Scaling up agricultural interventions: case studies of climate-smart agriculture

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Abstract

If climate-smart agriculture (CSA) is meaningfully to address the development challenges posed by climate change, effective approaches will be needed to scale up research findings. Here, eleven case studies are used to exemplify scaling-up strategies based on (1) value chains and private sector involvement, (2) information and communication technologies and agro-advisory services, and (3) policy engagement. We evaluated these case studies and the scaling strategies they exemplify, using a simple conceptual framework from the field of scaling up nutrition interventions. Results showed that these different strategies exhibit different characteristics; all offer considerable potential for taking CSA interventions to scale, but there still may be unavoidable trade-offs to consider when choosing one strategy over another, particularly between reaching large numbers of farmers and addressing farmers' specific contexts. The case studies highlighted several challenges: estimating the costs and benefits of different scaling activities, integrating knowledge across multiple levels, and addressing equity issues in scaling up. The case studies outlined here will continue to be monitored and evaluated, thus strengthening the evidence base around effective scaling-up strategies that can contribute to achieving food and nutrition security under climate change in the coming decades.

Keywords: Climate-smart agriculture, scaling, institutions, development, learning.

1. Introduction

All over the world, research on and dissemination of agricultural technologies and practices is pursued as an intervention to raise agricultural production, improve livelihoods and alleviate poverty for small-scale farmers (Kilima et al, 2010). Research in improved crop varieties, better farming methods, participatory policy analysis and new knowledge generation has contributed substantially to development impacts (Raitzer and Kelley, 2008; World Bank, 2011). The developing regions overall saw a 42 per cent reduction in the prevalence of undernourished people between 1990-92 and 2012-14 (FAO, 2014). But there are large regional differences: progress against poverty and hunger has been limited in South Asia, for example, and has gone backwards in sub-Saharan Africa since 1990-1992 (FAO, 2014). About 815 million of the more than 7 billion people in the world, or one in nine, are estimated to be suffering from chronic undernourishment (FAO, 2017), almost all of whom are living in developing countries. Climate change adds considerable urgency to the situation, as it may massively disrupt food systems, posing population-wide risks to food supply. Funding and political will are needed to support developing countries to contribute to the Paris Agreement to reduce greenhouse emissions in order to limit global warming to well below 2 °C. At the same time, future demand for food must be met, while increasing the adaptive capacity of small-scale farmers and increasing resource use efficiency in agricultural systems (Lipper et al., 2014). Opportunities abound, but there are many barriers that may constrain the uptake of appropriate interventions at the scale required.

The concept of climate smart agriculture (CSA) offers a suite of approaches for transforming and reorienting agricultural systems to support food security in the face of climate change, by focusing on the potential synergies and trade-offs between agricultural productivity and food security, adaptive capacity, and mitigation benefits (Campbell et al., 2014). Incremental change may be

inadequate to bring about the societal changes needed to mitigate and adapt to climate change and enhance food security (Biermann et al., 2012), particularly in the longer term as the impacts of climate change become increasingly obvious (Rickards and Howden, 2012; Cooper et al., 2013). In addition to the need to move beyond small, incremental changes, there is also a need to move from working with small numbers of farmers to achieving outcomes among large portions of the farming population, in efficient and effective ways.

Many agricultural technologies and practices, including those qualifying as CSA, are not achieving their full potential impact because of low levels of adoption by farmers in developing countries. Despite successful pilot projects, uptake of new and innovative agricultural technologies and practices has often been poor, and we have still not been able to resolve problems of food insecurity and rural poverty. It is this need to show real impact beyond the plot or site level to impacts on more people over wider areas, and on institutions and policies, that drives the interest in scaling up (Pachico and Fujisaka, 2004). The key issue is how to scale up promising pilot initiatives so that they can have a substantial impact on poverty (Wigboldus et al., 2016). For simplicity, we use the term "scaling up" to capture a number of processes. Scaling up brings more quality benefits to more people over a wider geographical area, more quickly, more equitably, and more lastingly (Franzel et al., 2001). Scaling thus refers to the benefits brought about through the intervention not only in terms of the number of people and the geographical area but also in terms of time and equity scales (Pachico and Fujisaka, 2004).

The main question this paper seeks to address is what are the advantages and disadvantages of specific approaches that hold out promise for scaling up CSA research findings to contribute meaningfully to the challenges of poverty and climate change. The aim is to build on the existing agricultural adoption and CSA literature to unite the concepts under a common framework and draw

from the learning to inform future actions. We draw on eleven case studies that were selected from a portfolio of CSA projects undertaken by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS; Förch et al., 2014), a program currently entering its ninth year and working across five regions with a total annual budget of approximately $60 million. The case studies exemplify three strategies, discussed in section 2 below, to scaling up based on (1) value chains and private sector involvement, (2) information and communication technologies (ICT) and advisory services, and (3) policy engagement. The case studies were chosen as a way of conducting learning within the program and drawing lessons from a range of different situations. The case studies were analysed using a simple conceptual framework, described in section 3, originally developed for scaling up nutrition-related interventions in developing countries. Results are discussed in section 4 in relation to how different strategies can help address some of the generic challenges of scaling up to reach development outcomes concerning food security. We conclude with some reflections on remaining challenges to the scaling-up of CSA to meet development targets.

2 Background on scaling strategies

An extensive literature exists on the challenges of adoption of agricultural technologies, and many plausible reasons can be advanced for low rates of uptake (Glover et al., 2016). For example, promising technologies may require small-scale farmers to have access to markets and credit (Shiferaw et al., 2015) and to appropriate information (Mullins et al., 2018). In some situations, policy enablers may be critical for adoption (Jayne et al., 2018). Adoption is sometimes seen as a linear, binary and individual decision when in fact the dynamics are much more complex (Glover et al., 2016). A gap between researchers, policymakers and practitioners continues to exist, despite efforts to disseminate, apply and scale up the results of research (Hartman and Linn, 2008).

