Climate-smart agriculture: in need of a theory of scaling

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Abstract

Since 2011, the CGIAR program on Climate Change, Agriculture and Food Security (CCAFS) has supported research in different parts of the world on how climate-smart technologies, practices and information can address the challenge of transitioning to climate-smart agriculture at a large scale under the new realities of climate change. The working paper critically examines how CCAFS researchers have conceptualized and practiced the scaling of climate-smart agriculture interventions. The review of CCAFS research is complemented by a discussion of some of the recent social science literature on scaling and closely related topics, such as (diffusion of) innovation and institutionalization. Although more recently the conceptual, methodological and practical challenges related to scaling of climate-smart agriculture have received more attention, there remains a need for the development of a more coherent theory of scaling informed by insights from sociology, political sciences and gender studies.

Key words

Adoption, climate-smart agriculture, practice of scaling, theory of scaling

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Acronyms

CSA	climate-smart agriculture
CSV	climate-smart village
M&E	monitoring and evaluation
R&D	research and development

Part 1. Introduction: scaling through the eyes of CCAFS

Since 2011, the CGIAR program on Climate Change, Agriculture and Food Security (CCAFS) has supported research in different parts of the world on how climate-smart technologies, practices and information can address the challenge of transitioning to climate-smart agriculture at a large scale under the new realities of climate change (emphasis added).[1] This CCAFS research claims to fill an observed knowledge gap. Despite the significant global action and investment in climate-smart agriculture, there is scant evidence of what technologies and practices work where and why, what the synergies and trade-offs are among the three pillars of climate-smart agriculture (productivity, adaptation and mitigation), and what successful scaling mechanisms (including financial services) are that can generate a transformation of agriculture[2].

In the work of CCAFS globally, scaling has been an important and recurring topic. Scaling mechanisms expected to be useful, according to CCAFS, include agricultural and climate (change) related policies, government (investment) programs, improved supply chains, information and communication technologies (e.g. agro-advisories), impact investment by the private sector, financial services, and social networks (e.g. farmer to farmer exchanges) (concerning the role of social networks, see the review by Martínez-Barón et al. 2018[3]). In a recent blog (December 2018), CCAFS states that best CSA practices "eventually need to reach 500 million farmers".[4]

[1] For more details, see: https://ccafs.cgiar.org/flagships/climate-smart-technologies-and-practices and https://ccafs.cgiar.org/flagships/participatory-evaluation-csa-technologies-and-practices-climate-smart-villages-learning
FAO originally developed the concept of climate smart agriculture. http://www.fao.org/climate-smart-agriculture/overview/faqs/history/en/

[2] A number of projects were develop to address these questions. For example: https://ccafs.cgiar.org/synthesis-and-support-climate-smart-agriculture-evidence-building-and-scaling#.XBDTwdOWwcQ, https://ccafs.cgiar.org/certified-supply-chains-and-impact-investment#.XBDWZ9OWwcQ and https://ccafs.cgiar.org/innovative-finance-scaling-climate-smart-agriculture#.XBDUktOWwcQ Final reports were not available by the time of writing of this paper.

[3] The role of social networks has received little attention in CCAFS research. The authors argue that more research is needed to address the link between social networks, social capital and the potential scaling of adaptation practices that present mitigation co-benefits in a climate change context.

[4] https://ccafs.cgiar.org/blog/climate-and-agriculture-cop24-depressing-or-exhilarating#.XBo7gtOWwcS

A recent (early 2018) search in the CCAFS on-line publication repository using the keyword scaling (the English term only) gave 113 references spanning the whole programming period since the start in 2011. A repeated search (December 2018), gave 144 (two are in Vietnamese). A poster title of 2015 captures succinctly why CCAFS pays attention to scaling (Girvetz et al. 2015): "25 million African farming families by 2025: science-development partnerships for scaling climate-smart agriculture". A working paper from the same year reinforces this: "Reaching more farmers. Innovative approaches for scaling-up climate-smart agriculture" (Westermann et al. 2015). Not only aspirational publications can be found; also more practical. A CCAFS Info Note published in 2016 has the title 'CSA Plan': A guide to scaling climate-smart agriculture –Concepts and lessons from designing CSA programs and policies in sub-Saharan Africa (Rosenstock et al. 2016). More recently, Aggarwal et al. (2018) claim that the climate-smart village approach is an effective framework of an integrative approach for scaling up adaptation option in agriculture.

