, and short-term planning cycles, especially where institutional frameworks are poorly governed, when addressing the challenges of scaling-up more sustainable agricultural practices.

All the dimensions of this complex problem must be addressed together if change is to be induced on a larger scale. There is need for both improved practices, technologies and models (some of which will emerge from farmer-led research) that can lead to higher yields and enabling environments to effectively support rapid adoption by larger numbers of people. Orchestrating this change in the context of climate-smart agriculture is particularly challenging, as the sustainable management of natural resources requires the integration of effects at different scales. Spatially, from plot or farm level to landscapes, river basins and ecosystems, interventions can have different types of outcomes that need to be understood and evaluated against each other. Socially, it requires that the actors operating at these scales work in concert through institutions and governance systems, from the individual household and community to district, provincial and national administrations. Lastly, it requires integration across short and long timeframes in order to capture immediate and delayed effects on welfare, social cohesion and the environment.

Climate-smart agriculture (CSA) is an approach to reorienting agricultural planning and investments to better achieve three main objectives: improve food security, support climate change adaptation and reduce agriculture's contribution to greenhouse gas emissions, particularly in developing countries. The FAO (2013) defines CSA as “agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes GHGs (mitigation), and enhances achievement of national food security and development goals.” Since the term was coined in 2009, CSA has seen both incredible appeal and strong opposition (Neufeldt et al. 2013). The concept has galvanized great public and private sector

support for its potential to join the global agendas of development, agriculture and climate change under one brand. At the same time, it has raised concerns that some aspects of CSA, in particular GHG mitigation, will be promoted at the expense of food security and adaptation. As with any potentially transformative approach, the actual outcomes of CSA will be most beneficial when interventions and investments are informed by diverse knowledge sets and community priorities.

What are the requirements for scaling up CSA? Is it possible to predict which projects will lead to long-lasting and transformational change and impact at larger scales? These are the questions taken up in a series of workshops from 2012 to 2014 in New Delhi, India. Workshop participants identified key ingredients for scaling up CSA and how these could be combined to achieve larger impact. This paper builds on eight case studies from South Asia (Section 6) that illustrate the dimensions and complexities of scaling up CSA, with lessons that extend beyond the subcontinent. A recent CCAFS working paper has analyzed 11 CSA case studies to better understand their approaches to scaling up (Westermann et al. 2015). While the two papers address the same overarching topic, they look at the topic of scaling up CSA from different angles and with different case study geographies. Our paper focuses primarily on development program design, whereas the CCAFS paper is motivated mainly by the need for a better dissemination of, or adoption model for research outputs. Moreover, different from the case studies we build on here, which are taken from development projects in South Asia, the CCAFS paper refers to case studies outside the Indian subcontinent with the exception of ‘climate-smart villages’ in India. Together, the two papers complement each other very well.

To learn about scaling up from the case study projects showcased at the New Delhi workshops, we focus on CSA practices and technologies that are applicable to many different contexts and large-scale implementation (those that lend themselves to replication and expansion). We also consider important elements of these projects that can be adapted to other contexts, inspire related innovation elsewhere or catalyze policy change. At the workshop, a number of challenging questions were raised, including:

- How can target groups and communities influence scaling up (for example, through articulated demand, farmer-to-farmer exchange, self-financing models or local support institutions)?
- What forms of leadership are important (such as local innovators, community professionals, farmer associations or national champions)?
- How can the design of projects and programs ensure rigorous implementation while allowing for context-specific approaches?
- What are the common denominators of successful partnerships and alliances?
- How do scientific research, experiential evidence and knowledge networks contribute to scaling up?

The central question is how to build on innovation and demonstration of practices and technologies that are climate-smart in their context to achieve adoption and impact at scale.

SECTION 2: BACKGROUND

2.1 What is climate-smart agriculture?

Since the term was coined in 2009, climate-smart agriculture (CSA) has received much attention as a new way of describing practices that provide benefits in development, food security, adaptation and mitigation (FAO, 2010; Lipper et al, 2014). CSA is the area in the Venn diagram (Figure 1) in which there is a triple-win among adaptation, mitigation and food security. There is often a close correlation between enhanced productivity and adaptation because increased income can lower climate risk and vulnerability, and lower risks can spur behavioral change toward longer-term benefits. However, short-term productivity rise is often achieved at the expense of long-term system resilience to weather extremes (and other risks), which might therefore result in a decline in adaptation (Smith et al. 2013). Another example of concomitant benefits for food security and adaptation are climate information systems and early warning services that help farmers reduce the exposure to climate hazards. While increased production and food security is often correlated with a rise in GHG emissions, enhanced productivity can result in a reduction of emission intensity per unit product and limit conversion of land to meet growing demands (Garnett et al 2013). Some practices, like agroforestry and rangeland regeneration, can also store carbon from the atmosphere in biomass or as soil organic matter and thereby contribute to climate change mitigation and adaptation at the same time (Thorlakson and Neufeldt, 2012).

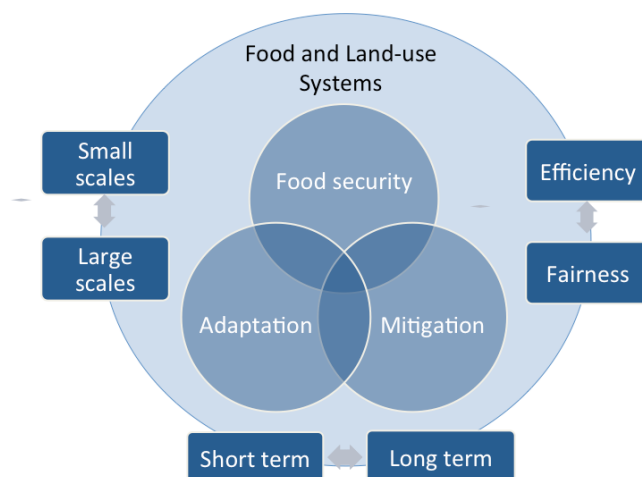


Figure 1. Schematic of climate-smart agriculture (Source: Henry Neufeldt)

From the above it can be concluded that CSA is not a closed system or set of technologies that work everywhere. Indeed, it is crucial to take a context-specific approach to identify what works where, why and for whom. To that end the CSA Resource Book (FAO, 2013) specifies that: “CSA is not a specific technology, nor a set of practices, nor a new agricultural system that can be universally applied. It is an approach to developing the technical, policy and investment conditions to achieve sustainable agricultural development for food security under climate change; a way to guide the needed changes of agricultural systems, given the necessity to jointly address food security and climate change. It requires site-specific assessments to identify suitable agricultural technologies and practices.” Although we often speak about CSA technologies, one should bear in mind that these technologies might not deliver the expected outcomes everywhere.

Promotion of CSA happens within overarching food systems, so it is important to consider its effects over space and time, as well as issues of justice, equity, governance, trade, migration, demographic change and behaviour. Finding the right balance is therefore very important. In addition, it is necessary to consider elements of fairness when looking at the outcomes of changes leading to greater system efficiency (Figure 1). Higher efficiency has often enough resulted in the most vulnerable sectors of society, in particular women, the elderly and youth, losing out against corporate or social interests (FAO 2002; Jost et al. 2015). Finally, CSA cannot be addressed without considering the demand and supply for food and other agricultural products, which often drive the larger systems. For example, shifts toward diets higher in animal proteins can counteract attempts to improve sustainability at local scales and incentivize management practices that could undermine the long-term provisioning capacity of the land (IASSTD 2009; Beddington et al. 2014).

2.2 CSA technologies and enabling environment

Practices that have been found to be potentially climate-smart in a wide range of contexts include, but are not restricted to: agroforestry, improved soil management such as through conservation agriculture, improved water management such as water harvesting and drip irrigation, integrated livestock and grassland management, improved nutrient management such as micro-fertilization and improved crop varieties (see Table 1). While these technologies may be considered good candidates for climate-smart options, it is crucial for any CSA solutions to take the context into account to determine how they contribute to productivity, adaptation/resilience and mitigation in a given location.

Practices that strongly contribute to these three pillars under the right conditions can have negative effects if the environmental or social context is not addressed sufficiently. For example, planting too many trees in water-constrained environments may lead to groundwater depletion and long-term loss of landscape productivity. Planting agroforestry trees that do not provide required services such as nitrogen fixation and instead compete with annual crops for light, nutrients and water could have negative effects on productivity.

Similarly, more intensely managed livestock systems could lead to contamination of surface water if the slurry and manure are not properly managed. Adoption of improved management practices also depends strongly on investment costs and returns on investment, as well as constraints related to time, labour, access to machinery and existing supply and value chains. Technologies referred to as climate-smart may address productivity, adaptation/resilience and mitigation to different degrees, but it is widely agreed that food security has to rise during the shift to more integrated practices (GACSA 2014).

Table 1: Overview of categories of CSA technologies and practices and their benefits

Examples of technologies and practices	Examples of benefits
Soil management	
<ul style="list-style-type: none"> • Zero-tillage, minimum-tillage or conservation tillage • Erosion control (such as reducing the degree and length of slopes through progressive and bench terracing) • Protective soil cover from mulch, crop residues or cover crops • Soil compaction management • Restoration of degraded soils • Fallowing 	<ul style="list-style-type: none"> • Practices that increase soil organic carbon maintain productive soils, require fewer chemical inputs and support important ecosystem functions such as nutrient cycling, contributing to enhanced productivity, adaptation, mitigation and building resilience to climate change
Nutrient management	
<ul style="list-style-type: none"> • Integrated soil fertility management using inorganic and organic fertilizers; management of nitrogen fertilizer; using mulch, compost, manure or green manure in place of inorganic fertilizers 	<ul style="list-style-type: none"> • Integrated nutrient management such as green manures can contribute to adaptation and reduce costs to farmers
Crop management	
<ul style="list-style-type: none"> • Crop diversification • Crop rotation • Intercropping (e.g. with leguminous plants) • Increasing the use of perennial crops and grasses • Growing nutrient-use efficient crop varieties • Integrated pest and/or weed management • Breeding and using crop varieties with increased resistance to extreme conditions such as droughts • Mulch or cover cropping • Rice intensification and improved cultivation techniques • Landscape-level pollination management 	<ul style="list-style-type: none"> • Pollination management can improve landscape level ecosystem resilience • Planting nitrogen-fixing crops can contribute to adaptation and reduce costs to farmers
Water management	
<ul style="list-style-type: none"> • Water harvesting • Groundwater development • Construction or enhancement of dams • Irrigation (e.g. modern technology, accurate scheduling) • Drainage and flood management • Restoration of riparian habitat or creation of rivers • Improved hydrological monitoring and weather forecasting capacity 	<ul style="list-style-type: none"> • Irrigation improvements can reduce GHG emissions, contributing to mitigation; increase crop and grassland productivity; and support adaptation
Livestock management	
<ul style="list-style-type: none"> • Grazing management on pastures or rangelands (such as rotational grazing, adjusting stocking densities to feed availability, and altering plant species) • Feed management (such as improved feed quality, diet supplementation, using improved grass species and forage legumes, and low cost fodder conservation technologies such as baling and silage) • Assisted natural regeneration and/or fire management of 	<ul style="list-style-type: none"> • Diversification of incomes from livestock management can increase adaptation • Incorporating livestock manures can support adaptation and reduce costs to farmers • Improved pasture and grassland management, including rotational grazing can boost resilience, contribute

Examples of technologies and practices	Examples of benefits
<ul style="list-style-type: none"> grazing systems • Manure management (such as recycling and biodigestion, composting, and improved storage) • Animal breeding (such as for heat-tolerant and locally-adapted breeds) • Disease surveillance and control • Vaccines • Weather warning systems and weather-indexed insurance • Infrastructure (such as housing and shade) • Temperature control systems 	<p>to mitigation and increase productivity and food security</p>
Integrated systems	
<ul style="list-style-type: none"> • Agroforestry • Crop-livestock-tree systems • Rice-fish systems • Land fragmentation (riparian areas and forest land within the agricultural landscape) • Integrated food-energy systems (IFES) 	<ul style="list-style-type: none"> • Integrated soil-crop-water management improves the soil's capacity to retain nutrients, improving productivity • More integrated systems often have important biophysical and socioeconomic benefits when compared to conventional systems (e.g., without the integration of trees, etc.) • IFES reduce energy poverty next to providing food and nutrition
Energy management	
<ul style="list-style-type: none"> • Wind and geothermal energy (such as windmills) • Solar power (such as photovoltaic panels) • Energy-efficient cook stoves • Equipment for bio-oil extraction and purification • Fermentation and distillation facilities for ethanol production • Solar-, wind- or bioenergy-operated water pumps • Renewable energy-powered vehicles • Heat generation and recovery systems (such as heat pumps, geothermal energy, insulation) • Dedicated energy crops 	<ul style="list-style-type: none"> • Energy technologies can improve energy efficiency, increase the use and production of renewable energy, and broaden access to modern energy services • Developing and using local energy sources can increase incomes and expand the diversity of energy sources, increasing resilience to climate change
Conservation and management of genetic resources	
<ul style="list-style-type: none"> • Use of genetically diverse varieties and breeds • Using grazing animals to manage landscapes and wildlife habitats • <i>In situ</i> conservation of wild relatives (for example protecting important species by designating sites as genetic reserves) • <i>Ex situ</i> conservation (for example, conserving species in gene banks) 	<ul style="list-style-type: none"> • Diversity on farms can contribute to risk management, adaptation and resilience

Summarized from FAO 2013

Changes in technologies and practices that are often climate-smart alone normally do not achieve an impact that can be successfully scaled up; local action must be supported by strong enabling conditions. For example, in order to adopt CSA practices, farmers must overcome barriers to change, including up-front costs in inputs and labour, foregone income

and increased risks during the transition to improved practices. Conditions such as secure land rights, social protection schemes, financing, incentives and information provided through extension services can empower farmers, particularly the most vulnerable, to invest in CSA practices. Similarly, legislation, institutional structures, policies and plans for disaster risk reduction can help farmers manage risks and uncertainty related to climate change and benefit from improved practices (FAO 2013). Table 2 provides an overview of the enabling environments needed to pave the way for CSA, focusing on those enabling conditions related to production.