Attention is being increasingly paid to the role of intermediaries and innovation brokers who can help to bridge this gap, drawing on many different groups of actors and stakeholders (Schut et al., 2014). The emphasis on the effectiveness of agricultural research to produce adoptable technological options has increased in recent years, in line with long-standing demands for agricultural research to achieve greater impacts and demonstrate its value (Pachico and Fujisaka, 2004). This is not to blur the distinction between research and development; rather, it is about developing explicit strategies that enable next users through partnerships, engagement, capacity development and learning to apply research results in non-research processes, and helping to inform next users as to what makes enabling environments conducive to scaling up and out (Vermeulen and Campbell, 2015). Below, we outline three such strategies that offer potential for achieving this.

2.1 Scaling strategies based on value chains and the private sector

In discussing the concept of value chains, we utilize the generic definition from Orr et al. (2017) of value chain development as "facilitat[ing] the participation of smallholders and small and medium rural enterprises in higher value markets for agricultural and forest products" (p. 14). This concept has become popular among many development actors over the past decade. It broadens the scope of agricultural development from beyond the farm level to encompass the entire market system surrounding food production. There is a body of literature focused specifically on such approaches, and the concept has been divided into four broad strategies, which include improving value chain coordination (both horizontal and vertical), improving process and products, changing and adding functions, and upgrading the institutional environment (Kilelu et al., 2017). We include this diversity of approaches when we discuss value chain development as a mechanism for scaling up climate smart agriculture.

Value chains have two characteristics that make them suitable for reaching a large number of farmers. First, they provide a mechanism for linking multiple actors around a common objective by creating space for dialog, knowledge exchange and capacity building, and strengthening negotiation capacities. Value chains can act as a delivery mechanism for government and private extension services, credit, and subsidy programmes. Second, they provide market-driven demand (currently, often towards green and more organic products) that may provide a demand-led strategy for adoption of technologies and practices. Scaling up already climate smart value chains or introducing practices and technologies into existing ones may thus be an efficient way to reach large numbers of farmers with reduced transaction costs. However, strategies based on value chains may not be appropriate for the informal sector or for agricultural production for household consumption.

2.2 Scaling strategies utilising ICTs and agro-advisory services

In order to reach more farmers and overcome the high transactions costs incurred by face-to-face interaction associated with conventional extension services, the use of information and communication technologies (ICTs) and associated agro-advisory services is becoming increasingly important. ICTs are being recognised as part of strategies to adapt to, mitigate, and monitor climate change within agricultural innovation systems. The rate of growth of mobile phone technology is particularly striking. In 2009, mobile cellular penetration in all developing countries exceeded 50 per cent, reaching 57 per 100 inhabitants, up from 23 per cent in 2005 (Pretty et al., 2011). By early 2017, it was estimated that there were 960 million mobile subscriptions across Africa, with an 80 percent penetration rate among the continent's population (Jumia, 2017). ICTs can thus be an effective means for both the public and private sector to improve access to many different types of information (such as market prices, weather information, advisory services and early warning information, for example) as well as increase awareness about climate change and climate-smart

practices and technologies (FAO, 2013). The revolution in ICT and information management systems is radically opening up access to external knowledge among even the poorest (Pretty et al., 2011). Small-scale farmers, particularly women, have a huge advantage when the right ICT is brought into the agricultural system (Sylvester, 2013). There are potential constraints in that if women, the poor and other vulnerable groups are to benefit, these groups need to be considered and targeted specifically. We separate out strategies involving ICT and agro-advisories because they involve both public and private sectors and involve direct interaction with farmers; the next strategy, on policy engagement, focuses more on the creation of an enabling environment.

2.3 Scaling strategies revolving around policy engagement

It has long been recognised that appropriate policies and political engagement are essential for scaling up agricultural technologies and practices. Nevertheless, there are competing interests in policymaking, necessitating the identification of windows of opportunity for meaningful engagement (recognising that engagement outside these windows may on occasion be futile). The scaling up of CSA practices will require appropriate institutional and governance mechanisms to co-generate information, ensure broad participation and harmonise policies. It may not be possible to achieve all the CSA objectives at once. Context-specific priorities need to be determined, and benefits and trade-offs evaluated (FAO, 2013). If scaling up is very much about policy change (Jonasova and Cooke, 2012), the challenge is to move beyond informing policy change to informing the enactment of new policies – how policy is implemented will determine its potential for impact. Linn (2012) identifies two interlinked approaches to policy engagement: creating a political space and a policy space. Creating a political space, through advocacy and outreach, is to have the eyes and ears of major political actors and key constituencies who may facilitate or provide political obstacles to large-scale developmental processes. For example, getting buy-in at the highest levels of

government to commit a certain percentage of government budget on agricultural research and development requires activity in the political space. A policy space, on the other hand, is an opportunity to influence policy making and strategies through the provision of technical input to the formulation and implementation of policies that are robust in the light of uncertainty. Informing the design of smart subsidy programs for agricultural inputs based on econometric analyses from other countries, for example, involves acting within the policy space. These both influence the overall enabling environment in which agricultural activities operate and are scaled up.