The 113 references found in early 2018 in English all concern CCAFS work in Africa and Asia. Of the 144 references found by the end of 2018, nine concern Latin America. When searching in the CCAFS on-line repository using the Spanish term for scaling, "escalamiento," 26 references were found early 2018 (e.g. Boa et al. 2015, Bouroncle et al. 2015, Bouroncle et al. 2017, CCAFS 2013); unexpectedly, they were reduced to only two at the end of 2018. Among the 26, one was the Info Note *Diseño de una metodología para el escalamiento de las prácticas de agricultura sostenible adaptada el clima en Cauca, Colombia* or Design of a methodology to scale sustainable agricultural practices adapted to the climate in Cauca, Colombia (Mora Montero 2017). The Info Note reported on a scaling methodology based on the identification of analogue sites with similar climate and socio-economic characteristics as the CCAFS reference site, in this case the CCAFS denominated "climate-smart village" in Cauca. The InfoNote is one of the examples of practical (methodological) guidance to scaling or a how to guide.

The study produced by Westermann et al. (2015)[5] is likely the most comprehensive review of 'CCAFS scaling' to date. The authors underline that CCAFS scaling is required to achieve impact beyond the plot or site level and reach more people over wider areas [similar to what

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[5] The original CCAFS working paper was recently republished, with a few author additions, as a journal article in Agricultural Systems: http://doi.org/10.1016/j.agsy.2018.07.007

usually is called scaling out or horizontal scaling], and to impact on institutions and policies that drive the interest in scaling up [sometimes called vertical scaling] and have a substantive impact on poverty. They argue that inherent in the notion of climate-smart agriculture is the need for hundreds of millions of smallholder farmers to adopt climate smart practices and technologies, which will inevitably involve new and innovative ways of moving to scale (ibid: 11; emphasis added). From this obvious circular argument, it is not so surprising that a push approach appears as the preferred CCAFS scaling approach. However, the authors observe that not necessarily the (CCAFS) researchers themselves have to bring things [presumably the climate-smart interventions proposed by the CCAFS program] to scale, but, that it is key to develop explicit strategies that will enable next users through partnerships, engagement, capacity development and learning to apply research results in non-research processes. Researchers should also help to inform next users about what makes enabling environments conducive to scaling up and out (12; emphasis added). In Part 2 of this working paper, we will return to this publication by Westermann et al.

Emerging questions

One can conclude that since the start of the program in 2011 there has been a lot of 'talk' (writing) about scaling of climate-smart agriculture in the CCAFS program. Since scaling climate-smart agriculture is a concept that relates to development processes one would expect that CCAFS has a sound conceptual framework or a theory of scaling of climate-smart agriculture. It this the case?

What is exactly meant by scaling in the CCAFS literature? How does CCAFS know that the technologies and practices that it wants to scale are effective (e.g. defined in technical, economic, social and gender terms) beyond the pilot sites they have been tested in to some degree and with the involvement of some farmers?

How does CCAFS define its scaling targets? Are targets defined quantitatively or qualitatively or both?

Do the researcher and managers of CCAFS involve others, in particular farmers and farming communities (according to CCAFS, the ultimate targeted practitioners of climate-smart agriculture) in defining the scaling agenda? If so, how are these perspectives and interests communicated? Are they integrated in programming?

Have possible negative, unintended and/or hard to anticipate consequences that may result from scaling been analyzed?