Table 2. Enabling environments needed for implementing and scaling CSA technologies and practices

Challenge	Enabling environment
Policies and programs	
<ul style="list-style-type: none"> Supporting effective planning, design and implementation 	<ul style="list-style-type: none"> Cross-sectoral coherence, coordination and integration among agencies in charge of climate change, agricultural development, food security and other sectors at the national and local level Partnerships with non-government stakeholders CSA mainstreamed into core government policies and programs including policy expenditure and planning frameworks from the local to national level Public support focused on research, developing human capital, sustainable management of soil and land, social protection and safety nets, and technology and value chain development CSA integrated with disaster risk management and social safety net programs
<ul style="list-style-type: none"> Overcoming barriers to adoption 	<ul style="list-style-type: none"> Secure land rights/tenure Equitable access to land Policies that provide an enabling environment for the adoption of CSA by the private and public sectors, informed by solid understanding of financial and socio-cultural barriers An integrated approach to providing incentives for CSA, such as payments for environmental services combined with removal of ineffective subsidies
Local institutions	
<ul style="list-style-type: none"> Overcoming barriers to adoption (by providing financial services, credit and access to markets) 	<p>Organizations and institutional arrangements that provide:</p> <ul style="list-style-type: none"> Social safety nets (such as cash transfers, seed distribution, food for work) Payments or rewards for environmental services Micro-credit and insurance (such as index-based weather insurance) Strengthened formal and informal agricultural markets
<ul style="list-style-type: none"> Producing, sharing and facilitating access to knowledge 	<ul style="list-style-type: none"> Institutions that produce and share information and help people translate this information into knowledge and action (such as farmer field schools, farm radio shows, local agricultural demonstration plots and events, and farmer-to-farmer exchanges) Agricultural business hubs Information and communication technologies to improve agricultural information access Investment in agricultural education and training institutions Robust sources of information and extension that are tailored to local conditions

Challenge	Enabling environment
<ul style="list-style-type: none"> Sharing and managing knowledge across institutional silos and facilitating collaboration 	<ul style="list-style-type: none"> Networks to support information exchange and partnership building (for example between research institutes, agricultural advisory and extension service providers, climate information services and farmers' organizations) Institutional arrangements that support collaborative action (such as water or forest management groups, community-based restoration)
Disaster risk reduction (DRR)	
<ul style="list-style-type: none"> Using existing disaster risk reduction and climate change adaptation capacities to support CSA 	<ul style="list-style-type: none"> National enabling environment (national legislation, institutional structures, policies and planning frameworks) for disaster risk reduction and climate change adaptation Global policy frameworks, community-based participatory processes for assessing local risks, and technologies and practices for DRR and climate change adaptation Vertical links between a national enabling environment and local support and implementation Partnerships between DRR and climate change adaptation communities
Social protection/Safety nets	
<ul style="list-style-type: none"> Protecting lives, livelihoods and potential development gains from CSA against climate-related and other risks Overcoming barriers to CSA adoption for poor and food-insecure people, households and communities 	<ul style="list-style-type: none"> Safety nets that provide resource transfers (such as cash, food or voucher transfers), enabling poor and food insecure farmers to invest in practices that improve productivity, adaptation and resilience-building, as well as disaster risk reduction measures (such as weather index-based insurance) Access to finance through loans, savings and microcredit Access to different forms of insurance (crop, livestock, index)
Monitoring & Evaluation (M&E)	
<ul style="list-style-type: none"> Assessing, monitoring and evaluating CSA to support learning and policy development 	<ul style="list-style-type: none"> M&E based on and integrated into existing national level systems, programs, policies and projects for agriculture, development, natural resources management and disaster risk reduction Information and communications technology to collect, process and transmit M&E data and facilitate communication among stakeholders National systems of data collection relevant to M&E complemented by local systems and local knowledge and observations
Capacity development	
<ul style="list-style-type: none"> Meeting the intensive knowledge and learning requirements of CSA 	<ul style="list-style-type: none"> Socio-institutional learning processes that develop CSA skills at the national level including engagement of national and local formal and informal education and training institutions Strengthened agricultural innovation systems with public and private research, extension and advisory services that produce, document, blend and share different kinds of knowledge (such as scientific and indigenous) Inclusive, gender-sensitive spaces for multi-stakeholder communication, knowledge-sharing and learning such as cross-ministerial roundtables and multi-stakeholder strategy development platforms Knowledge networks and platforms that use ICT, Communication for Development approaches and knowledge-sharing methods to

Challenge	Enabling environment
	<p>enable information access, facilitate communication and support learning</p> <ul style="list-style-type: none"> • Training and capacity development for people and institutions in data collection, assessments, monitoring and evaluation for CSA

Summarized from CSA Sourcebook (FAO 2013)

The enabling conditions for CSA span institutional arrangements, policies and financial investments from the local to international level. These conditions can include changes along food chains from input production all the way to consumption patterns (HLPE 2012a), food laws and standards.

Individual and collective capacity in areas such as learning, decision-making and strategic planning can help create the right enabling conditions, making this an indispensable area for investment in guiding responsible scaling in agricultural development (Wigboldus and Leeuwis 2013). Without investing to strengthen those capabilities, efforts may go toward scaling technologies rather than conditions for change. In other words, scaling the capacity for scaling is part of the scaling process (Wigboldus and Leeuwis 2013).

SECTION 3: SCALING UP CSA

3.1 What is scaling up?

Scaling up, as defined by The World Bank (2003), is “to efficiently increase the socioeconomic impact from a small to a large scale of coverage”, referring to the “replication, spread, or adaptation of techniques, ideas, approaches, and concepts (the *means*), as well as to increased scale of impact (the *ends*).” Achieving this goal requires looking beyond the traditional project cycle to identify opportunities for wider and lasting impact by expanding, replicating, adapting and sustaining effective approaches (Linn, 2012). Scaling up is typically a long-term, non-linear process that combines generalized and context-specific approaches, focusing on the order of activities, integrating local and ‘external’ knowledge and mainstreaming new processes and principles (World Bank, 2003). It can occur horizontally, by replicating promising or proven practices, technologies or models in new geographic areas or target groups (e.g. Linn, 2012; World Bank, 2013); vertically, by catalyzing institutional and policy change (e.g. World Bank, 2003); and diagonally, by adding project components, altering the project configuration or changing strategy in response to emergent reality. Scaling up can occur directly, where an organization is directly responsible for change, and indirectly, where an organization influences change. The processes and possible pathways for scaling up CSA are discussed further in Section 4.3.

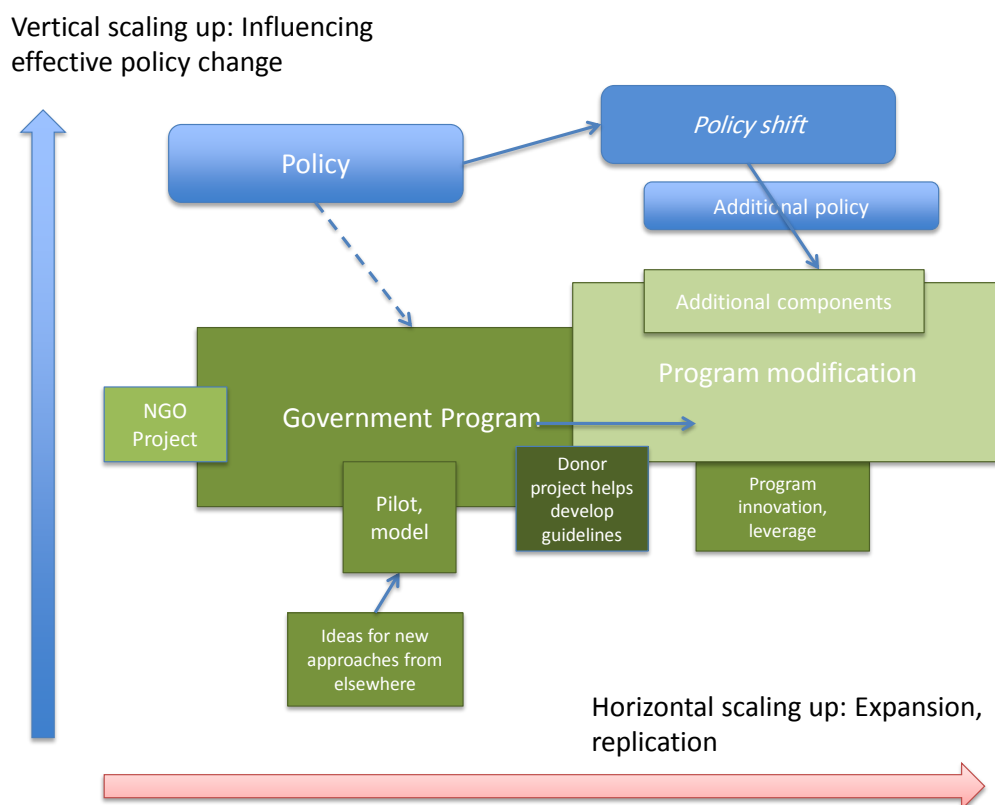


Figure 2. Conceptual illustration of a non-linear scaling up pathway. Governments, donors, NGOs, policy makers and others play diverse roles with regard to pilots, projects, programs, guidelines, program modifications and policy shifts in a complex web of activity and influence. Source: Jim Hancock.

In scaling up new ideas, approaches, models, methods or policies, it is important to identify expected success from the outset (World Bank, 2003; Linn, 2012). As the process of scaling up is one of continual iteration and improvement, identifying appropriate indicators for success is a key requirement for measuring success or failure. Tracking indicators can help test the underlying hypotheses around the change process and determine whether the Theory of Change (see Box 1 and Figure 3) was appropriate or needs refining. This makes it possible to identify necessary improvements or deviations from the intended pathway and take corrective measures.

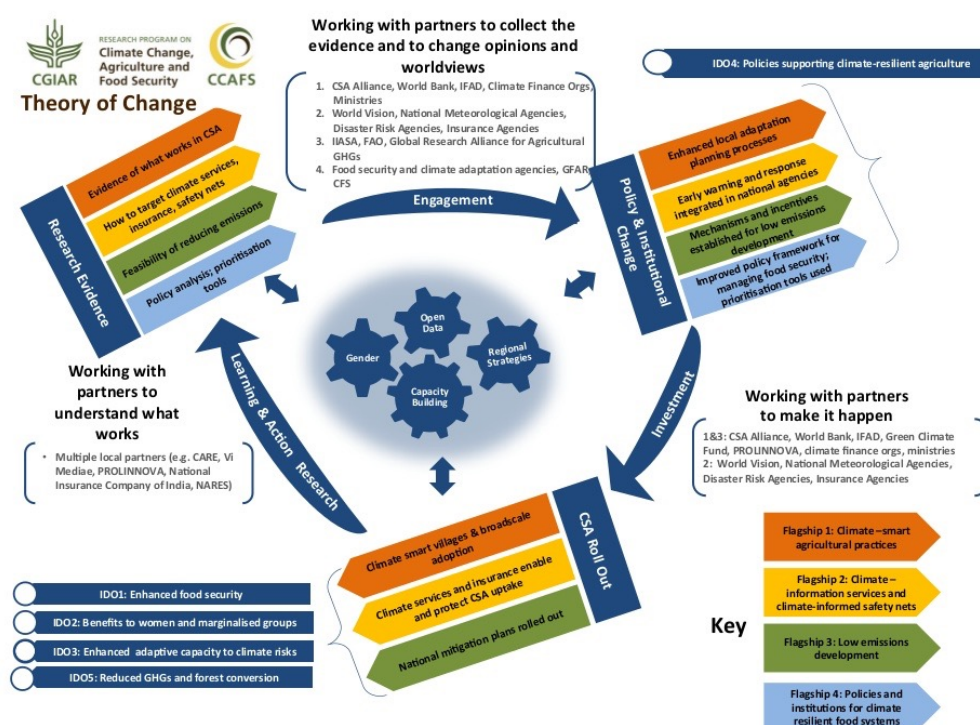


Figure 3. CCAFS Theory of Change. This shows the Flagship Projects, activities (learning and action research, etc.), key strategies for impact (social learning approach, partnerships, etc.) and the key roles of partners

It is important to note that not all projects can or should be scaled up; it is part of the discovery process that not everything works (Linn 2012). Project leaders are rightly concerned to ensure that successful innovations are not restricted to pilot locations or small groups, but caution is warranted before promoting expansion of a flawed innovation or assuming that a successful pilot will be applicable in another context. As projects and impacts grow in scale, there is potential for perverse outcomes (such as market oversupply due to rapid yield increases), increased logistical and capacity requirements (such as new technology and expertise not available in the area) and greater friction due to bureaucratic and political factors (such as beneficiaries being alarmed by transformation of existing systems). Further, it may not be desirable to scale up some practices, such as using soy for livestock feed or practices that favour large-scale farmers.

Box 1. Theory of Change

Theory of Change (TOC) is a testable mental model of change that identifies the interventions necessary to achieve a long-term goal. It describes the ideal process of scaling up CSA, articulating how and why interventions will lead to change by linking activities with specific outcomes. This process begins by defining long-term goals, then mapping out the intermediate and short-term outcomes necessary to achieve them, including the causal connections between these outcomes. Charting this “pathway of change” requires articulating the underlying assumptions used to explain the change process (The Centre for Theory of Change, 2013).

TOC is a fundamental part of program planning, decision-making and evaluation. It can help organizations strategically plan the change process; communicate with internal and external partners; monitor and evaluate outcomes and impacts; and better understand and develop the theory behind their programs, initiatives or organizations as a whole (Stein and Valters, 2012).

A TOC must be testable and can therefore be modified or improved if the scaling up process does not play out as expected and actual outcomes differ from desired outcomes. It is most effective when it is developed at the outset of an initiative, as this allows the greatest influence on planning and decision-making. The TOC can also foster collective thinking around a change process and identify gaps in this thinking (Adekunle and Fatunbi, 2014). It is most effective when it incorporates the perspectives of diverse stakeholders.

A good example of a TOC is that of the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS, 2013), which seeks to catalyze positive change towards climate-smart agriculture, food systems and landscapes. A cornerstone of CCAFS’ Theory of Change (Figure 3) is partnerships. CCAFS will closely collaborate with development partners, including the major organizations that set the agenda for rural development globally and nationally, and also include small-scale farmers, and their representative organizations. Such partners will help set the research agenda, leading to more demand-driven research.

3.2 What makes scaling up CSA unique and challenging?

Scaling up CSA differs from scaling up many technological innovations in the agricultural sector. For a new grain variety to be successfully adopted it is necessary to provide a functioning supply chain and a marketing and communications approach. The new variety may require modifications to sowing, fertilizing and harvesting practices, but adaptive measures can be developed and shared with farmers to avoid increasing uncertainties in farm management (e.g., Thomas et al. 2007; Alem et al. 2009; Campbell and Beckford 2009). It is often sufficient to provide evidence of higher yield to achieve the desired uptake.

Scaling up CSA, on the other hand, will often require a more profound change. For example, integrating trees into an agricultural system involves new training, developing a new supply chain, altering known practices and managing the trees for competition with annual crops. An even more profound change could be required if a changing climate or other external driving forces demands abandoning known lifestyles and values. This can be deeply traumatic if not

properly managed. Introducing practices that require more profound shifts will therefore typically evoke more resistance.

CSA initiatives take place amidst many other different scaling processes, and can be influenced by, complement, conflict with and trigger other forms of scaling (Wigboldus and Leeuwis 2013). These range from increasing or decreasing environmental degradation and water availability to education and income. To drive a particular scaling process, it is important to understand how it could best fit and interact with existing and anticipated scaling processes (Wigboldus and Leeuwis 2013).

CSA initiatives cut across biophysical, socioeconomic and institutional dimensions, which present different issues at different scales. Awareness of these three dimensions is key to envisioning, mapping out, implementing and monitoring CSA impacts at scale (see Section 3.3v, Multi-dimensional monitoring and evaluation)

- **Biophysical dimension.** Achieving successful land use change, reforestation or other interventions in one small watershed is a very different challenge from realizing change across an entire district or agroecosystems. When scales of desired impacts are larger, geographic variation and similarity – often described as the mosaic of micro-environments – need to be taken into account more carefully in applying new technologies (see Section 3.3i, Landscape analyses and approaches: incorporating multifunctionality and tradeoffs).
- **Socio-economic dimension.** While a grant for technical assistance can foster improvements in production, income, livelihoods and climate resilience in a small community, achieving long-term changes across thousands of villages requires different approaches and investments. At larger scales, market effects such as economies of scale and differences in market access come into play. For example, what may be an unusually successful crop from a new production system at the local community level could be a surplus in that region's markets. If an intervention is to contribute to impact in a larger area, a wider range of social and cultural groups and contexts need to be understood. An adaptation technology that is suitable for one hilltribe may not be applicable in similar environments with other ethnic groups, due to different norms or work burdens.
- **Institutional dimension.** Pilot projects that encompass a small number of communities are important for generating and testing new ideas and informing dialogue. They often have intensive capacity building and facilitation support through NGOs. However, small projects may not always take into account the institutional dynamics required to apply key lessons at large scale, to engage provincial bureaucracies or to put in place a trained and capable team of extension officers across an entire district. When moving to larger and longer-term scales, budgets, fiscal issues and public expenditures become strong forces for success or failure. Where there is success at scale, political economy and interests also increase. The type of support community and producer groups need when they operate at larger scales introduces new challenges for them. When they operate as larger organizations and experience success, they may be pulled into local political dynamics as project funds become larger and more prone to political manipulation.