3 Methods

3.1 Analytical framework

Appropriate literature and validated frameworks concerning the scaling of CSA are still scarce. Recent literature on scaling innovations in agriculture addresses approaches built on innovation systems (Hermans et al., 2015; Camacho-Villa et al., 2016), multi-stakeholder platforms (Hermans et al., 2017) and social learning (Riddell and Moore, 2015). Other work focuses on selected scaling pathways such as policies (Schut et al., 2014; Pitt and Jones, 2016) and private sector engagement (USAID, 2017). More generic scaling frameworks exist, such as those of Cooley and Linn (2014) and Wigboldus et al. (2016). In choosing a framework for this study, we searched for one that would give appropriate recognition to the highly context-specific needs and conditions of CSA (see section 3.3 below). Gillespie et al. (2015) present an analytical framework for scaling up nutrition interventions for broader impact in developing countries. Their framework is based on a literature review of interventions related to scaling up nutrition, health, agriculture and development, along with analysis of the key elements identified from the review. Like CSA, nutrition interventions in developing countries are highly site- and context-specific (de Pee, 2015; Vossennaar et al., 2016;

Raymond et al., 2018). Accordingly, we judged the Gillespie et al. (2015) framework to be the most well-aligned with our objectives. It includes nine thematic elements of success. Based on our own review of literature related specifically to scaling up CSA, we include an additional tenth element that is only marginally addressed in the Gillespie et al. (2015) framework: equity concerns. The ten elements of the framework are briefly described below as they relate to scaling up CSA.

1 Vision/goal

A clear vision and goal for the uptake of CSA is imperative for success, and matching timescales of needs and outcomes is part of having a common vision and goal. This can be, in part, hampered by an insufficient understanding of farmers' priorities. Having a clear idea of what farmers need and want is important not only for scaling up processes but also for small-scale uptake of new practices. Farmers' concerns need to take centre-stage in CSA scaling initiatives, and if technologies are genuinely appropriate, then scaling up is more likely to occur (Cooper et al., 2013). CSA technologies and practices may take relatively long periods of time before benefits arise: for example, improving organic matter and water holding capacity in soils, planting trees and managing landscapes. Many farmers may have shorter-term objectives, and the characteristics of the targeted interventions may not be fully aligned with these (Franzel et al., 2001; Hartmann and Linn, 2008). The same issue applies to risk (Rohrbach and Okwach, 1999; Kohl et al., 2017): the risk associated with the intervention may be inimical to small-scale farmers' objectives and attitudes. Some CSA practices may be seen as conflicting with traditional methods of management or disrupting existing livelihood systems (James et al., 2015). Participatory approaches may help to overcome some of these barriers, making project activities more responsive to meeting farmers' needs, but participatory approaches may be impossible to replicate widely because of resource limitations.

2 What is being scaled

Gillespie et al. (2015) note that stakeholders need clarity concerning what is being scaled up, in achieving large-scale impact. CSA is more than a set of practices or technologies; it is rather an approach for integrating multiple interventions across a range of food systems, landscapes, value chains and government regulation or policy (Lipper et al., 2014). The range of CSA interventions is very wide, and their entry points range from the development of technologies and practices to processes that can strengthen the institutional and political enabling environment (FAO, 2013). The evidence base as to the potential impact of different CSA interventions at scale is not large yet, but it is growing (Dinesh et al., 2017). At the same time, adoption and innovation are increasingly being seen as a complex of iteration and interaction, and both demand for ("pull") and supply of ("push") specific interventions may be involved, depending on the circumstances (Wigboldus and Leeuwis, 2013; Wigboldus et al., 2016). In the former case, interventions may be taken by farmers and adapted to their needs, to achieve scale (Bohringer, 2001; Anderson, 2008; Schot and Geels, 2008). In the latter case, interventions that are not aligned with farmers' needs or that do not take existing power dynamics and incentives into account, have limited chance of achieving scale despite excellent results at the household level (Lundy, 2016).

3 Context

A challenge for scaling up strategies is to reduce the transaction costs involved in making technologies and practices more context specific. Is CSA more context-specific than other agricultural interventions? Available evidence suggests that it is (Duong et al., 2016; Rosenstock et al., 2016; Lamanna et al., 2016; Wreford et al., 2017). The reasons may be to do with the explicit focus on climate change and the goal to produce triple wins (where this can be done) in mitigation, adaptation and food security: CSA may be more context-specific because climate change impacts and vulnerabilities vary considerably, both in space and time. The context specificity may limit its potential for scaling up or slow down its uptake, or at least the farmer may need to make

modifications for the technology to succeed (Binswanger and Aiyar, 2003). Successful scale-ups may create sophisticated, context-specific procedures constantly adapted in the light of new experiences and highly dynamic circumstances – in such cases, there may be no blueprint for CSA practices (Kaczan et al., 2013).

4 Drivers and barriers

There are numerous barriers that preclude easy adoption and scaling of CSA practices. In some situations, options will be needed to cover up-front costs (cost of conversion, loss of productivity during transition, increased labour demand), perhaps through well-targeted input subsidies or combining CSA technologies and practices with rapidly yielding crops or livestock (Cooper et al., 2013). Integrated approaches are needed to build adaptive capacity and mitigate environmental and socioeconomic risks, for example by diversifying incomes or providing insurance schemes that unlock a productive opportunity that was previously unattractive because of risk (Franzel et al. 2001; Greatrex et al., 2014). The policy and regulatory framework and its enforcement are likewise critical for effective scaling up - this may include land ownership, extension services, taxes or subsidies on agricultural inputs, credit and insurance schemes - because they provide the rules and incentives or disincentives for adoption of innovation, i.e., helping farmers with their own adaptation costs. There is plenty of evidence that sustained, direct engagement between scientists and decision makers can help to create enabling policy environments (Cramer et al., 2017) and that strong government support is crucial for large-scale success (Cooper et al., 2013), particularly in the early stages of scaling up to help reduce the initial risks to private sector involvement and early adopters (Kohl et al., 2017).