Aim of this research paper

This research working paper aims to answer some of these questions. It critically examines how CCAFS originally 'talked' about climate-smart agriculture and its scaling (part 2): CCAFS scaling on paper. It then reviews how CCAFS researchers have defined (or not) and dealt with the concept of scaling, conceptually, methodologically and practically (part 3): we call this scaling in CCAFS practice (as reported by CCAFS researchers themselves). Part 4 of the paper examines some of the social science literature on scaling and closely related topics, such as (diffusion of) innovation and institutionalization and explores what could be learned from it. Part 5 concludes.

This research paper is largely based on a literature review of CCAFS publications available on-line (in English and Spanish) complemented by a number of non-CCAFS scientific publications. Originally, the idea was to elaborate on the review findings by including the answers to a small number of questionnaire responses that we sent to 10 researchers in Latin America working on agricultural development (some involved with CCAFS and some not involved with CCAFS) about their experiences with scaling agricultural innovations (see Annex 1 for the questionnaire). Four completed questionnaires were received. Two questionnaires dealt with ongoing research and reported that it was too early to comment on the scaling approach used. Two questionnaires described the scaling experience in detail. The answers to these questionnaires were transcribed and can be found in section 4 in the form of non-CCAFS case studies. The limited (completed) responses to the questionnaire is one of the limitations of the research paper.

The research paper benefits from the practical involvement of both authors with CCAFS research planning, implementation and monitoring during the last seven years in Africa, Asia and Latin America.

Complementary Guatemala study

This research paper will be complemented by a Guatemala field study report that focuses on the views of local stakeholders on scaling. The one week field visit made in November 2018 explored if and how options for scaling of climate-smart agriculture are perceived by people in the field, in one of the CCAFS climate-smart agriculture pilot sites: the so-called dry corridor of Guatemala where the CCAFS program selected one community, La Prensa, to become a climate-smart village[6]. The field study report in not included here, but will be published separately.

The CCAFS research program in Latin America started in 2013 (CCAFS 2013); planning and *ex ante* cost/benefit analysis of CSA interventions for **Guatemala** took place in 2014 (Sain et al. 2017) and local activities began in 2015. One area of research was at the community level through participatory research on climate-smart technologies and practices in one designated climate-smart village, similar to what CCAFS has been supporting in other regions of the world. In the CSV, farmers are engaged in participatory variety selection, diversifying the production system, producing organic fertilizer, making use of agro-climate information, contract farming, and becoming familiar with new finance mechanisms (Villarreyna Acuña et al. 2016).

A second area focused on how best to provide tailored agro-climatic services and food security information for better decision making at various levels ranging from national to municipal (Bioversity International 2017, Bouroncle et al. 2017, Mueller et al. 2018). Municipal Food and Nutrition Security Councils (Consejos Municipales de Seguridad Alimentaria y Nutrición or COMUSAN) are part of the municipal government structure and include government and non-government actors working on food security. Together with a community-based food security early warning system at municipality level, the council is supposed to improve climate resilient planning and implementation (Mueller and van Etten). The council is set up at scale in all municipalities of the country based on a political decision in SESAN. This assures political support, but does not guarantee sustainability. What looks promising on paper does not always work out in practice, certainly not if there are institutional challenges (e.g. high turnover of staff, new policy guidelines, corruption) and implementation is obstructed by perverse mechanisms, such as handouts to gain political support.

[6] See for more information, a blog story about one of the activities in La Prensa: https://ccafs.cgiar.org/blog/judging-beans-guatemalan-heights#.XBDRL9OWwcQ

A third area researched macro-level policy issues such as the identification of priority actions for adaptation in Guatemala's agricultural sector (Boa et al. 2014, Bouroncle et al. 2015).

Part 2: The CCAFS scaling approach −on paper−

The climate-smart village (CSV) approach, originally presented in 2011, includes (CCAFS 2016, Aggarwal 2018):

1. Understanding the effectiveness of a variety of climate-smart agriculture options (practices, technologies, services, programs, and policies), not only to enhance productivity and raise incomes,[7] but also to build climate resilience, increase adaptive capacity, and wherever possible, reduce GHG emissions. In Central America, CCAFS is experimenting with an ICT devise, GeoFarmer, to collect data at household level and monitor the results of CCAFS interventions (Suchini et al. 2018) to document and analyse the results of the options introduced;

2. Developing (no regrets) solutions in anticipation of future climate change impacts;

3. Understanding the socioeconomic, gender, and biophysical constraints and enablers for adoption; and

4. Testing and identifying successful adoption incentives, finance opportunities, institutional arrangements, and scaling out/up mechanisms while ensuring alignment with local and national knowledge, institutions, and development plans.