For agricultural systems to achieve climate-smart objectives, they need to look beyond the farm or field scale and become 'climate-smart landscapes' (Scherr et al. 2012). A landscape is a socio-ecological system comprised of a mosaic of different land uses (e.g. Freeman et al. 2015). These uses include everything from smallholder farms and livelihoods to agricultural,

forestry and mining industries, to recreation, tourism and protected areas. Landscapes are shaped by interactions between people, land, institutions and values (Minang et al. 2015) and their boundaries are often defined by a combination of context and objectives (Freeman et al. 2015). Climate-smart landscapes integrate climate change adaptation and mitigation into their management objectives (Scherr et al. 2012). According to Scherr et al. (2012), they are characterized by three key features: climate-smart practices at the field and farm scale, such as soil or grassland management; diverse land uses across the landscape to promote resilience; and management of land use interactions at landscape scale to achieve social, economic and environmental impacts, such as managing agricultural and forest development together. Scaling up CSA requires a landscape approach that combines these multiple social, environmental and economic objectives (Section 3.3i).

CSA stakeholders should be aware of factors that may hinder scaling up and the risks and common errors involved in operating at a larger scale (Table 3). These factors and risks span biophysical, social, economic, political and institutional dimensions and need to be systematically assessed in order to be avoided or minimized. We return to these challenges throughout this paper.

Table 3. Three categories of constraints

Understanding context	The complexity of agro-ecological and socio-economic landscapes makes it challenging to identify simple, unified technologies that can be tested and rolled out quickly. Developing agricultural systems in the hilly areas of Nepal, for example, is difficult due to variations in soil, climate and ethnicity, even between adjoining valleys. It is critical to appreciate landscape diversity, to consider the specific context of any intervention being scaled and to carefully assess the risks and likelihoods of failure of applying new ideas in different contexts.
Thinking beyond production	Agricultural production interventions, which are often a core element of CSA, frequently overemphasize production. This common error can lead to local oversupply of products, often accompanied by a ‘push’ of inputs from extension services. If producers lack an understanding of transaction costs or market accessibility, or underestimate existing market and institutional failures, this may hinder scaling up. These types of errors quickly halt further uptake, and even heighten scepticism about similar future interventions.
Capacity and support	Major constraints to rolling out new CSA systems include shortages in critical complementary services, for example supporting production oriented initiatives with marketing, and large-scale capacity in extension delivery (both staffing and skills). Lack of continuity in financing of support programs and gaps in trust and cooperation between key institutions can mean that certain pathways to scaling up will be riskier than others. Lack of institutional support can be caused by traditional and local government politics, to political economy at national level.

In general, when scaling CSA it should not be assumed that success at one level would mean success at other levels (Wigboldus and Leeuwis 2013). What works at one scale may not

work at others and what benefits one group may not benefit everyone. For this reason, experimentation should not stop after identifying something that works under a certain set of circumstances, but continue the process as it is taken to scale. Problems may also arise if there is incompatibility between scales, for example, if a spreading agricultural system exceeds the capacity of the environment to provide services such as fresh water (Wigboldus and Leeuwis 2013).

3.3 Practical elements for scaling up CSA

Through the first CSA scaling up workshop and the learning that has followed, we identified a set of seven key elements that provide practical guidance in the process of scaling up initiatives. Rather than a fixed set of principles or a checklist to be followed, these elements are a thought menu – a tool for CSA practitioners and policy makers to proactively think through challenges and opportunities in scaling up. These elements are relevant to scaling up more generally, but are especially important in the context of CSA, with its multi-dimensionality, timescales and knowledge requirements. This subsection introduces the seven elements, while Table 5 (Section 4) summarizes them during different stages of scaling up CSA.

(i) Landscape analyses and approaches: incorporating multifunctionality and tradeoffs

Landscapes are complex socio-ecological systems that evolve with time, and need effective management to guide this change toward positive outcomes (Sayer et al. 2013). A landscape approach (also called an integrated landscape approach or integrated landscape management approach; e.g. Freeman et al. 2015; Scherr et al. 2012) works across entire landscapes to achieve multiple social, environmental and economic objectives together (Minang et al. 2015). It captures a scale at which conflicts and tradeoffs between objectives can be understood and opportunities for synergies can be realized. Landscape approaches can act as frameworks for addressing complex landscape-scale challenges or “wicked problems” (e.g. Sayer et al. 2013), societal problems which have no single clear solution and where gains from one perspective are often losses from others (Rittel and Webber 1973). CSA requires a landscape approach to take into account both interconnected agro-ecological systems and community and institutional dynamics. This is critical for understanding the challenges of operating at a larger landscape scale, such as political economy, as well as the opportunities from synergies, community support systems, value chains and economies of scale. Climate-smart landscape approaches incorporate climate change adaptation and mitigation in their social, environmental and economic objectives (Minang et al. 2015).

One of the key defining characteristics of landscape approaches is multifunctionality, or achieving multiple objectives simultaneously (Freeman et al. 2015; Minang et al. 2015; Sayer et al. 2013). Multifunctionality is what gives interventions so much potential, as it can create greater synergy between climate change mitigation and adaptation and promote collective action (Minang et al. 2015). It is crucial to recognize and address the synergies and tradeoffs between the diverse goods, values and services that landscapes provide, and reconcile stakeholders’ associated uses, needs, values and objectives (Sayer et al. 2013). Landscape approaches also need to be aware of the processes and influences that play out at multiple scales within and across landscapes and can affect outcomes at all scales (Sayer et al. 2013). Multifunctionality and multiple scales are two of 10 principles proposed by Sayer et al. (2013) to help guide decision-making processes in landscape contexts. These principles are discussed throughout the elements we present.

The presence of diverse land uses across a landscape can provide resilience by reducing risks to production and livelihoods and providing access to a diversity of food, feed and employment options during extreme climatic events, as well as improving ecological resilience (Scherr et al. 2012). Resilience is an important principle in landscape approaches, as it is critical to sustaining important processes and benefits over time while interventions drive change (Sayer et al. 2013). Buck and Bailey (2014) suggest that framing a landscape approach around resilience can result in technical innovation, institutional capacity and political will. They propose a framework for socio-ecological resilience that comprises four closely interrelated landscape dimensions: livelihood resilience (for example through income diversification and nutritional improvements), agroecosystem resilience (for example through soil management), ecosystem resilience (for example through restoring woodlands or creating wildlife corridors) and institutional resilience (or increased capacity to learn and innovate, for example through knowledge exchange networks).

Working at the landscape level requires understanding that optimal outcomes are almost always unattainable (Sayer et al. 2013). Because of the many stakeholders, interests and values involved, tradeoffs and compromises are an inherent part of the process. Rather than pursuing win-win ideals, Freeman et al. (2015) suggest that integrated landscape approaches should identify realistic objectives and potential tradeoffs to achieve multifunctionality. This means that decision makers must consider all stakeholders and include them in the landscape approach process as best as possible (Sayer et al. 2013; see also Box 4). The landscape approach is less about end goals than about a process of continual negotiation, decision-making, learning and revision (e.g. Sayer et al. 2013). The nuances of how different concepts and principles are applied within a landscape approach can create very different outcomes (Freeman et al. 2015).

(ii) Addressing drivers and spaces: context-specific factors affecting scaling up

According to Linn (2012), successful scaling up requires testing assumptions around drivers and spaces. Drivers are factors that push the scaling up process forward while spaces, the enabling environment, are needed for an initiative to grow. These should be captured when developing a Theory of Change (see Box 1). Analyzing the factors for success, which incorporate drivers and spaces, form part of the framework for building evidence-based policy decisions for scaling up (World Bank, 2003). Linn (2012) distinguishes four drivers and nine spaces needed for successful scaling-up.

Drivers

Drivers of change are:

- Ideas and models that work at a small scale or have been successfully scaled up elsewhere;
- Visions that recognize the necessity and feasibility of scaling up the idea, and leadership of one or more champions to drive and guide the process;
- External catalysts, such as political or economic crises or pressures from outside actors that provide additional impetus to move the scaling-up process forward;
- Incentives and accountability of results necessary to drive actors and institutions, including rewards, competition, political pressure, community demand, peer reviews and independent evaluations (Linn 2012).

Examples of drivers include community demand for changes in technologies, larger scale market ‘pull’ for certain agricultural products and environmental or social stresses that reach a critical level. For example in Bangladesh, one of the countries most at risk of severe climate

change impacts, inadequate access to food and fodder, drinking water and fuel wood triggers human migration and the establishment of unplanned settlements in the country (see Section 6, Case Study 5). Such stresses can create a political push that helps rally resources toward new technologies or practices. Changes in wider incentives, such as modifications in subsidies, realistic payments for environmental services, corporate sustainability standards or access to carbon financing, can provide a strong pull to increase efficiencies and set the stage for taking production systems to larger scale.

Box 2. Case study lessons: Drivers and spaces in practice

Several case studies highlight the role of drivers and spaces in pushing the process of scaling up forward and enabling initiatives to grow. The National Agricultural Innovation Project (NAIP) in drylands (Case study 4) found that simple, easily adopted technologies that quickly generate economic gain are suitable for rapid replication, while on-farm demonstrations and field visits, community mobilizers such as NGOs, material support (such as quality seedlings and cost offsetting) accelerate uptake. Both NAIP and a community-based Sustainable Land Management (SLM) project in Bhutan showed that external stresses (drought-induced crop failures and a dire need for farmland rehabilitation, respectively) increased farmer receptivity and uptake of practices in their contexts. The SLM project found that direct benefits to farmers combined with penalties for non-participation were effective incentives, while NAIP showed that the involvement of local leaders played an important role in driving uptake.

The National Agricultural Innovation Project in humid areas (Case study 6) sought to overcome key constraints to carbon finance for smallholder farmers, and thereby to the implementation of CSA practices. By establishing a community-owned enterprise for rural resource governance to safeguard land tenure and deliver services to farmers, it addressed key ‘spaces’ and enabled smallholders to access global carbon finance to support CSA. The Cereal Systems Initiative for South Asia (CSISA, Case study 7) is investigating farmer incentives, non-technical barriers to adoption, change agents such as self-help groups and risk-moderation strategies to help enable farmers to invest in sustainable intensification of cereal-based systems at scale in Bangladesh, India, Nepal and Pakistan.

Spaces (the enabling environment)

The spaces required for successful scaling up cover the entire range of enabling environments that create new entry points for CSA stakeholders to engage in. They include fiscal and financial resources, policy and legal frameworks, market constraints, institutional and organizational capacity, stakeholder support, cultural norms and values, partnership mobilization, knowledge sharing, capacity building and environmental sustainability (Linn, 2012). For example, a large number of national State rainfed agriculture and irrigation programs in India provide an opportunity for incorporating new technologies. Smaller modifications to government program guidelines can affect large numbers of farms and create new triggers for emerging initiatives.

Institutions and governance are as much a part of landscapes as land and people. Their effective functioning is also one of the greatest challenges to implementing landscape approaches (Sayer et al. 2013). Research institutes, government agencies, NGOs and other institutions involved in implementing CSA must have the systems and capacity in place to manage a complex and evolving scaling up process. These include multi-stakeholder planning, supportive landscape governance and resource tenure, strategically targeted

investments and multi-objective monitoring and evaluation systems (Scherr et al. 2012). These must be supported by a clear, shared vision of possible pathways for scaling up (see (iv) Project management). It is important to incorporate continuous review of the capacity of key implementing and emerging institutions, including service providers and extension agents (see Section 3.3vi, Capacity building).

Large landscape initiatives will need long-term political and institutional support from local governments and sectoral agencies to avoid duplication, manage conflict and take advantage of opportunities for synergies (Scherr et al. 2012). Governance mechanisms need to be flexible enough to respond to emerging knowledge about CSA or landscapes and recommendations from stakeholder negotiations (Scherr et al. 2012). Landscape governance may be essential to regulate interactions between people and landscape units, particularly in landscapes with different kinds of tenure (Minang et al. 2015).

At its core, however, CSA will always involve farmers, traders and agribusiness companies, and the success of any initiative will depend on how it addresses their needs and realities. Decentralized governance can enable local stakeholders to make important planning decisions that take into account local needs and priorities (Scherr et al. 2012). Secure land and resource ownership, use and access rights are important in the long term and can help practitioners overcome barriers to adopting new management practices (Scherr et al. 2012). At scale it will be important to engage with and nurture the emergence of representative bodies such as farmer federations and associations, involving them in program and policy decisions relating their production, marketing, trade and services.

Identifying drivers and spaces is an important approach to understanding immediate opportunities for scaling up CSA. For example, mapping value chain dynamics, especially for production-oriented agricultural technologies, can highlight the scope and prospects for diversification or added value, and the interest of players who create market demand.

(iii) Fostering effective partnerships and knowledge management

Strong partnerships and leaders

Because scaling up is a long-term, evolving process, core institutions need to identify and engage with a range of partners on a continuous basis. These include international donors, national funding agencies and programs, local to national levels of government, the private sector, civil society, community-based organizations and the research community. Each of these groups plays different roles in the process of scaling up (Section 4.6).

Harnessing influential local leaders, action researchers, facilitators and community mobilizers can help identify issues and engage a wider range of players and resources in scaling CSA. Change agents, ‘champions’ and individuals who are either politically savvy or committed to the end goals of inclusive CSA can be fundamental to successful scaling up. These individuals are often managers of NGOs or institutes, high-level government technical officers or senior scientists who have a strong understanding of both field-level practical realities and institutional and political dynamics. For example, the Government of India’s (GoI’s) landmark decision to adopt a National Agroforestry Policy in 2014 can be credited largely to early and ongoing engagement with government, NGO and industry representatives. After the GoI’s National Advisory Council (NAC) established a working group to develop the policy in 2013, a series of national-level consultations brought together key ministries, research institutes and representatives from NGOs and industry to engage

with agroforestry policy and related issues (ICRAF 2014). Well-placed stakeholders who can engage with decision makers and the media can also help scale up CSA, sometimes in addition to scientists and technicians.

Any partnership should consider the nature of existing roles and mandates, and the participation and governance of the institutions involved. This ensures that there are clear expectations and ‘rules of engagement’ around how the partnership will evolve and the mutual benefits it will deliver, as political and reputational stakes will rise with increasing scale and complexity of engagement.

Political support for multi-stakeholder planning, governance, targeted investments and multi-objective impact monitoring is necessary to achieve climate-smart landscape initiatives at scale (Scherr et al. 2012). Territorial development initiatives and cross-border platforms can help coordinate policies and programs in support of climate-smart landscapes, while regional development programs can provide communication platforms for coordinating local projects (Scherr et al. 2012). Both require the full participation of farmer groups and local civil society organizations (Scherr et al. 2012).

Stakeholder participation

Helping the poor to successfully participate in stakeholder processes can motivate them to engage and help them benefit from the process (Buck and Bailey 2014). One way of achieving this is to include the voices of poverty-focused community organizations and public agencies in negotiation processes (Buck and Bailey 2014). Stakeholder participation processes should also ensure that marginalized stakeholders can engage on equal levels with more powerful stakeholders (Duff et al. 2009). Social learning, or opportunities for stakeholders to learn by sharing information, is one way to help manage these kinds of social power dynamics and ensure that all interests are given equal voice (Freeman et al. 2015). Participatory approaches that combine collaborative processes and social learning in integrated landscape approaches can significantly improve management outcomes (Freeman et al. 2015).

Designers and facilitators of participatory approaches to landscape management should value different types of knowledge (Buck and Bailey 2014). Combining local, cultural, indigenous, scientific, experimental and experiential knowledge can encourage collaboration, improve communication and understanding, promote innovation and support equity in participation and decision-making (e.g. Buck and Bailey 2014; Freeman et al. 2015).

Fostering learning

Knowledge of CSA and the complex rural development environment in which it operates is constantly evolving. Creating space to learn from experimentation is therefore necessary in order to improve approaches to scaling up CSA. Action research (or co-learning) is one approach to solving real, pressing challenges, in which a diverse group uses their knowledge and skills to take action and reflect on its results, both as individuals and as a team (Coe et al. 2014). Applying co-learning with key CSA stakeholders including farmers, local extension workers, practitioners and policy makers, can help create a culture of adaptive learning focused on achieving results at small and large scales. Because co-learning requires individuals to think critically and work collaboratively, it also builds the capacity of stakeholders to confront new challenges (Coe et al. 2014).

Creating space for learning can help define, refine and test strategies for scaling up. It can identify alternative approaches, such as shifting from replicating interventions to using experiences to influence policy. Learning can be used to examine emerging risks and areas of uncertainty, and the flexibility or safeguards required to address them. It can also help modify approaches for targeting and ensuring equitable benefits, challenges that increase with scale due to greater bureaucracy and limited facilitation capacity.