5 Scaling up processes, pathways

A key issue in scaling is identifying the most effective points where science-based interventions can leverage the greatest change that benefits the largest number of people. This may imply intervening at relatively upstream leverage points in the system, or otherwise increasing cost effectiveness. Scaling up rarely occurs in one dimension only: "As programs scale up quantitatively [larger number] and functionally [more complexity], they typically need to scale up politically and organizationally" (Hartmann and Linn, 2008: 8-9). Scaling up thus has a considerable management component (Neufeldt et al., 2015), particularly because what is being scaled up is often a bundle of different things, not just one technology (Kohl et al., 2017). The complexity of the climate change challenge in general, but particularly in terms of its cross-level dynamics, requires a multi-dimensional approach to scaling up CSA responses (Scherr et al., 2012). At the institutional level, there is a need for effective development and deployment of institutions and mechanisms that can carry forward the scaling up process (Schut et al., 2014). Many institutions may need to be involved and to cooperate, and thus need to be coordinated: from line ministries to local policymakers, both traditional and governmental, in villages, districts and provinces, as well as international development and donor communities who influence investment as well as frame discourses within which decision making takes place (Linn, 2012; Franzel et al., 2001). Progress can often only be made by working at multiple levels and dealing with cross-level relationships and impacts (Sayer and Campbell, 2004).

6 Capacity to scale up

Given the importance of the enabling environment for scaling up, any programme working on issues of scaling should take into account existing institutions and their capacities as well as the policy and regulatory framework, and the opportunities and constraints they provide (Cooper et al., 2013; Cramer et al., 2017). However, programmes or projects may choose another strategy that more directly targets institutional capacity building or policy change to facilitate scaling up processes. Scaling up can become very much about institutionalising or mainstreaming policy change (Jonasova

and Cooke, 2012). There may also be opportunities to reduce the costs of scaling up through designing research for development activities that revolve around processes that can be scaled, rather than the technologies themselves (Wigboldus and Leeuwis, 2013).

7 Governance

There are several issues related to governance for scaling up, including coherence vertically (alignment across different levels) and horizontally (cross-sectoral) and managing trade-offs (Gillespie et al., 2015). To overcome the challenges inherent in conventional approaches to scaling, new strategies should be tested, introducing CSA into existing structures (Kohl et al., 2017) – it may not be necessary to invest in scale but rather to partner with actors who already have achieved scale, and in this way add value to what others are doing. Such actors can include commercial organisations, input supply businesses, and government programmes, for example. Scale is best achieved through actors who set and enforce rules (i.e., powerful actors in the system) and not only by engaging with actors who are on the receiving end of these rules and have limited capacity to change the overall system dynamic (i.e., farmers). Because of this, some of the best scaling interventions that most benefit small-scale farmers take place far away from the farm. This also implies that a broad view needs to be taken of the many different partnerships and governance arrangements at multiple levels that may need to be forged and maintained (Adekunle and Fatunbi, 2012; Opondo et al., 2012; Cramer et al., 2017).

8 Financing

This characteristic relates to the delivery mechanisms that are used to reach farmers and their associated costs. Traditional extension approaches, especially participatory ones, often have high transactions costs and struggle to work over large areas beyond the pilot villages (Braun and Hocde, 2000). Transactions costs are high due to the need to reach individual farmers and to create the

structures necessary to reach groups of farmers (Aw-Hassan, 2005). Evidence of the costs and benefits of social learning approaches in agricultural research and implementing development work is thin (Kristjanson et al., 2014), possibly related to the perceived high transaction costs which may make social learning uneconomic over the short term (though possibly profitable in the longer term) (LeBorgne, 2016). In addition, agricultural extension often deals in broad recommendations and thus does not address different farmers' objectives or contexts. Different farmer contexts may result in unintended barriers to adoption, or trade-offs may arise if adoption does occur. By contrast, cheaper scaling strategies based on ICTs, for example, may have enormous reach but limited effect on other key constraints to uptake.

9 Monitoring and evaluation, learning, accountability

Engagement and learning are critical to create a space with key constituencies and actors to avoid political obstacles to the scaling processes (Linn, 2012). Social learning conceptualised as triple-loop learning may offer one approach to help understand whether and how meaningful and lasting engagement with stakeholders is contributing towards the scaling of research results to achieve development outcomes (Kristjanson et al., 2014). Social learning refers to processes where people with different perspectives and knowledges about a problem tap into their collective wisdom, try new practices and learn from cycles of acting and reflecting together (Harvey et al., 2013). The dialogue, action and feedback loops allow participants to track unfolding changes and transform how they approach problems over time (see, for example, CCAFS, 2015; Tran et al., 2017). These loops refer to three basic questions (see LeBorgne et al. (2014) and Annex Table 1, for example): is there basic evaluation of the effectiveness of the work? Then is there a loop back from project results to the assumptions of the work? And is there a loop back from the results to the context of the scaling up work?

10 Addressing equity concerns

As noted above, equity considerations have long been associated with scaling issues: the fewer assets a household has, the less ability or willingness the farmer may have to innovate. In addition, new practices and technologies often do not reach the poor (Snapp and Heong, 2003), and may not be suitable in the first place (for instance, if some level of investment is needed to adopt particular practices). While support for CSA has come from many countries, particularly in Africa, the concept itself has been heavily contested, particularly around social equity. Karlsson et al. (2017) note that to improve CSA outcomes, more attention should be given to the institutions that may constrain change and innovation in the poorest and most vulnerable groups. Others have stressed the importance of embedding notions of equality, more equal power relations and social justice into both the policy and practice of CSA (Chandra et al., 2017). Technologies and practices are introduced into existing landscapes that are almost always characterised by unequal power relations (James et al., 2015). Indeed, the argument might be made that scaling out as an idea implies "more of the same", with inherent risks of rigidity (Wigboldus and Leeuwis, 2013). At the very least, existing social and gender relations need to be addressed and scaling up monitored for early indications of winners and losers (Notenbaert et al., 2017).