In the CSV approach, a village could also be an agroecologically defined area, e.g., a small watershed. In Spanish, the word 'territorio' (territory) is used in the concept of Territorio Sostenible Adaptado al Clima (TeSAC), literally, climate-adapted sustainable territory. The spatial difference between village and territory is important. Originally, the CSV approach focused on practices and technologies related mainly to crops (in a village). The territory approach is more holistic and agroecosystem based. Not only does it focus on a larger geographic area, but also considers the diversity of natural resource use, the maintenance of

[7] Not included here is social equity. Some authors have argued that what equity actually means in the context of CSA has been poorly theorized and discussed by CCAFS. They asked the question if CSA produces 'triple wins' or 'triple faults'? (Karlsson et al. 2017). Equity is **not** one of the three pillars of CCAFS' approach to promote CSA, which are productivity, adaptation and mitigation. An analysis of equity requires an analysis of power relationships –hardly included in any CCAFS publication.

ecosystem services and the importance of collective action (Sherr et al. 2012. Louman et al. 2015). The evolution of the approach is evident in the first series of profiles of Climate-Smart Agriculture for Latin America jointly prepared by CIAT and CATIE (see, for example, profiles for Colombia and El Salvador; World Bank, CIAT and CATIE 2014a and 2014b, respectively). However, exact boundaries of the territory under study are not always clearly defined, e.g. the CCAFS TeSAC in Guatemala.

The CCAFS started piloting the CSV approach in 2012 in Africa: Burkina Faso, Ghana, Mali, Niger, Senegal, Kenya, Ethiopia, Tanzania, and Uganda; and South Asia: Bangladesh, India, and Nepal. In 2014, CSVs were set up in Latin America: Colombia, Guatemala, Honduras, and Nicaragua; and Southeast Asia: Cambodia, Laos, Vietnam, and Philippines. By the end of 2018, there are 36 CSV sites in total where variable sets of activities take place supported by CCAFS partner organizations including CGIAR centers, international/national research and development organizations, government agencies and civil society/community-based organizations (Aggarwal et al. 2018).

Farmers involved in CSV activities –usually a relatively small percentage of the total farmers in the village or territory, e.g. ranging from 10-20% in CSVs in Guatemala, Nepal and Vietnam, for example− receive training to improve their knowledge and skills about topics such as technology development; planning, monitoring and evaluation; and gender dynamics (Osana Bondilla-Findje 2018, personal communication). Activities in many CSVs build on previous interventions by programs or projects and use existing approaches and methodologies, perhaps with some adaptation, e.g. CCAFS is using the farm field school approach in Guatemala.

The main result of CSV experimentation with CSA technologies and practices is supposed to be a **portfolio** of options that together lead to the triple wins that CCAFS is aiming for. However, CCAFS left some things undefined. For example, how are these portfolios to be made up: e.g. do a pair of two technologies or practices constitute a portfolio? Does each of the technologies need to have a triple-win benefit or would two or one suffice? What are the criteria to prioritize efforts in a territory considering the possible synergies (or not) between different practices and technologies? Does there need to be a balance between CSA interventions that have outcomes at farm level and interventions that have an outcome at village or territory level? How many households do need to practice effective CSA interventions to turn a village or territory into a climate-smart village or territory? This last questions has direct consequences for scaling: how much scientific evidence is needed to define a CSA intervention ready for scaling out and up?

CCAFS envisioned the scaling to take place by means of institutional and financial mechanisms that enable successful adoption by more farmers in and around the CSV sites, and, as a more ambitious scaling goal, far beyond the CSVs. CCAFS believed that promising innovations could easily be scaled out by national/subnational governments, NGOs and private-sector actors in regions with similar agroecological conditions, through their programs and projects.