Knowledge networks

Stakeholder interactions are critical for understanding and scaling up CSA experiences. These include: creating a shared understanding of success through common assessment frameworks, using different perspectives to evaluate why achievements did or did not meet expectations, identifying critical factors that influence success or failure, appreciating the limitations of and opportunities for applying lessons at a large scale or in new situations, and engaging effectively with the players in decision making processes who actually influence change. These interactions point to the need for structured processes that blend the science and art of knowledge management, emphasizing working together to create effective new knowledge. Important knowledge management processes include:

- Developing multidisciplinary approaches to gather and analyze information related to CSA, including building supportive links with the CSA science community and related disciplines.
- Building capacity and systems for adaptive management so that planning, monitoring and evaluation and policy making are results-oriented, but flexible enough to address problems that arise during implementation and adapt to new contexts and pressures.
- Fostering networks and communities of practice amongst CSA practitioners to support tacit knowledge sharing. This is especially important for addressing emerging issues, opportunities and solutions.
- Linking CSA stakeholders and their activities into the broader development community through partnerships, coalitions and meetings between government, donors and the science community. This could offer greater opportunities for dialogue and collaboration on integrating promising CSA practices into large-scale agriculture or rural development programs.
- Developing and implementing strategies for influencing policy decisions with the help of new groups and alliances.

(iv) Strategic and adaptive participatory project management

In addition to bringing multiple knowledge perspectives, stakeholders are important in the context of program processes. Agricultural landscapes and their processes are complex and dynamic, stakeholder interests are diverse and changeable, and knowledge of CSA, landscapes and related management approaches are evolving. This makes project management a central component of any CSA initiative. In particular, project design and planning can set interventions up for success by forming strong stakeholder engagement strategies, developing partnership opportunities, planning for adaptive management and defining exit strategies.

Stakeholder engagement is also fundamental to the success of landscape approaches (Sayer et al. 2013), making it an excellent starting point for project management. Approaches should identify all stakeholders and their values and goals from the outset, even if only some groups will be involved as the project progresses. The project design phase is the best time to plan for stakeholder participation and set out important rules of engagement from beginning to end of an intervention's lifespan (see 3.3(i), Partnerships). Planners will need to address the

challenge of engaging very food insecure farmers in multi-stakeholder management (Buck and Bailey 2014).

Box 3. Case study lessons: Partnerships, knowledge management and capacity building

The case studies presented in Section 6 show that the elements of scaling up often go hand-in-hand. In particular, partnerships, knowledge and capacity building often complement one another. For example, a community-based Sustainable Land Management project in Bhutan (Case study 2) used both partnerships and knowledge to help overcome constraints in scaling up CSA. The project engaged community members, researchers, extension workers and local government and leveraged indigenous knowledge and social cohesion to address issues of labour, financing and collective marketing. A survey-based research project in Sri Lanka, India and Bangladesh (Case study 3) investigated home gardeners' perceptions of climate change and documented adaptation strategies. Project leaders showed how this kind of information can be used to inform intervention design that is targeted at the right individuals, how best to reach those individuals, and how government programs can support adaptation (for example by building on strategies that are already in use).

The Cereal Systems Initiative for South Asia (CSISA, Case study 7) is creating innovation hubs, site-specific information and communications technology systems and public-private partnerships for technology access to encourage millions of farmers to invest in sustainable intensification of cereal-based systems at scale across four countries. The initiative links participatory technology development with rigorous science, informed by an understanding of markets, capital, risk and the policy environment and complemented by technology targeting, training, distribution networks and demand generation. Emphasizing integration of disciplines and institutions, it aims to engage a diversity of strategic partners, including agribusiness, farmer innovators, government and extension personnel, agricultural dealers, service and credit providers and NGOs. The Climate Change Adaptation in Rural Areas in India project (CCA RAI, Case study 8) also focused on strategically engaging partners, and found that consulting with and engaging stakeholders in project implementation facilitated scaling up. Even a large program like the National Initiative on Climate Resilient Agriculture (NICRA, Case study 1), which mobilizes 300 scientists, plus other stakeholders, must link into other ongoing programs to be successful.

The majority of case studies highlight the importance of capacity building, including NICRA and CCA RAI, and the community-based SLM project in Bhutan. NICRA, for example, seeks to enhance the capacity of scientists, NGOs, farmers, self-help groups, development banks and other stakeholders to undertake action research and spread technologies. The National Agricultural Innovation Project (NAIP) in humid areas (Case study 6) established the community-owned enterprise 'Gramya Sampada Kendra' for rural resource governance to safeguard land tenure and deliver conflict management and other services for farmers, thus building capacity among farmers, local decision makers and other stakeholders. An ICRAF-led CSA project in Bangladesh (Case study 5) found that improving farmers' skills and knowledge through training and providing technical support through extension both support scaling up. Several case studies, including NICRA, used field demonstrations or hub sites to showcase technologies in areas where they would be locally relevant.

All relevant stakeholders and interests should be included in project planning to determine priorities (Scherr et al. 2012), develop a shared vision and define clear, achievable and measurable objectives. A key part of setting a project up for success is agreeing upon an exit strategy, which can be challenging for landscape approaches that generally lack defined endpoints (Sayer et al. 2013). Negotiating and agreeing upon a logical process of change (see Box 3), including the reasons for action, risks and uncertainties, can help ensure transparency, build trust among stakeholders, and in turn form the foundation for effective management and conflict resolution in landscape approaches (Sayer et al. 2013). Investments in building trust and developing shared goals, the quality of stakeholder engagement and acknowledgement of stakeholder concerns can determine the success of a landscape approach process (Sayer et al. 2013). For example, creating and maintaining a shared vision can help coordinate the activities of multiple actors (Sayer et al. 2013). Involving diverse stakeholders in planning is also an opportunity to develop partnerships, build alliances and consolidate resources (Scherr et al. 2012).

Stakeholders such as program leaders, government officials, farmers and NGOs can have very different values and needs, with objectives ranging from immediate production increases to long-term sustainability. In such cases, working toward a common concern entry point, such as a readily attainable initial target, can build confidence and initiate the process of agreeing on broader goals (Sayer et al. 2013). A well-known approach to assess project management, performance management and development is SMART (Doran, 1981), which stands for Specific, Measurable, Assignable, Realistic and Time-related. While the approach is primarily used within corporate organizations, it can also be used to identify metrics and measure project management objectives.

Achieving project objectives is rarely a straight path to an end goal, but an ongoing process of negotiation, learning, revision and development (e.g., Sayer et al. 2013). Adaptive management, an approach that views interventions as learning experiments and uses their outcomes to inform decisions and improve management, is essential for achieving sustainable outcomes (Minang et al. 2015). More recently, adaptive collaborative management (ACM, or adaptive co-management) emerged as an approach that brings together all stakeholders that share an interest in landscape resources to collectively plan, observe and learn from experience (e.g. Plummer 2009). This approach addresses diverse interests, values and actions among multiple actors and supports equitable management. CSA projects and programs should be designed to ensure that processes of continual learning and adaptive management could support change over time, using a strong monitoring and evaluation framework.

Decision-making underpins all aspects of project management and its quality depends on the process behind it (Sayer et al. 2013). The Stakeholder Approach to Risk-informed and Evidence-based Decision-making (SHARED) is an example of a decision support process currently under development (see Box 4). The recently developed Resilience Adaptation Transformation Assessment (RATA) Framework guides decision makers in understanding systems, creating a shared vision and determining if it is resilient and sustainable, selecting the best indicators for monitoring and reporting, and using the results of M&E to support learning and inform decisions (O'Connell et al. 2015). Using processes like SHARED or RATA from the outset of project planning can lead to better decisions and outcomes over the project's lifespan.

Box 4. Stakeholder Approach to Risk-informed and Evidence-based Decision-making

Stakeholder Approach to Risk-informed and Evidence-based Decision-making (SHARED) is an example of an interactive engagement process for collaborative learning and co-negotiation of development decisions (Chesterman and Neely, 2015). SHARED uses inclusive, evidence-based decision making to address risk, agree upon outcomes and achieve greater returns on investment. The SHARED process is made up of four inter-related phases that can be adapted to different contexts, stakeholders and resources (Figure 4). It begins by facilitating stakeholder discussions to understand the context for decision-making, identifying desired outcomes and developing a stakeholder engagement strategy. It then gathers, integrates and analyzes evidence for decision-making and uses interactive, collaborative learning to test decision options towards a desired outcome. Lastly, it develops an implementation strategy and monitoring plan to track outcomes and respond where needed. This unique approach can help address the complexity of decision making, tailor facilitation processes and tools to specific contexts and test decisions that are linked to specific, intended long term impacts (Chesterman and Neely, 2015).

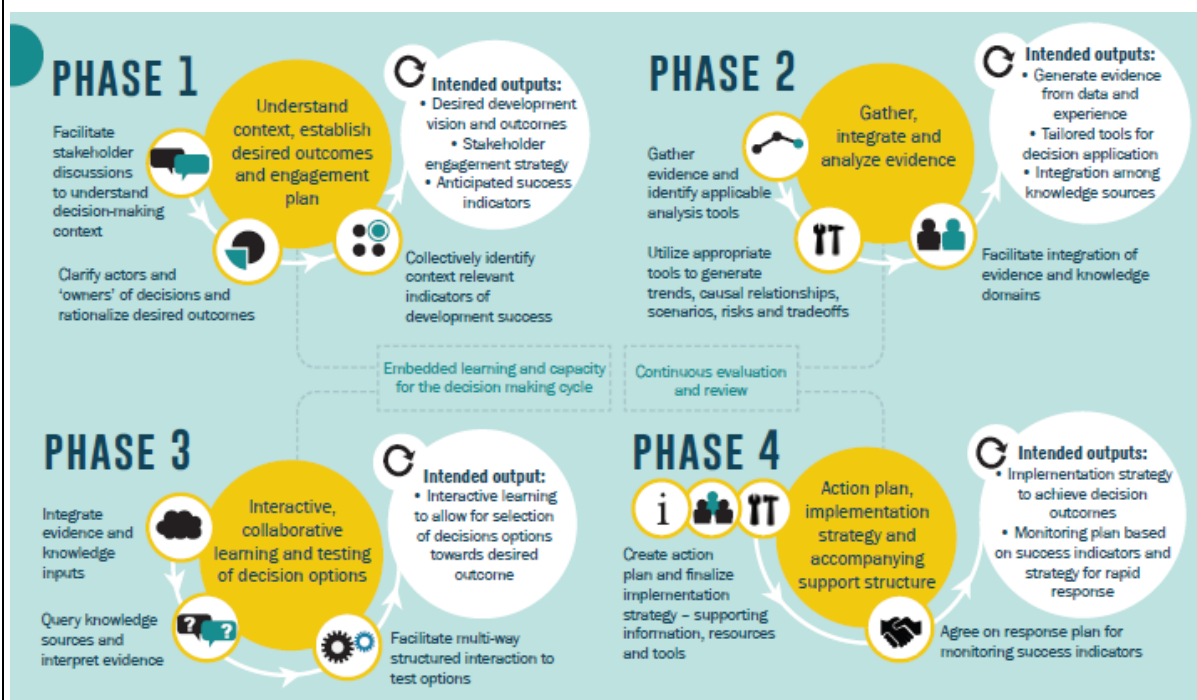


Figure 4. Schematic of the Stakeholder Approach to Risk-informed and Evidence-based Decision-making (SHARED) process. From Chesterman and Neely (2015).

(v) Multi-dimensional monitoring and evaluation

Monitoring and evaluation (M&E) systems track changes over time and space to measure progress toward social, economic and environmental objectives at different scales. This knowledge can be fed back to further refine and improve theories of change (see Box 1) and adapt management approaches where needed. The entire process might look something like this: project managers develop a Theory of Change, select indicators, choose a data collection method for each indicator, establish a baseline, determine progress against the baseline, communicate change and refine the Theory of Change. This requires a robust evidence base generated by M&E systems.

M&E systems are essential for capturing the effects of different scales in scaling up CSA. Without in-depth understanding of how interventions affect multiple dimensions of space, time and agency makes it impossible to assess their long-term and large-scale effects. It is also important to identify what barriers exist to large-scale adoption and how they can be circumvented.

Strong frameworks for generating evidence

Strong planning and M&E systems are not only a core element of project management, but of learning and generating knowledge. This is especially true if the systems are participatory, systematic and capture information from a range sources and methods. M&E are critical in generating the evidence for whether or not a new CSA process is working and why and helping stakeholders communicate this information. The CSA Sourcebook (FAO (2013), Module 18) outlines the major elements of CSA assessment, monitoring and impact evaluation required to manage CSA programmatic approaches, incorporating multiscale climate, mitigation and livelihoods adaption dimensions.

Strong planning and M&E systems require a rigorous/objective impact assessment framework, accountability and feedback mechanisms. These help ensure that stakeholders on the ground are engaged and can verify results as CSA interventions go to scale. Monitoring systems are needed to track intermediate outcomes, intended targeting of beneficiaries, and effective and efficient use and allocation of project resources. Methods to measure efficiency in the overall process, such as cost-benefit analysis and financial assessment of benefits at farm level can help determine if processes make economic sense when taken to scale.

A good understanding of the robustness of evidence is important for assessing and building up an evidence base for decisions on scaling up. Words such as ‘innovation’, ‘good’ and ‘best practice’, and ‘success’ are used frequently without a clear reference framework for how strong the M&E information is that will help policymakers and managers make decisions about scaling up. It can therefore be useful to look at how, how often and in which contexts practices have been evaluated, as part of the discussion and learning about potential practices, and thus the degree of confidence there is for adoption, expansion or other forms of scaling (Table 4).

Table 4. State of Practice Framework

State of practice	Level of evidence	General applicability
Policy principle	Proven in multiple settings, replication studies, evidence quantitative, scientific	Consistently replicable, widely applicable “truism” essential for success
Best practice	Evidence of impact from multiple settings, meta-analyses, expert review	Demonstrated replicability, limited risk
Good Practice	Clear evidence from some settings, several evaluations	Promise of replicability, medium risk
Models	Positive evidence in a few cases Program evaluations, conference workshops	Limited number of settings and experiences
Promising practice	Unproven in multiple settings, anecdotal evidence, testimonials articles, reports	High risk
Innovation	Minimal objective evidence, inferences from parallel experiences and contexts	New idea, no previous experience; highest risk

From Hancock 2003, and sources

Dimensions of monitoring and evaluation

One of the challenges for M&E systems in CSA initiatives is to capture diverse livelihood, environmental and socioeconomic objectives and benefits. This requires monitoring diverse objectives ranging from GHG emissions and biodiversity conservation to food security and the effectiveness of important institutions (Scherr et al. 2012). Achieving climate-smart landscape initiatives at scale requires multi-objective impact monitoring (Scherr et al. 2012). This should include the social components of social-ecological systems which are often overlooked (O’Connell et al. 2015). While methods for measuring simple indicators, such as soil pH, are well developed, methods to measure more complex indicators, such as leadership or trust, are not (O’Connell et al. 2015). These complex indicators are often required for monitoring the diverse objectives in climate-smart landscape initiatives. Another challenge is to put in place impact assessment systems that track long-term changes, beyond the timescales usually associated with development projects.

To understand how effective initiatives have been at building resilience, monitoring systems must overcome the challenges of limited time and information and the fact that resilience is influenced by very context-specific factors (Hills et al. 2015). Hills et al. (2015) present a monitoring instrument for tracking changes in resilience and in turn informing decisions on program planning and management, using proxy indicators to reduce resource requirements. This instrument covers three indicator categories: the capacity of people to adapt (such as the capacity to learn and self-organize); enhanced livelihoods and farm functioning (such as asset diversity); and ecosystem services that support resilience (Hills et al. 2015).