3.2 Selection and evaluation of case studies

Eleven case studies were selected, representing a range of recent and on-going scaling activities on the part of several CGIAR centres and their partners within CCAFS. Cases were selected based on their approach and ambition to deliver widespread impact, coupled with peer appraisal that this was being achieved or was likely. We restricted the selection of cases to only those with direct CCAFS involvement; this was done to build learning within the program itself. It also helped to ensure access to key personnel and information about the case studies. After an initial analysis of the cases

they were allocated to one of the three strategies for scaling up discussed in section 2 above. The case studies are shown in Table 1. Short write-ups of each can be found in Westermann et al. (2015). Information on each case study was collected through a template filled in by the leaders of the case study projects, related to the characteristics outlined in section 3.1 above. One-on-one follow-ups were conducted as needed. Each case study was then evaluated qualitatively in terms of the degree to which the methods used addressed each of the ten elements. A score was assigned ranging from little or none (0) to highly positive (3), representing a major focus of the case studied, based on a consensus among the scorers (the authors).

4 Results

Table 2 provides a comparison of the different scores assigned to the ten elements for each case study, and these are summarised by scaling strategy and element in Table 3. Results are discussed below.

1 Vision/goal

Several of the case studies have a clear vision/goal and are addressing stakeholders' objectives explicitly, to different extents (the first element in Table 2). For the two scenario-based policy engagement case studies (CS8, policy formulation in Cambodia and CS10, CSA planning in Honduras), articulation of the vision for the work was developed jointly with policy makers. In comparing the three scaling strategies (Table 3), the case studies utilising ICT and agro-advisories tended to have relatively limited vision concerning specific stakeholders, perhaps not surprising given the blanket targeting of the information being disseminated. Several of the value chain and policy engagement case studies demonstrated a relatively strong sense of vision among stakeholders, due to the participatory nature of the engagement. Well-designed stakeholder engagement processes can help

achieve a common vision, whether around the design and selection of the CSA practices and technologies to be scaled up, or in relation to policy formulation and planning that can benefit a country's agricultural sector.

2 What is being scaled

This element is related quite closely to the strength of the vision exhibited by the case studies. Of the four case studies based on value chain and private sector strategies, three are working to scale CSA practices and technologies with a vision that has been developed with farmers, mostly to do with scaling the provision of customised recommendations for CSA practices that can help to increase the resilience of small-scale farmers in ways that are economically and socially viable. In the case of CS4, index-based insurance in Nigeria, as soon as it became clear that scaling up this intervention was going to require meaningful engagement with farmers, the project started to partner with other organisations that were already interacting with communities on the ground. For the three ICT / agro-advisory case studies, a range of information is provided via broadcasting to whomever receives it. However, interaction with recipients is taking place, with that information being used to revise the content broadcasted. In the case study on agro-climatic advisories in Colombia (CS6), for example, the project is responding to the identified needs of a wide range of partners through national farmers' organisations. The policy engagement case studies are all working with national partners on specific national policies and plans. These case studies show differences in what is being scaled: the Cambodia scenario-guided case study (CS8), for example, is addressing the enabling conditions that facilitate the adoption of CSA practices by farmers, and in the climate-smart villages in India case study (CS9), two state governments are tailoring CSA interventions in hundreds of villages to local conditions and these are being evaluated by farmers.

3 Context

In terms of their effectiveness in addressing the context specificity of CSA, none of the three scaling strategies was particularly strong. For the value chain / private sector case studies, this has presented a considerable challenge, with the possible exception of the dairy development in Kenya case study (CS2), which is working through a wider range of different institutions (cooperatives, companies and regulatory agencies) that are able to articulate the needs of diverse stakeholders throughout the value chain. For the other case studies, the appropriateness of different technologies and practices in specific contexts may depend heavily on the knowledge of local input dealers and insurers. For the ICT / agro-advisory case studies, various mechanisms are being utilised: working with national grower associations in Colombia (CS6), with other providers and sources of climatic data in Senegal (CS5), and with broad baskets of different options for different agro-ecological zones in Kenya (CS7). For the policy engagement strategy, the scenario-based case studies (CS8, CS10) operate at the national level and so do not address sub-national targeting or trade-off analyses, though it is possible to downscale the scenarios to provide such information. For CSVs in India (CS9), there are no fixed packages of interventions, but rather they differ in content depending on the region, its agro-ecological characteristics, level of development, and the capacity and interest of farmers and local government. There is still considerable research work to do, however, on understanding which interventions work where, why and under what conditions. For the case study of alternate wetting and drying (AWD) in rice systems in Vietnam (CS11), this is a technology that can be effective using current irrigation infrastructure, and it is also being targeted to areas where it will work with improved irrigation infrastructure.

4 Drivers and barriers

In terms of addressing the policy, institutional and economic barriers that can inhibit farmers adopting CSA technologies and practices, the ICT / agro-advisory case studies (CS5-7) appear to have limited if any effect (Table 2). Two of the value-chain case studies have some effect on specific

barriers: index-based insurance in Nigeria (CS4) in relation to institutional barriers, and the dairy development study in Kenya (CS2) in relation to both policy and institutional barriers. As expected, the policy engagement case studies have real strengths here: the two scenario-led case studies address policy, institutional and economic barriers explicitly, and the CSVs in India case study (CS9) involves the mainstreaming of climate smart approaches into existing local development and poverty alleviation policies and plans, thus potentially overcoming many of the barriers to adoption (although whether this potential is realised remains to be seen). Similarly, the AWD in Vietnam case study (CS11) seeks to integrate mitigation objectives into national and sub-national agricultural modernisation and rehabilitation programmes.

5 Scaling up processes, pathways

The case studies presented a range of strategies with respect to processes, pathways and the inclusion of cross-level methods. For example, the case study on index-based insurance in Nigeria (CS4) works with different levels at the spatial and knowledge scales, as it is using satellite imagery to help make on-farm decisions. The case study on radio-based information services in Senegal (CS5) is also working at different spatial scales, from the farm to the national level. The scenario-led policy case studies (CS8, CS10) are based on integrating elements about household- and community-level adaptation with drivers of regional and global change. In general, however, while some of the case studies operate across spatial scales, there is only limited cross-level activity. This may be because of the challenges presented in integrating different types of knowledge at multiple scales (Scherr et al., 2012; Schut et al., 2014).