Over the years, the CCAFS scaling mechanisms tested across the regions included:

- Horizontal scaling (scaling out) of climate-smart options: CSVs provide demonstration sites for farmer-to-farmer learning and/or enable local promotion of options through local government plans, programs, and policies or through private-sector business models.

- Vertical scaling (scaling up): CSV research and lessons learned provide evidence for the efficacy of practices, technologies, services, processes and institutional options and are thus able to influence large-scale CSA investment plans; promote mainstreaming of institutional changes; and/or inform policy instruments.

As an example, in Central America, CCAFS interacts regularly with policy-makers at regional level, such as the Consejo Agropecuario Centroamericano (Central-american Agriculture and Livestock Board) and the Consejo de Ministras de la Mujer de Centroamérica y República Dominicana (the Board of Women's Ministers of Central America and the Dominican Republic) to influence their decision making. At the Central American regional level, CCAFS's goal is to reach several millions of smallholder farmers (Osana Bonilla-Findji 2018, personal communication).

Aggarwal et al. (2018) include a section on potential scaling synergies and trade-offs, but omit to review examples of the latter in the review of actual CCAFS experiences. These authors mention that modeling is in progress to assist with this task. They note that (ibid):

“There is still a need for greater evidence for the CSV approach in different agroecological environments. It is especially important to understand the trade-offs between food security, adaptation, and mitigation in current and future socioeconomic and climate scenarios. More research is needed to demonstrate that adaptation strategies do not become maladaptive. The role of an appropriate monitoring and evaluation framework and indicators of climate smartness that can be easily measured becomes very important.”

This is a remarkable observation after seven years of CCAFS program activities in three continents and 36 sites.

Part 3: Scaling in CCAFS practice

This section reviews CCAFS scaling practices (approaches, methods, tools, mechanisms) from around the world as described in publications by CCAFS researchers often together with their national and/or international partners. The review starts with single practices followed by more complex practices. One non-CCAFS example is presented: the Collaborative Participatory Plant Breeding Program in Central America.

Community fund

ICRAF has experimented with community innovation funds in **Vietnam**, simple kick-start funds to support farmer interest groups who have limited access to formal financial services for implementing climate-smart agriculture practices. A Community Investment Fund (CIF) can be implemented as sole fund or as co-investment to community savings and loans groups (ICRAF 2018). A CIF functions as a kind of village saving and loan association usually is a group of 10-25 people who save money collectively and take small loans from those savings. The activities of the group run in cycles of one year, after which the accumulated savings and the loan profits are distributed back to members. The purpose is to provide simple savings and loan facilities in a community that does not have easy access to formal financial services. Both these mechanisms put farmers in the driver seat allowing demand driven adoption of CSA technologies. Other authors (non-CCAFS related) have more deeply analyzed the role of community-based organizations, such as in Bangladesh (Karim and Thiel 2017). In the CCAFS literature, this remains an under-researched area.

Climate risk maps

Son et al. (2018) report on the use of climate-related risks maps and adaptation plans for the Mekong Delta of **Vietnam** that serve to recognize climate-related risks, identify potentially affected areas and develop regional and provincial adaptation plans for rice production in the Delta region. The maps are used by the provinces in the Delta to recommend changes in the rice cropping system and sowing/transplanting systems to be adopted by farmers. The recommendations take into consideration flood, drought, and salinity intrusion risks at sub-ecological zonal level, but based on an integrated regional approach. While the map itself can be considered a tool at scale, it allows recommendations to be made at a smaller scale. It is not clear if farmers have started to make changes based on the recommendations.[8]

Large field model

Another, very particular, linear scaling approach used in Vietnam is the so-called 'large field model' which simply argues that to make scaling possible smallholder farm plots should be "aggregated" into large farms so that new technologies can be rolled out over a large area without the hindrance of multiple boundaries and barriers (Thang T.C. et al. 2017). It seems that the authors mean physical boundaries and barriers; discussion of socio-economic or other boundaries and barriers is strikingly absent.