Campbell et al. (2001) proposed a framework for assessing system performance based on the sustainable livelihoods approach. This approach identifies five different forms of capital: physical capital, such as household assets and infrastructure; financial capital, such as credit and savings; social capital, such as social organizations and relationships of trust; natural capital, such as water and forest resources; and human capital, such as knowledge, skills and health. Selecting indicators based on these five capital assets can help prevent bias toward any one discipline.

To address the challenge of comparing livelihood systems in different dryland regions, Fraser et al. (2011) developed a framework to assess the vulnerability of socio-ecological systems to climate change. They suggested a three-dimensional assessment of agroecosystems, household assets and institutions to identify how systems, groups and regions within each component change through time.

The specific M&E assessment approaches used should vary with the scale of the system in question, along with the socioeconomic and ecological context, while indicators need to be based on local conditions (Fraser et al. 2011). An urgent need is the development of monitoring systems that bring together different types of information from different sources and make it accessible to all stakeholders so that it can be fed back into theories of change (Sayer et al. 2013).

(vi) Practical and local capacity development through learning by doing

Just as solving complex development problems takes more than technical knowledge (Nederlof et al. 2011) agricultural innovation often involves making very different types of changes at the same time, such as new technologies, organizational changes and new policies (Posthumus and Wongschowski 2014). As a relatively new field, CSA is at an intensive stage

of innovation and learning, and now is the time to nurture and develop the means of innovation and the mechanisms supporting them. Farmer-led research and co-learning approaches can help develop new technological practices that are supported by locally appropriate farmer incentives, infrastructure and institutional systems.

However, innovation does not stop after a small-scale field model has been tested and deemed successful. New approaches need organizational systems that can continue to support CSA innovation at larger scales. These systems should provide stakeholders, especially communities, with the flexibility to take risks and the ability to access knowledge, ideas, support and resources to innovate further. Unlike ‘traditional’ extension services that have transferred outside solutions to farmers, new approaches need to be farmer-based, driven by local needs, participatory and considerate of groups such as women, young people and the very poor (Kiptot et al. 2012; Kiptot and Franzel 2014; Degrande et al. 2013). Several extension approaches can help spread innovation when technical solutions are not enough: farmer-to-farmer extension and farmer field schools; Rural Resource Centres and relay organizations; and innovation platforms (see Annex I for brief descriptions of these approaches).

- **Farmer-to-farmer extension:** The volunteer farmer trainer approach uses farmer trainers to train their peers, mobilizing people to disseminate information and promote the adoption of agricultural.
- **Community nurseries and farmer field schools:** A widespread approach for enabling a process of structured, field-level learning and problem solving among farmers by bringing them together on experimental farms or other field-level examples of successful innovation.
- **Innovation platforms:** These are spaces for fostering learning and creating change by bringing diverse actors (e.g., farmers, researchers, local authorities, conservation officials, extension officers, supply chain actors financiers) together to share knowledge and find solutions to common problems in an equitable and dynamic space.
- **Rural Resource Centres:** These are community-based hubs for information access, interactive learning, training and networking that values local knowledge and priorities and encourages researchers, extension workers and farmers to learn.

Different socioeconomic and ecological contexts, different practices and different groups, such as women may need different approaches (ICRAF 2015).

(vii) Maximizing the benefits of including women and other disadvantaged groups

Resources, roles, relationships and land rights all influence how individuals participate in CSA and to what benefit. Together with social norms and household decision-making, these factors can limit women’s potential to contribute to natural resource management (e.g. Bernier et al. 2013; Neufeldt et al. 2015). For example, women in agriculture and rural areas of developing countries have less access than men to agricultural assets, inputs and services and to employment opportunities (FAO 2011), including land, tools, labour and cash (Bernier et al. 2013). These differences have an impact, not only women, but the agricultural sector, the economy and society at a greater scale. According to the FAO (2011), granting women equal access to productive resources as men could increase yields on their farms by 20-30 percent, increasing agricultural output by 2.5 percent in developing countries (FAO 2011). Clearly, if CSA initiatives are to achieve their goals and share their benefits equitably, practitioners must find ways to close gender – and other – gaps.

The Sustaining Agriculture in a Changing Climate (SACC) project in western Kenya found that taking a learning approach to CSA projects can improve both gender equity and project outcomes (Bernier et al. 2013). This flexible approach gives staff and community members the opportunity to suggest changes. The project found that three dimensions of empowerment (CARE 2015) greatly influence the ability of people to participate in and benefit from CSA projects: agency, structure and relations (Bernier et al. 2013). To achieve their goals, CSA initiatives need to emphasize women's aspirations and capabilities to implement innovations on farms, provide them with access to resources (the structure) needed to do so and encourage male support for women's needs and rights (Bernier et al. 2013). The best way to do this is to work with both men and women when implementing new practices. For example, by creating spaces for men and women to jointly participate in decision-making, the project helped challenge male-dominated decision-making. Giving women a voice in knowledge-sharing platforms and highlighting their innovations may enhance their ability to innovate and adapt (Bernier et al. 2013). In the case of SACC, both men and women valued the non-cash benefits of CSA projects, including better household communication, new roles and responsibilities for women and improved community relationships.

Livelihood benefits, including access to credit, more fuel wood and, in particular, enhanced incomes, are strong motivators for both women and men to adopt new agricultural practices (Bernier et al. 2013). Including women in decision-making around land use planning and providing them with increased access to land, labour and extension services could lead to more widespread adoption of improved technologies and enhanced food security at larger scales (Neufeldt et al. 2013; Ross and Morris 2001). Developing equitable national legislation around access to productive resources is a key step towards this, but must overcome long-standing socio-cultural norms that can make it challenging to adapt to new laws, particularly where local norms are enforced by older and often male community members (FAO 2002). Participatory awareness campaigns that involve local communities in design and implementation can encourage community buy-in and effective implementation (Clark et al. 2011). Education and training programs can also help women and other vulnerable groups understand natural resource management practices and help traditional communities adopt laws that support equitable decision-making and benefit sharing (Neufeldt et al. 2015). CSA initiatives should be aware that gender and social differences within communities are dynamic and nuanced (e.g. Neufeldt et al. 2011), that involving women in projects may increase their work burden if not done carefully (Bernier et al. 2013) and that local institutions, which play a key role in scaling up and sustaining projects, may not always support gender equity and inclusivity (Bernier et al. 2013).

SECTION 4: PATHWAYS TO SCALING UP

The purpose of this section is to assist program managers, donors, investors, policy makers, researchers, practitioners and other actors to understand the principles, precursors, partnerships and investments that are most likely to facilitate scaling up of CSA. Where appropriate, it points to the possibility of unintended or perverse outcomes. It provides a conceptual framework designed to enable project leaders and partner institutions to locate themselves in a scaling up process (see Figure 6) and to identify potential pathways toward implementation of CSA at scale. This may involve:

- Strategic mapping of different scaling approaches onto a project's specific objectives and opportunities (Section 4.3);
- Clarifying organizational roles, entry points and exit strategies across the three conceptual stages of scaling up (Section 4.4);
- Employing adaptive strategies to drive transitions across stages and support 'spontaneous' scaling up¹ that occurs through unplanned processes of adoption.

4.1 What do we know about pathways to scaling up?

While every CSA project will operate on its own timeframe, scaling up is best seen as a long-term, non-linear process. The literature suggests that scaling up is best achieved by dynamically combining generalized and context-specific approaches with careful attention to sequencing of activities, integration of local experience with 'external' knowledge and mainstreaming new processes and principles (World Bank 2003). This may involve ongoing adaptation of program protocols to local conditions, explicit mechanisms for harmonizing micro- and macro-scale concerns and close monitoring of the impact of alterations in policy and program governance.

Organizational approaches to scaling up can range from hierarchical, centralized leadership by a single institution to explicit strategies for sharing leadership across organizations, sectors and scales (Hartmann and Linn 2008; World Bank 2003). A project's organizational approach will be influenced by defined objectives and strategies and may evolve toward complex interactions among diverse organizations (World Bank 2003). For projects that require significant initiative by local communities, a shared leadership approach that solicits rich input and ownership by target groups may be most relevant.

Wigboldus and Leeuwis (2013) identify four general approaches for engaging with scaling depending on the situation in question, which they term push, pull, plant and probe. A push approach involves driving an initiative to scale in relatively simple situations with little uncertainty. In technically complicated situations, a pull approach works 'backwards' to achieve a desired future in situations. A plant approach describes working with other issues and actors to take something to scale in a socially complex situation. And in situations with the most uncertainty and disagreement, a probe approach can test which scaling processes might achieve desired goals.

¹ Hartmann and Linn (2008) suggest that "spontaneous diffusion can work for basic ideas and technologies and for information about good practices, but requires an information and knowledge infrastructure that often still is not in place in developing countries."

4.2 Horizontal, vertical and diagonal scaling up

While the process of scaling up CSA projects is generally non-linear, we can think about ‘horizontal,’ ‘vertical’ and ‘diagonal’ scaling processes.²

Horizontal scaling involves replication of promising or proven practices, technologies or models in new geographic areas or target groups (e.g. Linn 2012; World Bank 2003). For example, a CSA technology or practice that has proven to be effective on pilot farms is promoted through farmer-to-farmer exchanges. Or a successful microfinance model is replicated in similar, but distinct areas through organizational outreach. In general, relatively homogenous and high population density areas (such as Bangladesh) are considered to be well suited to horizontal scaling (World Bank 2003).

Vertical scaling involves catalyzing institutional and policy change (e.g., World Bank 2003) by demonstrating the effectiveness and efficiency of practices, technologies and models, thereby removing barriers to uptake by a larger number of practitioners. For example, demonstration of effective CSA interventions at pilot scale provides compelling motivation and guidance for alteration of programs operated by a national ministry. Or a successful pilot of a community based management approach will influence strategy and governance of a development program that affects a large population. In general, projects that deliver innovative management models (rather than practices and technologies) or focus on institutional processes and policy change are considered to be well suited to vertical scaling.

We can also think about ‘diagonal’ scaling, which involves adding project components, altering the project configuration or changing strategy in response to the emergent reality. For example, a marketing component is added to a crop yield improvement project in anticipation of potential market oversupply from surplus production. Or extension services or other government programs are adapted and expanded as a new CSA technology is shown to be locally effective. Might review of a broader set of CSA projects show that, in most cases, project leaders should plan to adaptively incorporate vertical components in order to accelerate horizontal scaling that is slow or fails to penetrate particular target areas or groups?

In any approach there can be ‘direct’ strategies, in which an organization is directly responsible for effecting change, and ‘indirect’ strategies, in which an organization tries to influence others to change and adopt new practices or policies. In practice, there will be overlaps among horizontal, vertical and diagonal scaling, as well as between direct and indirect approaches.

A number of hypotheses emerge regarding how horizontal and vertical scaling processes occur in practice and the way that these processes interact. For example, is there evidence to support the conclusion that simple changes in practices or technology, which face few structural barriers to uptake, may occur relatively rapidly through horizontal scaling while changes that require institutional or policy shifts will take more time and occur through vertical scaling? If so, this general rule would be useful to project leaders in determining whether to work toward a primarily horizontal or vertical scaling up strategy. Similarly, is horizontal scaling necessary before vertical scaling can occur? As further cases are examined, can we conclude that horizontal scaling is a necessary process for advancing from one stage

² In this paper, we focus on the processes associated with the terms horizontal and vertical scaling. Alternative concepts include ‘scaling out’ in which ideas are picked up and adapted elsewhere and ‘scaling down’ in which a mechanism is found for effectively devolving a policy implementation.

to the next while vertical scaling can occur within a single stage?

4.3 The three major stages of scaling up

There are three major conceptual stages of scaling up: effectiveness, efficiency and expansion (Korten 1980). These stages represent a general sequence of investments, transitions and outcomes on the path to CSA adoption and impact at scale. Each stage in this general sequence has distinct incentives, knowledge requirements, risk tolerances, success metrics and expectations about return on investment. These stages should not be thought of as truly separate or sequential, but as a non-linear continuum where progress can be made on multiple stages at the same time. It is not a requirement to go through all stages; certain elements of any stage may be skipped. Figure 6 represents the major stages of scaling up and Table 5 summarizes the key elements (Section 3.3) involved in each stage.

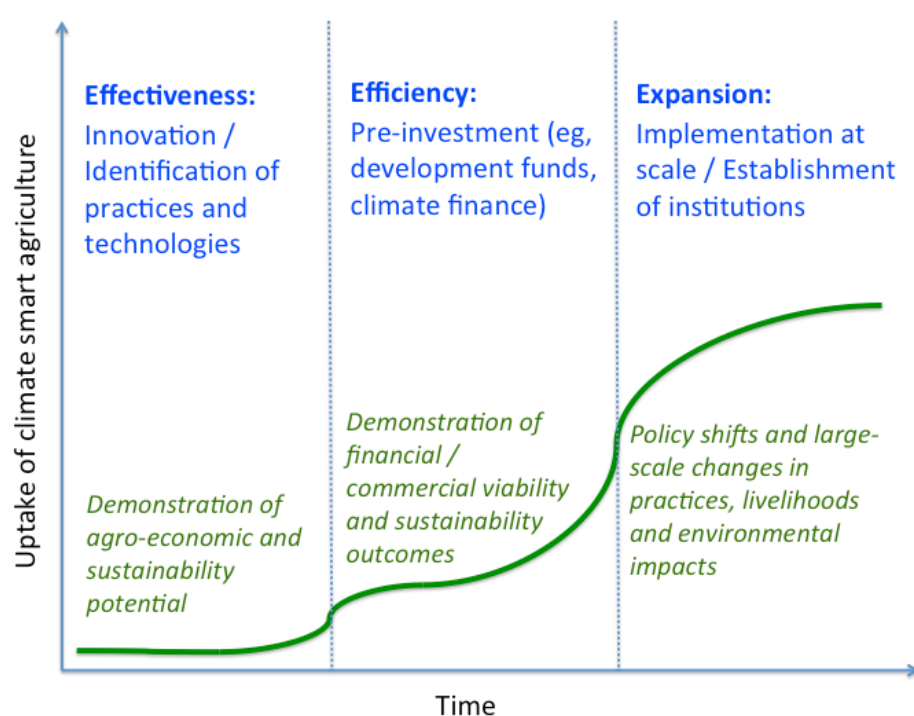


Figure 6. Major stages of scaling up CSA. This diagram conceptualizes the objectives and outcomes of the three stages and the transitions (dotted vertical lines) that must be made to scale up CSA practices and technologies from innovation to implementation at scale. Source: Christine Negra. (For related work on program learning, see Korten 1980)

Stage 1: Effectiveness

In the effectiveness stage, CSA practices and technologies are identified or developed (for example, through farmer-led research), tested at pilot scale and evaluated for agricultural, socio-economic and sustainability outcomes. This can be thought of as a ‘proof of concept’ stage. Key actors in this stage may include innovative farmers and agribusinesses, researchers, local leaders and NGOs. ‘Public good’ investment will likely be needed from global donors and national governments where investment is considered too risky by private actors, except in cases where large agribusinesses direct research and development funds toward CSA pilot projects.

What are the sources of innovation at this stage?

- Innovation can focus on specific CSA practices and technologies or entire farming systems (such as infrastructure, seeds, labour, equipment and markets);
- Innovation can emerge or be explicitly encouraged on farms (such as productivity or resilience), within agribusinesses (such as products or price), across communities (such as social entrepreneurship or policy change) or within bounded landscape units (such as watersheds or forests);
- Scalability of a project will generally improve in cases where ex-ante analysis or project mapping is used to articulate scaling pathways and quantify intended outcomes;
- The underlying Theory of Change held by project leaders will shape this stage of project implementation (see Section 3.1), as will the design criteria imposed by funding sources for initial project activities.

How does leadership emerge?

- Environmental, financial or other stresses create community demand for innovative responses, mobilizing local leaders and action researchers;
- The mandates of national institutions, government plans and regional programs drive agency and program staff to seek viable interventions and entry points;
- Different types of institutions can create or enhance their capacity for coordination, risk management and other functions.

How can we evaluate effectiveness?