6 Capacity

There was a wide spread in capacity development activities among the case studies. Some case studies, such as climate-smart coffee and cocoa (CS1), are developing site-specific adaptation

guidelines for mainstreaming into existing certification training curricula. The case study on scenarios in Cambodia (CS8) highlighted capacity development with partners and governments as a key mechanism for upscaling and noted the importance of time and resources for training and mentoring processes. Many of the case studies highlighted the need for capacity development at multiple levels if scaling up is to occur. For the case study on index-based insurance in Nigeria (CS4), for example, a major challenge has been working with farmers so that they understand how index insurance works. The case study on radio-based climate information services in Senegal (CS5) has been concentrating on increasing the capacity of the national meteorological agency to carry out long-term data analysis and provide actionable information to farmers. The case studies highlighted the fact that capacity development is a crucial enabler of scaling, and to be effective it has to be appropriately resourced and targeted. The scaling strategies considered here suggest that there are no short cuts or "easy wins" with respect to capacity development for scaling (Table 3).

7 Governance

Within the element of governance, we focused on the role of partnerships and alliances between stakeholders. Almost all the case studies described strong partnerships and alliances, in many cases involving research partners such as the private sector and international non-governmental organisations (NGOs). This is particularly noticeable with the value-chain case studies, to a somewhat lesser extent with the policy engagement case studies, and least of all with the ICT / agro-advisory case studies (Table 3). The case study on edutainment for CSA in Kenya (CS7, "Shamba Shape-Up") is an interesting example, though, in that the making of the different television episodes can involve a wide range of researchers, but these tend not to amount to lasting relationships. The case study on agro-climatic advisories in Colombia (CS6) required the setting up and maintenance of a partnership consisting of national grower associations (both not-for-profit and private-sector), the national meteorological office, several national and international research organizations to generate

knowledge of how climate and agriculture interrelate in specific contexts, and national and local government organizations. In general, all case studies revolve around a broad set of interactions with many different types of partners.

8 Financing

The case studies represent a wide variety of different delivery mechanisms to convey information to sometimes very large numbers of people. Tables 2 and 3 show some differences between the three scaling strategies, although all the case studies have ambitious targets, and in some cases information may be reaching millions of recipients. The case studies based on value chains generally demonstrated strong and effective partnerships for delivery with the private sector to achieve scale. The mass media delivery strategies of the ICT / agro-advisory case studies are clearly effective in reaching large numbers of people. The policy engagement case studies generally aim to deliver at scale through modifying the enabling environment via the development of appropriate plans and policies, but for the scaling-up process to succeed, effective implementation has to occur, which may take considerable further time and effort. Information on project cost is not included in Tables 2 or 3: we were not able to develop robust estimates of the costs associated with each case study on a standardised basis. The cost of information provision to farmers is one element. For the case study on agro-climatic advisories in Colombia (CS6), the direct cost was estimated at $5 million per year, or about $7.10 per farmer. For the case study on edutainment for CSA in Kenya (CS7, “Shamba Shape-Up”), the cost per episode is about $50,000, covering around five stories or segments in each episode. But there may be other costs associated with implementing decisions at the farm level and taking technologies and practices to scale. In many of the case studies, partners provided resources directly, and some leveraged large amounts of money. It might be expected that these three scaling-up strategies would have considerable potential for cost effectiveness. To evaluate this, more detailed studies on the costs of the different strategies are clearly warranted.

9 Monitoring and evaluation, learning, accountability

A range of approaches to learning is also demonstrated by the case studies. Almost all case studies are engaged in at least double-loop learning, which involves basic evaluation of the effectiveness of the work (first loop) along with a link from project results to the assumptions of the work (second loop). One case study, radio-based climate information services in Senegal (CS5), is bringing together a broad mix of partners for engagement and integrating different knowledge and perspectives; capacity is being built at different levels, farmers are being trained as local game changers, and the project is facilitating learning and allowing for new ideas; these are the essential elements of triple-loop learning. Edutainment for CSA in Kenya case study (CS7) presents a different type of learning altogether: there is engagement of viewers, better informed stakeholders, and a new type of social network via viewer identification with the farmers featured on the show, who can act as champions or mobilisers of change. Currently, there are only limited feedback loops in place, beyond farmers being able to request information sheets on the practices featured, and thus informing the content of future episodes as demand for information is analysed. The case study on index-based insurance in Nigeria (CS4) is also noteworthy in that although partnerships exist, they revolve around national-level institutions. The challenges being addressed are largely technical, to do with data and index design, and at this stage in the process, there appears to be little learning and reflection happening with stakeholders, although this may change over time.

10 Addressing equity concerns

The case studies based on value chain and private sector strategies did not consider equity considerations to any great degree. This is not surprising, given that this scaling strategy is primarily addressing farmers who are already relatively strongly market-integrated. In future, there is the potential for government policy to address equity issues in some of the case studies. This could

occur through the case study on the Kenyan dairy Nationally Appropriate Mitigation Action (NAMA) (CS2) and government support in Nigeria for subsidised input bundles including insurance products for farmers (CS4), for example. The situation is similar for the case studies using ICT / agro-advisories. Radio, TV and national growers' associations can target large numbers of people and can be designed to have some discriminatory power in targeting groups such as women, youth and children. Discriminatory power related to wealth levels and access to resources seems more problematic. All the case studies utilising policy engagement were scored as having some explicit consideration of equity issues, although in no case was this particularly strong. The two scenario-based case studies (CS8, CS10) both involved a wide cross-section of stakeholders as well as explicit links from local to national and regional processes, although it remains to be seen whether the policies as implemented will have strong and lasting effects on equity. CSVs in India (CS9) are attempting to target women's groups explicitly, but involving other marginalised and socially disadvantaged groups remains a challenge, to a large extent because of prevailing cultural norms.

5 Discussion and conclusions

The eleven case studies evaluated describe a wide range of activities at different stages of completion and located at different places on their respective impact pathways. The three scaling strategies they represent appear promising in terms of their ability to scale up climate-smart agriculture to contribute meaningfully to the challenges of poverty and climate change. Our results support the notion that different strategies for scaling up have different characteristics. There may thus be trade-offs to consider when choosing one strategy over another. For example, policy engagement strategies can be effective in overcoming barriers and may be better suited to address equity concerns than strategies based on value chains and ICT-based agro-advisories, but by themselves they may not be well-suited to addressing farmers' challenges in relation to policy goals.

ICT-based agro-advisories can reach large numbers of farmers, but there may be trade-offs in relation to lack of clarity around stakeholders' goals and limitations in marrying great reach with context specificity. The value chain case studies exhibit clarity as to what is being scaled and are relatively effective in addressing cross-level governance issues through close involvement of the private sector, but they are less effective in addressing learning and equity concerns than the other strategies. Knowing some of the limitations from these case studies can help program designers create better structured interventions in future to address some of the shortcomings noted here.

Most of the case studies were building on sometimes complex partnerships involving multiple stakeholders. While engagement mechanisms varied, the great majority of cases studied had strong stakeholder engagement activities and were continuously paying attention to stakeholders' needs and their own situations. Our results also showed that most of the cases studied were engaging in at least double-looped learning. By themselves, the case studies do not provide evidence to suggest that the more looped the learning, the more effective the scaling up, but this is a reasonable working hypothesis that can continue to be tested through time.

The work has highlighted three outstanding challenges. One is the issue of estimating the costs and benefits of different scaling activities. The case studies provided little robust information on the costs of the different strategies, but while challenging to estimate, cost comparisons would be very useful for gauging economic efficiency. While it may be envisaged that strategies for scaling up based on value chains, ICT / agro-advisory services and policy engagement could be highly cost effective, more rigorous information is needed, and this warrants further work. A second challenge is that of integrating knowledge across multiple levels. This vertical coordination across scales has also been recognized as a challenge in the nutrition arena, for example (Gillespie et al., 2015). This is not only just the challenge of moving from successful small-scale projects to informing and

implementing policy with broad reach; it also requires devolving action from national levels to local levels (or scaling down) to ensure that interventions are appropriately contextualised and locally viable. The third challenge is that of addressing equity considerations in scaling up CSA interventions. Most of the case studies have not included explicit consideration of equity issues to date. This makes it difficult to establish who is benefiting from the adoption of CSA interventions and whether disadvantaged groups are being excluded.

The CCAFS program is now into its second six-year phase. Monitoring, evaluation and learning of program activities is taking several forms, including midline surveys to evaluate farming and household changes against the baseline in selected core study sites of the program (Förch et al., 2014). In the same way, the case studies described here will continue to be monitored, along with new scaling-up activities, as a contribution to the evidence base around the effectiveness and efficiency of scaling strategies based on value chains, ICT and agro-advisories, and policy engagement. All three have a role to play in helping lower- and middle-income countries achieve food and nutrition security under climate change in the coming decades.

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Table 1. Summary of the case studies discussed. See Westermann et al. (2015) for more details.

#	Title	Organisations	Objectives, description
CS1	Climate smart value chains of coffee and cocoa in Ghana, Nicaragua, Peru	CIAT, IITA, Rainforest Alliance, Root Capital, Sustainable Food Lab	Enabling key public, private, civil society actors to develop site-specific CSA recommendations and incorporate them into their work with hundreds of thousands of farmers through extension services and tailored financing. The goal is to see the adoption of CSA practices by 15% of global cocoa producers and 7% of global coffee producers, and provision of USD 350m of tailored financial products to key value chain actors by 2019.
CS2	Sustainable dairy development in Kenya	ICRAF, ILRI, UNIQUE Forestry & Land use, Kenya Dairy Board, Min of Ag, Livestock & Fish, dairy cooperatives	Development of a Nationally Appropriate Mitigation Action (NAMA) for Kenya's dairy sector, aiming to improve dairy feeding regimes and husbandry practices and achieve a sustainable increase in milk production by smallholders, and thus improve the livelihoods of 600,000 smallholder farmers and enhance resilience to climate change while reducing the emission intensity of dairy production.
CS3	Integrating private businesses in scaling CSA in Kenya	CIMMYT, Min of Ag, Kenya Ag & Livestock Res Org (KALRO), National Cereals & Produce Board	Activities designed to reach 3 million farmers with information on CSA to increase the efficiency of agricultural input use, using 1500 farm supply dealers in 9 counties of Kenya.
CS4	Index-based weather insurance in Nigeria	CIMMYT, IITA, AfricaRice, Nigerian Federal Min of Agr & Rural Development, Swiss Re, Pula Advisors	Development of a roadmap for scaling up insurance and providing technical support to strengthen implementation of index-based insurance. Goal is to cover 14.5 million smallholder farmers with an inclusive, innovative and diverse agricultural insurance system, starting with a pilot targeting 350,000 maize and rice farmers in five states.
CS5	Climate smart information services in Senegal	ICRISAT, national met agency (ANACIM), Association of Rural Radios, Min of Ag	Provision of agro-meteorological advisory packages tailored to meet local farmers' needs as expressed in discussion groups, based on downscaled seasonal forecasts and 10-day forecasts through the season that are interpreted and disseminated using 82 rural radio services in local languages throughout the country.
CS6	Agro-climatic advisories and CSA in Colombia	CIAT, Min of Ag, national growers associations, Nat Inst of Hydrol, Met & Env Studies, Colombian Corp for Ag Research	Training farmers' association to select, multiply and spread the most adapted varieties according to their regions, interpret seasonal forecasts, and analyze their own production systems, via an information platform and other material. The goal is to reach 700,000 farmers.
CS7	Edutainment for scaling out CSA in Kenya	Mediae, a wide range of contributors including CIMMYT, CIP, ICRISAT, ICRAF, ILRI	Information provision via "Shamba Shape Up", a reality TV series in which farmers are trained in technologies and practices suitable to their needs. Interested viewers can access leaflets describing the interventions shown in more detail. The show regularly reaches 5 million viewers in 3 countries in E Africa.
CS8	Scenario-guided policy formulation in Cambodia	CCAFS, FAO, UNEP-WCMC, Min of Ag, Forestry & Fisheries	Development of the Cambodian Climate Change Priorities Action Plan (USD 147 million) using participatory scenarios, with the aim of enhancing the resilience of the agricultural sector and farmers' livelihoods, and the potential to benefit a large proportion of the country's population, most of whom live in rural areas.