- Effective early stage evaluation will ideally be conducted by technically qualified and independent entities (Hartmann and Linn, 2008);
- It is important to go beyond measuring yield increases and impacts during a project timeframe, and adopt a broader concept of impact, acknowledging time lags for emergence and maturation of project impacts;
- Emphasizing the potential to reduce vulnerability and risk is critical. Key elements are: 1) strength of institutional capacity; 2) fragility of agroecosystems including biodiversity and carbon/nitrogen/water balances, landscape mosaic interactions (crops, trees, livestock, fish and pests/disease); 3) abundance of assets including social networks, land access and rights, labour, knowledge and capital/credit;
- Project monitoring and evaluation will critically need to incorporate baseline assessment and comparison to a control.

What is needed to advance to the next stage?

- Action learning and hypothesis testing to prove the project concept and initial design and build the business case for the next level of investment;
- Refined estimates of costs and impacts;
- Defining knowledge needs (which account for context-specificity and spatial and temporal variability) and creating new action research teams and data-sharing agreements;
- Developing a menu of options for practitioners, delivering training and manuals;
- Overcoming constraints (such as location-specific technologies or missing services), linking programs and leveraging resources for new and expanded operations.

Stage 2: “Efficiency”

The efficiency stage tests ‘real world’ sustainability and economic viability of CSA practices and technologies with an expanded target group or in larger areas. This might take the form of adapting promising approaches (such as capacity building) rather than replication of CSA practices or technologies (World Bank, 2003). Greater attention is directed toward understanding costs and benefits, community demand, risks (such as lag time for return on investment) and barriers (such as weak land tenure or subsidies), as well as necessary institutions (for example, managing financial flows or extension) and infrastructure (for example, seed systems or monitoring). Leadership in this stage is likely to come from pioneer farmers, commodity federations, innovative agribusinesses and extension researchers. Financial support may flow from global donors, regional development banks, national governments, risk-tolerant agribusiness investors or NGOs. This ‘pre-investment’ capital may come from sources such as agricultural development funds or climate finance. Public-private partnerships may be more important at this stage than in the previous one.

What are the sources of innovation at this stage?

- Demonstrating multiple benefits and broad relevance in specific contexts to spark participation by significantly more practitioners;
- Integrating multiple considerations to understand synergies, tradeoffs and short- and long-term implications for practitioners, natural resources and markets;
- Experimenting with overcoming barriers (for example, unsupportive policies), filling knowledge gaps (for example, poorly characterized risk) and re-shaping practitioners’ incentives (such as yield, income, forward contracting, payments for environmental services);
- Articulating necessary shifts in policy and supply chains.

How does leadership evolve?

- To progress from pilot mode, project leaders cultivate partners to increase capacity and engage more broadly with target groups (such as community mobilizers, change agents, user groups and development programs);
- Local, regional and national institutions step forward to fill gaps (for example, development of distribution networks, analysis of market dynamics or improved governance) and secure resources to overcome capacity limitations;
- “Champions” (such as pioneer farmers or local leaders) with broad, realistic experience and perspectives on local capacity and policy context signal long-term commitment and build institutional platforms (Linn, 2012).

How can we evaluate efficiency?

- Through systematic monitoring of critical indicators at multiple scales to monitor uptake and local perceptions, benefit-sharing (for example, through social audits) and accountability;
- By creating feedback mechanisms to share indicators with target groups.
- By tracking any divergence between actions to foster CSA uptake and meet funder/financier expectations.
- By tracking indicators of change that allow testing of impact at temporal and spatial scales relevant for stakeholders and within timeframes that allow adaptive project management.

What is needed to advance to the next stage?

- Project leaders modify strategy (for example, redirecting or dropping failed approaches) and refine target groups (for example, vulnerable populations such as women and youth or those most likely to take action);
- Supporting organizations build appropriate systems for knowledge-sharing (such as information and communications technology), lateral learning (such as farmer-to-farmer) and marketing;
- Project partners refine messaging to ensure that it is targeted and tangible, and address connectivity gaps;
- Project leaders document and respond to constraints (such as the short-term nature of projects and producer planning horizon, transaction costs, low producer response to markets and trust gaps);
- Institutions charged with program implementation develop simple, transparent, low-cost procedures and articulate connections between local concerns and the wider context to minimize barriers, maximize understanding and facilitate access by more people to resources or training (World Bank 2003).

Stage 3: “Expansion”

In the Expansion stage, proven CSA practices and technologies are implemented at scale, supported by national policy, public infrastructure and knowledge systems, resulting in improved livelihoods and environmental condition. Advancement to this stage will commonly require establishment of public and private sector institutions to build capacity (such as local farm associations and agribusinesses), provide oversight (such as quality control for implementation and financing) and manage risk (such as insurance or safety net programs), coupled with adjustments in the policy context (for example, re-orientation of subsidy programs). Private financing (for example, by farmers, commodity federations, agribusinesses or financiers) dominates and is based on the expectation of a robust return on investment.

What are the sources of innovation at this stage?

- Mainstreaming acceptance and support for tested CSA practices and technologies (for example, within the farming community, within large development programs or within government agencies);
- Innovation hubs, incubators or other mechanisms which help bring innovations to viable business propositions accelerate awareness and access to technology and novel partnerships provide essential infrastructure;
- Policy shifts change the mix of incentives perceived at farm-level and improve the enabling environment for CSA uptake;
- New models and mechanisms for return on investment-based financial flows are established.

How does leadership evolve?

- Champions continue to build shared ownership across communities, government and the private sector, anchored in specific initiatives (for example, policy shifts, infrastructure investments);

- Major institutional players acknowledge the need for policy and market adaptation and program convergence and take appropriate action;
- Farmers find ways to embed CSA practices and technologies into the value chain (for example, niche markets or added value);
- Supply chain players use a ‘pull’ approach to diversify production strategies (e.g. establishing commodity sourcing protocols).

How can we evaluate expansion?

- Through assessment of the level of collective investment and engagement, policy change and major shifts in budget allocations;
- Through assessment of contribution to national objectives for improving socio-economic and environmental conditions (relative to baseline projections at beginning of CSA project);
- By characterizing tradeoffs and risks;
- By characterizing large-scale and long-term social and environmental impacts.

What is needed to continue expansion?

- Mechanisms for continual adaptive learning, benefit sharing and social equity;
- Construction of knowledge platforms (for example, portals, automated information delivery and crowd sourcing) through consortia;
- Overcoming constraints in institutional capacity and markets;
- Institutional exit strategies (such as scaling ‘down’);
- Cost reductions through improved value and supply chains.

Table 5. Summary of key elements in each stage of scaling up CSA

	EFFECTIVENESS	EFFICIENCY	EXPANSION
Landscape analyses and approaches	<ul style="list-style-type: none"> • Identify all stakeholders, land uses and values • Identify potential synergies, trade-offs • Think about realistic objectives 	<ul style="list-style-type: none"> • Integrate diverse considerations (land users and uses) • Understand and address synergies and trade-offs for multifunctionality 	<ul style="list-style-type: none"> • Policy and knowledge systems support a landscape approach and socio-ecological resilience
Drivers and spaces	<ul style="list-style-type: none"> • Community demand • Environmental stress; scarcity (vulnerability analysis) which drives political response • New government plans • Stakeholder vision for mainstreaming • Reviewing existing/emerging institutions • Managing coordination • Favorable market structure and players 	<ul style="list-style-type: none"> • Incentives (yield, income, forward contracting, risk, PES); financing • Favorable ownership; decision-making authority • Available capacity/staff /service provider limitations • Local producer and market institutions, and networks • Strengthening sustainability of community institutions 	<ul style="list-style-type: none"> • Embed in value chain (value add, niche markets); • “Pull” approach (diversify) • Program convergence • Programmatic home (decision points, transitions) • Engaging community institutions in policy debate • Policy & market adaptation

	EFFECTIVENESS	EFFICIENCY	EXPANSION
Partnerships and knowledge management	Partnerships and stakeholder participation		
	<ul style="list-style-type: none"> • Key players exist: <ul style="list-style-type: none"> ○ Local leaders ○ Action researchers ○ Funders ○ Facilitators • Build on existing mandates • Participation engagement clarified 	<ul style="list-style-type: none"> • Key stakeholders active: <ul style="list-style-type: none"> ○ Community mobilizers ○ Change agents; practitioner champions ○ User groups ○ Development programs • Need to ensure broader governance of initiative 	<ul style="list-style-type: none"> • Stakeholders active: <ul style="list-style-type: none"> ○ Champions in wider development community, media and politics ○ Related government ministries ○ Community groups representation at scale
	Fostering learning		
	<ul style="list-style-type: none"> • Shared stakeholder learning processes • Strategy/pathways/ hypothesis testing; • Vertical or horizontal approaches? • Program overlaps/ leveraging operations; mainstreaming 	<ul style="list-style-type: none"> • Modified strategy (redirect, drop failed approaches); • Modifying approaches to keep focus on target groups (e.g., women, youth) • Identifying ‘Diagonal’ pathways to scaling up • Explore flexibility to uncertainties and risks 	<ul style="list-style-type: none"> • Building adaptive learning into programs and capacity; • Identifying exit strategies/scaling ‘down’ (devolving responsibility) • How to keep learning about how to foster equity as scale
	Knowledge networks: customizing, sharing and delivering information		
	<ul style="list-style-type: none"> • Customized knowledge (including spatial/ temporal variability): menu of options • Identification of comparable practices and conditions, experiences for networking • Participatory action learning networks, learning routes. • Training; manuals; new teams • Data-sharing agreement 	<ul style="list-style-type: none"> • Farmer-to-farmer/lateral learning; ICT; services (information, marketing) • Messaging (targeted, tangible) • Create an information sharing culture • Connectivity gaps (last mile, downscaling) 	<ul style="list-style-type: none"> • Combined strategies (lateral + vertical) – expanding projects, but also using experience to influence policy • Portals; automated information delivery • Crowd sourcing for scale • Consortia; capacity building
Strategic and adaptive participatory project management	<ul style="list-style-type: none"> • Shared stakeholder learning processes • Building trust and shared goals 	<ul style="list-style-type: none"> • Adaptive collaborative management • Define exit strategy • Use common areas of interest to bring stakeholders together 	<ul style="list-style-type: none"> • Success with tangible targets builds momentum towards broader goals
Multi-dimensional monitoring and evaluation	<ul style="list-style-type: none"> • Ensure baseline and control are included in surveys • Think about experimental approaches to assessment • Put in place an evaluation plan • Establish participatory monitoring of process and effectiveness 	<ul style="list-style-type: none"> • Monitor benefit-sharing, accountability • Quantify uptake/social audits/local perceptions/ feedback mechanisms • Measure cost-effectiveness 	<ul style="list-style-type: none"> • Impact tracking is in place • Appropriate investment is in place • Assessing institutional impacts and change • Outcome mapping to help partner roles • Measure fiscal impacts

	EFFECTIVENESS	EFFICIENCY	EXPANSION
Capacity development through learning by doing	<ul style="list-style-type: none"> • Include process-driven research (matching technical aspects to context) • Balance technological vs practical and operational concerns • Whole farming system (infrastructure, seeds, labour, equipment, market) • Relay organizations provide feedback on technology development 	<ul style="list-style-type: none"> • Demonstrate multi- benefit, broad relevance in specific contexts • Foster and support innovators – link to start up systems • Strengthen community nurseries and farmer field school processes • Partnerships built between RRCs and other actors (e.g. NGOs) • Innovation platforms to spread awareness, technology access and partnerships 	<ul style="list-style-type: none"> • Innovations Hubs/incubators (to accelerate innovation); • Build tech access; • Support infrastructure for innovation • Farmer trainers linked with extension services and other structures • Formal accreditation of volunteer farmer trainers • Establish networks of IPs • IP principles engrained within organizations’ policies/initiatives
Ensuring inclusion: gender and other disadvantaged groups	<ul style="list-style-type: none"> • Take a learning approach • Work together with men and women • Design incentive schemes for vulnerable groups • Joint male-female decision making 	<ul style="list-style-type: none"> • Highlight women’s innovations • Ensure incentives fit women and other vulnerable groups • Participatory awareness campaigns • Appropriate education and training programs • RRCs target women and other disadvantaged groups 	<ul style="list-style-type: none"> • Examine and foster national legislation on resource access • Communities adopt laws supporting equitable decision making and benefit sharing

4.4 Driving transitions across stages

As CSA project leaders and their partners seek to advance across the stages of effectiveness, efficiency and expansion, they will need to track the practical, technological, socio-economic, institutional and policy dimensions of their project and find ways to adapt to unanticipated circumstances. Navigating transitions (see Figure 6) will be a dynamic process requiring informed choices, transparency and skillful communication. Where CSA projects successfully foster increased community participation in decision-making, friction may develop with existing cultural, bureaucratic or political forces (World Bank 2003).

From effectiveness to efficiency

Driving the transition from effectiveness to efficiency will require:

- Strategic multi-sectoral partnerships designed to deliver specific, time-bound objectives and anchor a community of practice in which shared knowledge, intellectual leadership, policy direction, product and program innovation accelerate transformation in global agriculture;
- Emphasis on demand-driven participatory research that crosses institutional barriers and demonstrates impacts that are meaningful to local communities;
- Strategic planning that defines the intended scale to be achieved (Linn 2012) and anticipates different success factors, resource needs and responses by stakeholders as a CSA project increases in scale;

- Direct and indirect strategies for promoting change by individuals and institutions (World Bank 2003);
- Making use of global public good financing in the first two stages while actively planning for a transition to a return on investment model (for example, mapping the range of expansion strategies).

From efficiency to expansion

Driving this transition will require:

- Developing support options based on demand for services (rather than preset activities), streamlining community interactions and fine-tuning service delivery (World Bank 2003);
- Transparent interactions with target groups, skillful combinations of outreach strategies (for example, lateral learning, information and communications technology and vertical support processes) and continuous feedback systems;
- Delivery of intermediate results that help to increase awareness and uptake among target groups and support by key stakeholders (Linn 2012);
- Engaging policy makers and building demand for CSA at the policy level;
- Using existing or new institutions to build capacity, deliver services, mitigate risks and continue CSA momentum beyond the project timeframe.

4.5 Key roles of stakeholder groups

Different stakeholder groups have unique incentives and abilities and will face specific challenges in scaling up CSA. Table 6 presents general descriptions of the roles likely to be played by six major stakeholder groups in CSA projects in each of the three stages. Potential challenges are identified for each stage and stakeholder group.

Table 6. Key roles of stakeholder groups during the three stages of scaling up

Stakeholder group	Effectiveness	Efficiency	Expansion
Target groups (Farmers, communities)	Local innovators and community professionals participate in research. <i>Challenge: Access to knowledge, inputs, financing.</i>	Farmer associations orchestrate farmer-to-farmer exchange. Village groups articulate demand. <i>Challenge: Weak/absent coordinating institutions.</i>	Farm groups implement new models (e.g., self-financing, group collateral). Local institutions advocate for policy and institutional shifts. <i>Challenge: Low fluency with policy and finance.</i>
Government (agencies, policy makers)	Local agencies contribute to development of practical interventions. <i>Challenge: Weak</i>	Agriculture institutions mobilize extension agents. Finance institutions safeguard financial sustainability.	Champions speak out. Decision makers adapt policies and provide financing in support of CSA uptake.