CS9	Climate Smart Villages in India	IFPRI, CIMMYT, community based organisations, private sector, state departments of agriculture, research & extension	75 CSVs developed in 3 states of India to build evidence that CSA can increase income for farmers as well as providing resilience and mitigation co-benefits mitigation, and as policy dialogue platforms with state- and national-level decision makers, with the aim of upscaling the approach to very large numbers of beneficiaries in India and elsewhere in South Asia.
CS10	Mitigation and adaptation planning in Honduras	CCAFS, Secretariat of Agriculture and Livestock, Central American Agricultural Council	Working to inform policies that include CSA to contribute to the improvement of smallholder farmers' livelihoods, via co-creation of climate impact evidence and climate and socio-economic scenarios (framing the scientific evidence), and then leveraging impact via policy dialogue, with the potential to reach >3 million farming households.
CS11	Alternate wetting and drying (AWD) technology in rice systems in Vietnam	IRRI, CCAFS, Min of Ag & Rural Development	Catalysing policy and investment for AWD implementation by linking a diverse range of partners and policy makers, integrating mitigation objectives into agriculture modernization plans and rehabilitation programs (e.g. for irrigation infrastructure), and developing rice components in national climate change action plans and the NAMA.

Table 2. Case studies evaluated according to their "strength of impact" on several elements: 0 = none or very little; 1 = slight; 2 = moderate; 3 = strong.

Cases study		Element									
		Vision/goal	**What is being scaled**	**Context**	**Drivers and barriers**	**Scaling up processes**	**Capacity development**	**Governance**	**Financing**	**Learning**	**Equity**
Case studies based on value chain and private sector strategies											
CS1	Climate smart value chains (coffee, cocoa) in Ghana, Nicaragua, Peru	2	2	1	0	1	2	3	3	1	0
CS2	Sustainable dairy development in Kenya	1	2	2	1	1	0	2	1	2	0
CS3	Integrating private businesses in scaling CSA in Kenya	2	2	0	0	1	0	2	2	2	0
CS4	Index-based weather insurance in Nigeria	1	1	1	2	2	1	3	3	1	0
Case studies utilising ICT and agro-advisories											
CS5	Climate smart information services in Senegal	1	1	1	1	1	2	2	3	3	0
CS6	Agro-climatic advisories and CSA in Colombia	1	2	1	0	1	1	3	1	2	0
CS7	Edutainment for scaling out CSA in Kenya	1	1	1	0	0	1	0	3	2	0
Case studies utilising policy engagement											
CS8	Scenario-guided policy formulation in Cambodia	2	2	0	3	2	2	2	2	2	1
CS9	Climate Smart Villages in India	1	1	3	2	1	2	2	2	2	1
CS10	Mitigation & adaptation planning in Honduras	2	1	0	3	1	0	2	1	2	1
CS11	Alternate wetting & drying in rice in Vietnam	1	1	2	1	1	2	2	1	2	0

Table 3. Summary of eleven case studies by scaling strategy. Values shown are mean "strength of impact" per element of the effects of the strategy. Data from Table 2.

Strategy	Element										Mean of elements
	Vision/goal	What is being scaled	Context	Drivers and barriers	Scaling up processes	Capacity development	Governance	Financing	Learning	Equity	
Case studies based on value chain and private sector strategies	1.5	1.7	1.0	0.8	1.2	0.8	2.5	2.2	1.5	0	1.3
Case studies utilising ICT and agro-advisories	1.0	1.3	1.0	0.3	0.7	1.3	1.7	2.3	2.3	0	1.2
Case studies utilising policy engagement	1.5	1.2	1.3	2.2	1.2	1.5	2.0	1.5	2.0	0.8	1.5
Mean across strategies	1.3	1.4	1.1	1.1	1.0	1.2	2.1	2.0	1.9	0.2	1.3

Appendix Table A1. Indicators for assessing the degree of learning exhibited in the case studies (from van Epp and Garside, 2014).

Type of Indicator	Indicator	Learning loop[1]
Process	Groups/individuals are engaged through appropriately tailored means	Double
Process	Systems are in place to foster and implement new ideas	Triple
Process	Capacity development activities target all participants in appropriate ways (e.g. governments, farmers, scientists)	Double / Triple
Process	Key individuals/institutions who will support/champion change are identified	Double
Learning Outcome	Knowledge of the problem enhanced by interactions	Double
Learning Outcome	Different knowledge types successfully integrated	Triple
Learning Outcome	Increased understanding between different participant groups of different needs and perspectives	Double / Triple
Value / Practice Outcome	New social networks established	Double
Value / Practice Outcome	More informed stakeholders	Double
Value / Practice Outcome	Reduced number and severity of barriers and/or increased number and potential impact of opportunities	Double / Triple

1 Learning loops (see, for example, LeBorgne et al., 2014):

Loop 1, are we doing things right: is there basic evaluation of the effectiveness of the work?

Loop 2, are we doing the right things: is there a loop back from project results to the assumptions of the work?

Loop 3, how do we know what's right: is there a loop back from the results to the context of the scaling up work?