Stakeholder group	Effectiveness	Efficiency	Expansion
	<i>scientific knowledge or mandate for change.</i>	<i>Challenge: Resource constraints for capacity building.</i>	<i>Challenge: Established interests oppose policy shifts or new financing.</i>
Researchers	Generate new knowledge about agriculture under climate change (e.g., plant adaptation) and adaptation options under different possible conditions through farmer-targeted research. <i>Challenge: Low access to farmer partners or funding for non-traditional research.</i>	Outline possible pathways for different interventions. Characterize uncertainty. Develop comparative mechanisms to integrate learning from many different cases. <i>Challenge: Low fluency in multidisciplinary research. Unclear/unpublishable research findings.</i>	Accelerate shared learning among research institutions, Extension and farmers. Assess impact over temporal and spatial scales through research in development. <i>Challenge: Contributions unrecognized/uncompensated by home institutions.</i>
Donors	Support concept/technical development, pilots and short-term impact evaluations. <i>Challenge: Inability to filter out weak project ideas.</i>	Provide consistent funding that is flexible to local circumstances. Support outreach to marginal groups. <i>Challenge: Applying appropriate indicators of preliminary success.</i>	Fund development of country strategies that identify institutional and policy opportunities. <i>Challenge: Verifying leverage points. Evaluating what constitutes positive policy change.</i>
NGOs	Leverage expertise and resources to support innovation and testing. <i>Challenge: Weak connectivity with research community. Low technological expertise.</i>	As ‘change agents,’ leverage community connectivity to disseminate information and promote uptake. <i>Challenge: Cultural barriers to innovation or social inclusion.</i>	Advocate for policy and institutional shifts. <i>Challenge: Weak foundation for building coalitions. Securing funding for policy work.</i>
Private sector (companies, investors)	Support technology development and testing (e.g., within a company; in precompetitive space). <i>Challenge: Low awareness of business case for CSA investments.</i>	Develop public-private partnerships and test innovative business models. <i>Challenge: Weak alignment with processes and timelines of other stakeholder groups.</i>	Innovate business models and lower costs of value and supply chains. <i>Challenge: Perceived or actual risks to profitability, supply chain or market position.</i>

SECTION 5: CONCLUSIONS AND RECOMMENDATIONS

Scaling up CSA is as a long-term, non-linear process that will often require combining generalized and context-specific approaches and complex leadership. There is no blueprint for scaling up CSA, but examination of the eight case studies presented here indicates that project leaders and partner institutions can pursue some general strategies including dynamically combining horizontal (replication of promising or proven practices, technologies or models in new areas or target groups) and vertical (institutional and policy change) scaling approaches in response to specific project needs. Leaders of CSA projects can anticipate and plan for transitions across the major stages of scaling up (effectiveness, efficiency and expansion), while also adaptively adjusting or adding project components.

Recommendations

- Successfully scaling up CSA requires both appropriate practices, technologies or models within favourable enabling environments, such as supportive institutional arrangements, policies and financial investments at local to international levels. CSA practitioners can anticipate potential opportunities and bottlenecks to scaling up such as market and policy drivers.
- Understanding biophysical, socioeconomic and institutional issues at different scales and integrating these dimensions is essential to planning, implementing and monitoring CSA scaling.
- While the challenges of adapting to and mitigating climate change are global in nature, agricultural development takes place at the community and household levels. Scalable CSA interventions need to be flexible enough to take into account local contexts while recognizing the impacts they can contribute to at scale.
- Going forward, a review of a broader set of CSA projects could address remaining questions: Are horizontal scaling approaches sufficient to promote simple changes in practices or technology or will vertical scaling commonly be required? Is horizontal scaling necessary before vertical scaling can occur? Can vertical scaling occur within a single stage?
- Gathering information about adoption and spread of CSA technologies still represents a significant challenge. A key research gap lies in estimating adoption rates for different agricultural technologies in developing countries, particularly using remote survey techniques.

The Global Alliance for CSA, a voluntary platform of countries, international organizations, non-governmental organizations, community service organizations, business actors and research partners, was launched at the UN Climate Summit in September 2014. It remains to be seen if this platform can indeed mobilize the financial, political and knowledge assets needed to achieve the necessary change. But with business-as-usual approaches unable to sustain humanity within planetary and local boundaries in the long term, there is no alternative to a deep transformation of food and agricultural systems.

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ANNEXES

Annex I. Extension approaches that can help spread innovation of CSA approaches

Farmer-to-farmer extension

The volunteer farmer trainer approach uses farmer trainers to train their peers, mobilizing people to disseminate information and promote the adoption of agricultural technologies (ICRAF 2015; Franzel et al. 2013). Provided it can overcome social norms, this approach has the potential to select female farmers for extension roles and reach more women farmers (Simpson et al. 2015).

According to Lukuyu et al. (2012), farmer trainers are generally most effective if they disseminate simple technologies; are selected through existing farmer groups; and are provided with training in technologies, communication and capacity-building skills. Their information sharing and training skills are often as important as their farming expertise (ICRAF 2015; Franzel et al. 2013; Lukuyu et al. 2012). Kiptot and Franzel (2014) have shown that farmers work effectively on a volunteer basis, but that human, social and financial capital are key to sustaining programs over time. Examples of these assets include recognition, increased social networks and status, and opportunities to sell inputs and services (Kiptot and Franzel 2014; Lukuyu et al. 2012). The initial motivators for farmer participation are likely influenced by cultural norms, religious beliefs and other factors that change from context-to-context, making it important to understand sources of motivation and emphasize reward structures around them (Simpson et al. 2015).

The volunteer farmer trainer approach is generally most effective and sustainable if volunteer farmer trainers are connected with government extension services, farmer organizations or other structures to provide technical support and updates on new innovations (Kiptot et al. 2012; Lukuyu et al. 2012; Simpson et al. 2015). Supporting farmer trainers to organize themselves into associations with formal accreditation can help raise their profile and support effective and sustainable training (Lukuyu et al. 2012; Kiptot et al. 2012). Experience in western Kenya has shown that ownership of farmer-to-farmer extension programs by local institutions such as local government and producer organizations is important to sustaining a program (Franzel et al. 2015). Three years after the project ended, farmer trainers were still training farmers thanks in part to support from local village authorities (Lukuyu et al. 2012).

Farmer-to-farmer extension, even among poor and remote farmers, can take advantage of technology. For example, to achieve participatory extension on very large rural livelihoods programs in India, NGO Digital Green has successfully piloted a process for farmer groups to produce low cost, low connectivity videos to share good practices in land management, nutrition and other areas amongst themselves. Evaluations show that this process, including the cost of trainers and cheap, easily available video project tools, is more cost effective than traditional extension (Gupta et al. 2014).

Community nurseries and farmer field schools

A widespread approach for enabling farmer-to-farmer extension is farmer field schools, which enable a process of structured, field-level learning and problem solving among farmers. This approach focused initially on integrated pest management in Southeast Asia,

and is now a widespread tool for research and extension in Asia and Africa, encompassing broader land management, pastoralism, climate change field schools and livelihood skills.³ FAO has been supporting farmer field school approaches since the 1990s.

Farmer field schools can boost farmers' school approaches since the 1990s, encompassing implement the best management options for their farms (ICRAF 2015). For example, the Nurseries of Excellence (NOEL) program in Aceh, Indonesia enhanced farmer capacity significantly within 18 months through training, technical consultations, demonstration plots and other services (Roshetko et al. 2013a). Within its first seven months, the Agroforestry and Forestry (AgFor) project in Sulawesi, Indonesia, had improved the knowledge and skills of 1,138 farmers, 25 percent of which were women (Roshetko et al. 2013b).

Innovation platforms

Innovation platforms (IPs) are spaces for fostering learning and creating change (Misiko et al. 2013; Homann-Kee Tui et al. 2013). They bring diverse actors together to share knowledge and find solutions to common problems in an equitable and dynamic space (Cadilhon 2013; Homann-Kee Tui et al. 2013). These actors can include farmers, researchers, local authorities, conservation officials, extension officers, supply chain actors, financiers, who often act as important links to the organizations or groups they represent (Homann-Kee Tui et al. 2013; Misiko et al. 2013).

Two important strengths of IPs are their flexibility and diversity. They can respond quickly to emerging problems and opportunities (Homann-Kee Tui et al. 2013; Posthumus and Wongtschowski 2014; Nederlof et al. 2011), solve problems that depend on the collaboration of many actors (Posthumus and Wongtschowski 2014; Nederlof et al. 2011) and develop better solutions than what individual actors are capable of on their own (Homann-Kee Tui et al. 2013). For example, they can recognize bottlenecks that hold back innovation (Homann-Kee Tui et al. 2013), engender ownership of solutions (Homann-Kee Tui et al. 2013), draw on the expertise, skills, inputs and funding available within platform members to implement solutions (Misiko et al. 2013).

IPs foster capacity development through learning, improving communication and bringing together people and ideas (Homann-Kee Tui et al. 2013), increasing capacity for innovation even after the platform is gone (Posthumus and Wongtschowski 2014). By bringing together farmers and other community members with diverse stakeholders from different sectors and levels they help overcome conflict between groups, organizations and institutions and give farmers and other local people a voice (Homann-Kee Tui et al. 2013; Misiko et al. 2013; Posthumus and Wongtschowski 2014; Nederlof et al. 2011). By changing the behaviour of their members, IPs have the potential to create significant impacts in the long term (Duncan et al. 2013).

Perhaps the greatest potential of IPs lies in linking together platforms with different experiences, strengths and focus. For example, connecting IPs from different districts, projects or countries via training sessions, cross-visits, or other means can help platforms learn from one another, exchange ideas and increase their bargaining power (Misiko et al. 2013; Homann-Kee Tui et al. 2013; Tucker et al. 2013). Linking local and national-level platforms can empower local people to influence policy, foster dialogue in policymaking and

³ For a quick overview see: https://en.wikipedia.org/wiki/Farmer_Field_School.

help scale up successful innovations (Misiko et al. 2013; Tucker et al. 2013). Overall, establishing and linking IPs at community, district and/or national levels can identify multi-level problems and coordinate strategic action for greater impact (Homann-Kee Tui et al. 2013; Tucker et al. 2013).

For IPs to work well, they need strong facilitation, self-organization (Misiko et al. 2013) and investment in engaging actors, developing relationships and partnerships and building trust (Homann-Kee et al. 2013; Nederlof et al. 2011). Based on learning from 12 different IPs, Nederlof et al. (2011) found that understanding the local context and realities; building on existing networks, partnerships and initial success; developing the platform together in a transparent and participatory way; and staying flexible can help initiate an effective IP. Bringing the right people together and facilitating their interactions is key; this requires facilitators with convening power, local understanding, neutrality and communication skills (Nederlof et al. 2011). IPs should also invest in capacity building with a focus on interaction, working together and learning by doing. Institutionalizing the IP approach – or engraining IP principles within organizations’ policies and initiatives – is a way to scale up IPs (Nederlof et al. 2011).

Rural Resource Centres

Rural Resource Centres (RRCs) are community-based hubs for information access, interactive learning, training and networking (Degrande et al. 2012; CTA 2015; Degrande et al. 2015; Takoutsing et al. 2014). This approach values local knowledge and priorities and encourages researchers, extension workers and farmers to learn together (Takoutsing et al. 2014).

Compared with ‘traditional’ extension approaches, RRCs offer farmers a number of benefits. These include easier information access, greater opportunities to test and adapt new technologies, greater involvement of women and youth and better networking opportunities with other rural actors such as NGOs, researchers, government, the private sector and other farmers (CTA 2015; Degrande et al. 2015; ICRAF 2012; Degrande et al. 2012; Figure 5). The RRC approach provides an opportunity for grassroots organizations such as NGOs or farmer organizations to manage RRCs to become self-sustaining (CTA 2015). It supports farmers to test, adopt and disseminate successful new technologies (Degrande et al. 2015), building their capacity through training in areas such as microfinance, entrepreneurship, business management, marketing and decision-making (ICRAF 2015; Asaah et al. 2011). Because RRCs give farmers access to a suite of innovations, services and information in one rural setting, they can significantly increase adoption (Degrande et al. 2015).

Experience from the World Agroforestry Centre’s Agricultural and Tree Products Program in Cameroon has shown that the RRC approach can help farmers directly and effectively scale up agricultural practices, if given support to facilitate their participation and build their capacity (Takoutsing et al. 2014). By encouraging farming communities to help themselves, the approach motivated local participation and helped farmers and RRCs to become economically independent (for example, via commercial tree nurseries and the sale of marketable tree products), after which they could disseminate knowledge and skills to nearby communities (Asaah et al. 2011). By working specifically with marginalized groups and offering information and technologies specific to women, the program’s RRCs have reached a significant number of women and youth (Degrande et al. 2015).

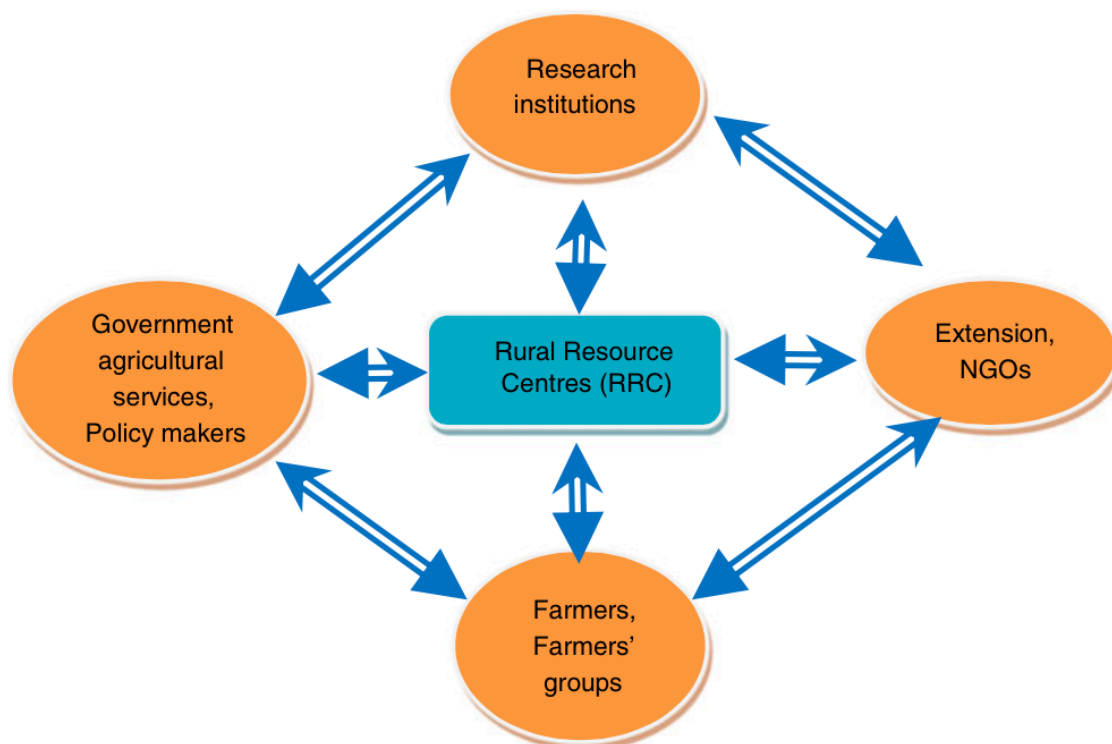


Figure 5. Interactions between researchers, farmers and extension staff in the rural resource concept. Taken from Takoutsing et al. 2014.

To increase adoption of practices, it is important to involve farmers closely in the development of new technologies from inception to dissemination, facilitate farmers groups and build their technical capacity (Takoutsing et al. 2014). Extension approaches must also consider local conditions, farmers' interests and local knowledge, the physical and institutional context, as these can all influence adoption by men and women (Takoutsing et al. 2014). Establishing partnerships between RRCs and actors such as local authorities, universities, research organizations and NGOs can help ensure their long term success and financial viability (Degrande et al. 2015). Research is still needed to understand what institutional arrangements are needed to support effective RRCs in different socio-economic and political contexts in order to scale the RRC approach (CTA 2015; Degrande et al. 2015).

Working with relay organizations (ROs) can also help reach farmers. ROs are community-based organizations involved in agricultural extension activities that connect research organizations with farmers and their communities (ICRAF 2015; Degrande et al. 2013). They provide a two-way exchange between these groups: disseminating innovations and providing capacity building and institutional support to farmers, while providing feedback on technology development to researchers (Degrande et al. 2013). According to Degrande et al. (2012), involving grassroots organizations such as relay organizations in agricultural extension, including those that use RRCs as part of their extension approach, may reach more women and youth than traditional extension services. Experience in Cameroon has suggested that external factors such as good road and communication networks and existing farmers associations might play a greater role in supporting effective ROs than internal factors such as human, material and financial resources (Degrande et al. 2013).

Annex II. Case studies

The case studies described below are summaries of CSA projects in various stages of scaling up that were presented at different workshops. They represent a wide spectrum of initiatives from which we drew many of the insights and lessons that informed this paper.

Case study 1: Aiming for scale with action research and a ‘saturation’ approach

The National Initiative on Climate Resilient Agriculture (NICRA) project is developing new approaches that will address near- and long-term climate change impacts on rainfed and irrigated agriculture in India, which is projected to experience major yield changes. NICRA seeks to enhance the capacity of scientists and other stakeholders to undertake action research on agricultural adaptation and mitigation and demonstrate site-specific technology packages on farmers’ fields. NICRA mobilizes 300 scientists to investigate agricultural resilience under conditions of increasing climate variability. Research domains and capacity building efforts (targeting scientists, NGOs, farmers, self-help groups and development banks) are led by a set of core partners. Key elements include demonstrations of site-specific technologies in 100 districts, competitive grants for ‘side’ topics, district-level vulnerability analyses and services such as agricultural advisories for local weather. With a budget of USD 750 million and the intention to reach 10,000 farmers each year, NICRA will invest in crop simulation modeling, 200 climate-smart villages and 230 NICRA hub sites to showcase resilient technologies. Early on, project leaders recognized the need for NICRA to achieve a minimum scale to be taken seriously in India. They adopted a ‘saturation’ approach to project implementation that focuses on all farmers in villages where a particular intervention is relevant. Village-level climate management committees, which include women representatives, established bank accounts to transact business. Monitoring efforts will focus on calculating footprints (carbon, water and energy) for a few sites and estimating mitigation achieved through project interventions.

Case study 2: Shared ownership and benefits for community-based land rehabilitation

Agriculture in the low-population Kingdom of Bhutan is practised under a wide array of conditions (elevation, precipitation and temperature). With only 3 percent of the land base suitable for farming, preserving and restoring farmland is critical for food security and livelihoods. A community-based Sustainable Land Management (SLM) project is working to reduce erosion, landslides and drought in maize-based, rainfed farming systems through joint community efforts and using available resources. To maximize agricultural production, farmland rehabilitation techniques were promoted including contouring, plantings, diversion channels, agroforestry, nursery trees and kitchen gardening. The cultural and political context of this project has several unique features. These include multi-functional local institutions and traditions that strongly promote universal participation in community initiatives, as well as a national institutional framework for sharing government resources. The project has engaged community members, researchers, extension and local government and leveraged indigenous knowledge and social cohesion to address issues of labour, financing and collective marketing. It has created transferrable resources including an action-focused R&D centre and a manual for Extension personnel. Initiated with USD\$ 10,000 from the Global Environment Facility (via the United Nations Development Program), the project’s next phase will be supported by USD 6 million from the World Bank. Project leaders note that direct benefits to farmers combined with penalties for non-participation (levied by the community), was an effective incentive for uptake of SLM techniques. An impact report

assessed social, economic, environmental and productivity outcomes and identified some early lessons:

- Community-based approaches should focus on capacity building and work with groups of no more than 20 to 25 households;
- It is essential to have a start-up fund and local leaders who are committed to project implementation in the short and long term;
- Uptake will be greater in communities where all households are in dire need of farmland rehabilitation.

Case Study 3: Documenting diverse contexts for adaptation in home gardens

In south Asia, home gardens contribute to food security and are a significant component of the landscape (for example, in Sri Lanka they make up 14 percent of land area); however they are threatened by climate change. Home gardens are extremely diverse in terms of practitioners, product uses (such as food, timber and medicine), tree species and presence of animals. With funding from the United States National Science Foundation, a survey-based research project in Sri Lanka, India and Bangladesh investigated home gardeners' perceptions of climate change and found that they were aligned with actual temperature measurements but not precipitation measurements. The study also documented adaptation strategies and found that practitioners were making changes in planting date, technology, agronomic management, tree species and animal types. Likelihood of adaptation was higher among those with farming experience and who dedicate significant time to home gardening, as well as in situations where gardens are large, diverse, well-served by infrastructure (such as roads, markets and water resources) and include livestock. Other important determinants were education and employment status and perceived and actual climate change. Project leaders emphasize the need for designing interventions targeted to sub-groups of home gardeners with similar levels of education, experience and investment in garden production. They recommend specifically targeting those who are less likely to use adaptation strategies. Since individual practitioners will select adaptation strategies based on private costs and benefits, they encourage government programs to promote strategies that generate more social net benefits and to build on strategies already in use by home gardeners.

Case study 4: Rapid replication hits a 'vertical limit'

The National Agricultural Innovation Project (NAIP) in drylands seeks to use the Clean Development Mechanism financing method to implement a multi-benefit project: mitigation; tree planting on degraded land for food, fodder and fuel; drought resistance; energy efficiency; livelihoods; and poverty reduction. It is focused on achieving broad uptake by smallholder farmers in target areas and developing a viable monitoring system. Engagement activities have included awareness meetings and pilot projects in every village, field visits and NGO support. Success metrics include extent of adoption and GHG emissions reduction. The NAIP project revealed two generalizable lessons for successful scaling up. First, simple, easily adopted technologies that quickly generate economic gain are suitable for rapid replication. Second, on-farm demonstrations and field visits ('seeing is believing'), community mobilizers (such as NGOs) and material support (for example, quality seedlings and cost offsetting) accelerate uptake. The project also highlighted context-specific lessons. Rapid uptake was facilitated by partnership with a longstanding NGO and previous efforts to build community awareness and institutional capacity. Drivers of uptake included effective involvement of local leaders, links with government programs, creation of a project-specific local institution, as well as drought-induced crop failures that catalyzed farmers' receptivity

to implementing tree-based systems. Project leaders noted that while building linkages, identifying potential areas for adoption and delivering demonstrations and technological information were within their control, they did not have the ability to influence policy and larger development programs or provide subsidized materials over extended periods.

Case study 5: Testing the effectiveness of alternative agriculture systems in Bangladesh

Considered one of the countries most at risk of severe climate change impacts, Bangladesh is threatened by flooding, droughts, cyclones, sea level rise and soil salinization, and natural resource degradation. Inadequate access to food and fodder, drinking water and fuel wood triggers migration and establishment of unplanned settlements in the country. Supported by World Bank funds, an ICRAF-led CSA project in coastal and terrace agro-ecosystems is promoting alternate livelihoods through uptake of new crop varieties (such as salt-tolerant species), multi-story agroforestry with fruit tree cultivation, vegetable production with aquaculture and other strategies for improving food and income security. A central component of the project is quantification of biological (for example, planting density and yield), economic and environmental outcomes in alternative agriculture systems. Project leaders point to several project elements that support scaling up:

- Improving skill and knowledge through training;
- Introducing modern technologies and managements;
- Introducing high value crops with suitable varieties;
- Ensuring quality planting materials;
- Frequent field visits and monitoring;
- Providing technical support (Bangladesh has a robust extension system that expands technology and seed access).

Case study 6: Overcoming constraints to carbon finance for smallholder farmers

The National Agricultural Innovation Project (NAIP) in humid areas seeks to boost agricultural resilience, crop yields, food security and incomes and to reduce GHG emissions and land degradation through an integrated, landscape-scale project that draws on proven CSA practices. The project promotes several technical strategies including sustainable intensification in low productivity systems and use of improved wood stoves and energy-efficient compact fluorescent lamp light bulbs. A central objective is to address constraints to smallholder benefits under conventional carbon finance (including minimum tradable volumes; burdensome and high-cost transactions; lack of approved Clean Development Mechanism methodologies for agricultural landscapes with small, fragmented land holdings). A parallel aim is to build capacity among researchers, farmers, local decision makers and other stakeholders to participate in the CDM Afforestation/Reforestation carbon finance mechanism.

A site selection grid was developed to comply with CDM guidelines requiring evidence of land degradation, predominance of privately held smallholder agriculture and forestry operations, proximity to the implementing agency and absence of other mitigation interventions or planned infrastructure development. Project leaders monitored land use practices, beneficiaries under project interventions and possible carbon credits. To ensure adequate institutional support over the long-term, the 'Gramya Sampada Kendra' community-owned enterprise for rural resource governance was established to safeguard land tenure and deliver conflict management and other services for small holders. According to

project leaders, creation of professionally-staffed, community-owned enterprises can enable smallholders to access global carbon finance to support implementation of CSA practices.

Case study 7: Multi-dimensional interventions to engage millions of farmers

The Gates Foundation-funded Cereal Systems Initiative for South Asia (CSISA) is creating innovation hubs, modern site-specific information and communications technology systems and public-private partnerships for technology access to encourage millions of small and medium-scale farmers to invest in sustainable intensification of cereal-based systems at scale in Bangladesh, India, Nepal and Pakistan. It aims to improve soil and nutrient management, livestock feeding, post-harvest storage and scale-appropriate mechanization in regions facing resource degradation, fragmented land holdings, erratic climate systems, poor market linkages and labour shortages.

A central principle underlying CSISA's work is linking rigorous science to participatory technology development, informed by a comprehensive understanding of markets, capital, risk and the policy environment. Development of innovative technologies (such as stress-tolerant, high-yield seeds) is complemented by technology targeting, training, distribution networks and demand generation. CSISA explicitly focuses on scaling up processes, emphasizing integration across disciplines and institutions, demand-driven research, policy analysis and market and business development (especially for small- and medium-sized enterprises).

CSISA partners are investigating farmer incentives and decision-making, non-technical barriers to innovation, change agents (such as dealer networks and self-help groups) and risk moderation strategies. Project leaders emphasize the importance of strong message development focused on economics and crop performance. As the project moves into its second phase, there will be greater strategic engagement of agribusinesses, farmer innovators, government and extension personnel, agriculture dealers, service and credit providers and NGOs to adaptively deliver an integrated set of support activities to target groups.

Case study 8: Multiple project components support local climate change policy

Funded by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and led by the Indian Ministry of Environment and Forests, the Climate Change Adaptation in Rural Areas in India (CCA RAI) project is promoting harmonization among states' climate change action plans (SAPCCs) to improve the policy architecture for climate change adaptation at the local level. CCA RAI delivers vulnerability and risk assessments (at district and local levels), climate proofing of rural development programs (including identification of co-benefits and opportunities to increase resilience at the local level) and fine-tuning of financial instruments for adaptation (such as micro-insurance). It emphasizes information and knowledge management, demonstration projects and capacity building (for example, training trainers). Most interventions are targeted to multiple levels (including community, district, state and national). Initial lessons from the CCA RAI project relate to the importance of targeting appropriate areas (for example, where government priorities are clear), engaging the most useful partners, adapting project strategies and sharing ownership (such as through broad representation in steering structures). Project leaders find that scaling up is facilitated by:

- Stakeholder consultation and engagement in implementation;
- Use of the SAPCC framework and the vulnerability assessment approach;
- Systematized demonstration projects at local level;
- Training programs, workshops and publications.

Annex III. List of participants in the three workshops

Workshop: Scaling-up of Climate-smart Agriculture Practices

Workshop I: 21-23 August, 2012, New Delhi, India

Name	Organization
Dr. Ashok K. Sahoo	Orissa University of Agriculture & Technology
Dr. Dibakar Mahanta	Vivekananda Parvatiya Krishi Anusandhan Sansthan
Dr. J. V. N. S. Prasad	Central Research Institute for Dryland Agriculture
Dr. Manmohan J. R. Dobriyal	Maharana Pratap University of Agriculture & Technology
Dr. M. Srinivas Rao	CSISA India Office, Project Management Unit
Dr. Sanjay Tomar	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
Prof. Dr. Md. Giashuddin Miah	Department of Agroforestry and Environment – BSMRAU
Dr. Anil K. Singh	Indian Council of Agricultural Research (ICAR)
Dr. B. Venkateswarlu	Central Research Institute for Dryland Agriculture
Mr Gyambo Tshering	Bajothang Wangduephodrang, Department of Agriculture, Royal Government of Bhutan
Dr. Andrew McDonald	Natural Resources Group, CIMMYT-India/RWC
Dr. Pier Paulo Ficarelli	International Livestock Research Institute (ILRI)
Dr. Carlo Carli	International Potato Centre (CIP)
Dr. Bharat R. Sharma	International Water Management Institute (IWMI)
Dr. K. R. Vishwanathan	Embassy of Switzerland, Climate Change and Development Division
Dr. Peter E. Kenmore	FAO
Dr. Anupam Joshi	The World Bank
Prof. HPM Gunasena	Coconut Research Institute
Dr. D K N G Pushpakumara	ICRAF, Sri Lanka
Mr. Ibrahim Shabau	Ministry of Fisheries and Agriculture, Maldives
Dr. Bhishma Subedi	Asia Network for Sustainable Agriculture and Bioresources
Dr. Bengali Baboo	NAIP
Dr. L S Rathore	India Meteorological Department
Dr. K. K. Singh	India Meteorological Department
Dr. Ashok Baxla	India Meteorological Department
Dr. Pramod K. Aggarwal	International Water Management Institute (IWMI)
Dr. Henry Neufeldt	World Agroforestry Centre
Dr. Virendra Pal Singh	World Agroforestry Centre, Regional Office for South Asia
Mr. Jamal P. Noor	World Agroforestry Centre, Regional Office for South Asia
Devashree Nayak	World Agroforestry Centre, Regional Office for South Asia
Babita Bohra	World Agroforestry Centre, Regional Office for South Asia
Prof Laurette Dubé	Desautels School of Management, Montreal
Prof Molly Jahn	University of Wisconsin-Madison
Dr. Jim Hancock	FAO-Headquarters
Ms. Christine Negra	Workshop Facilitator
Dr. Patrick Ward	IFPRI-New Delhi

Workshop II: 7-8 November, 2013, New Delhi, India

Name	Organization
Dr. Ashok K. Sahoo	Orissa University of Agriculture & Technology
Dr. Dibakar Mahanta	Vivekananda Parvatiya Krishi Anusandhan Sansthan (VPKAS)
Dr. J. V. N. S. Prasad	Central Research Institute for Dryland Agriculture
Dr. Amol Vasishth	College of Horticulture & Forestry, (MPUAT, Udaipur), Jhalrapatan - Jhalawar
Dr. Bisweswar Rath	Department of Agriculture & Cooperation, Ministry of Agriculture, Krishi Bhawan
Dr. Rajeev Sharma	Deutsche Gesellschaft für, Internationale Zusammenarbeit (GIZ) GmbH
Dr. Crispino Lobo	Watershed Organization Trust
Dr. R K Singh	Nand Educational Foundation for Rural Development (NEFORD),
Ms. Meera Mishra	IFAD– India Country Office
R P S Yadav	Indian Farm Forestry Development Cooperative Ltd. (IFFDC)
Dr. Mohinder Singh Kadian	International Potato Centre (CIP)
Dr. Pramod K. Aggarwal	International Water Management Institute (IWMI)
Dr. Sara Ahmed	IDRC, New Delhi
Dr. Peter E. Kenmore	FAO, New Delhi
Dr. Anupam Joshi	The World Bank
Prof. A.K. Singh	Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya, Gwalior
Prof. P. Das	The Science Foundation for Tribal & Rural Resource Development
Dr. Alok K. Sikka	Indian Council of Agricultural Research (ICAR)
Mr. R B Sinha	Ministry of Agriculture, Krishi Bhawan, New Delhi
Mr. BVN Rao	Ministry of Agriculture, Krishi Bhawan, New Delhi
Dr. Henry Neufeldt	World Agroforestry Centre
Dr. Virendra Pal Singh	World Agroforestry Centre, Regional Office for South Asia
Mr. Jamal P. Noor	World Agroforestry Centre, Regional Office for South Asia
Devashree Nayak	World Agroforestry Centre, Regional Office for South Asia
Dr. Navin Sharma	World Agroforestry Centre, Regional Office for South Asia
Rodrigo Ciannella	World Agroforestry Centre, Regional Office for South Asia
Ms. Gulshan Borah	World Agroforestry Centre, Regional Office for South Asia
Dr. Jim Hancock	FAO-Headquarters

WorkshopIII: 26-27 November, 2014, New Delhi, India

Name	Organization
Dr. Dibakar Mahanta	Crop Production Division, Vivekananda Parvatiya Krishi Anusandhan Sansthan (VPKAS)
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