Media campaigns

In **the Philippines**, the local CCAFS teamed up with the Philippine Federation of Rural Broadcasters (PFRB) to develop a campaign on climate change[9]. The campaign started in 2016 and involves 150 rural broadcasters in the Philippines who mobilize the rural sector (particularly farmers, fisherfolk and rural women) and advocate the practice of climate smart agriculture. CCAFS staff will provide members of the PFRB and their network of community radio practitioners with ready-to-be-aired interviews and scripts on climate-smart agriculture. The broadcast materials will be produced in the languages of selected pilot regions. To motivate broadcasters, a reward and incentive system based on listenership and impact will be put in place. It is assumed that listeners will adopt the CSA practices promoted on the radio (Cruz et al. 2016).

[8] CCFS South-east Asia has supported two other CSA scaling projects in recent years, one to scale CSA horizontally (from farmer to farmer), one vertically (from farmer to government). Unfortunately, no useful reports were provided by CCAFS about the scaling results of the two projects. More information and some stories about the two projects can be found at: https://ccafs.cgiar.org/evidence-scaling-out-climate-smart-agriculture-southeast-asia#.XBDOaNOWwcQ

[9] For more information about the work in the Philippines, see: https://ccafs.cgiar.org/publications/towards-portfolio-climate-resilient-technological-options-community-level-participatory#.XBDPLNOWwcQ One of the important findings is that in the country differentiated solutions are needed given that impacts of climate change are often unique to specific locations and tend to differ considerably, even from community to community.

Analogues and extrapolation

Poudel et al. (2017) used an extrapolation approach based on field evidence from **Nepal** to help CSA policy-makers and implementers at national and subnational levels to make informed decisions and invest in a strategic CSA portfolio[10]. This approach uses analogue sites – sites which display similar current and/or future climatic conditions to the CCAFS pilot project districts. Cultivation areas for rice, wheat, maize and millet in each district were used to estimate the geographic potential for scaling up of the selected CSA options. More than 50% climate similarity was assumed to be a favorable condition for technology transfer from one location to another (3-4). This was complemented by a detailed review of the national policy environment to evaluate the possibility of scaling up CSA: 1) determine whether CSA had been integrated into existing agriculture and climate-change-related policies, institutions and financial mechanisms; 2) to what existent institutions are able to plan and manage CSA; and 3) what barriers and opportunities the country is facing for scaling-up of CSA.

The study concludes that efforts to scale up CSA options need to take account of complex and continuously changing interactions between biophysical, social, economic, environmental, climatic and institutional factors. The complexity is compounded as these factors interact with different agricultural management levels (local to national, and geographically) over different time frames. Existing pathways to scale-up, however, do not adequately take into account these complex realities and embrace the common approach of "find out what works (in one place) and do more of the same (elsewhere)". (7)

In **Nepal** three models are proposed to support the pathways for scaling up of CSA options. These were (1) knowledge-transfer model, (2) commercial business model and (3) policy incidence model. The knowledge-transfer model is appropriate for knowledge-intensive CSA options. The knowledge-transfer model is about scaling up the technology by affecting farmers' adoption process through training, demonstration, participatory evaluation, exposure visits, etc.; the role of the public sector is vital to promote these technologies. The commercial business model is suitable for input-intensive or proprietary-based CSA options,

[10] For more information about the CCAFS scaling project in South Asia: https://ccafs.cgiar.org/scaling-and-out-climate-smart-agriculture-technologies-practices-and-services-across-south-asia#.XBDSz9OWwcQ

where private businesses can scale up the CSA options by selling the inputs required for scaling-up of the CSAs. Finally, some of the CSA options require removing policy bottlenecks and/or increased support from government.

Mora Montero (2017) developed a novel, supply oriented scaling methodology, piloted in the department of Cauca, **Colombia**, based on the principle of analog sites (derived from the climate analogue method) of five steps (pp. 1-2):

1. Mapping and analysis of actors that can influencing the scaling of CSA technologies and practices in a given region;
2. Characterize the factors that enabled/hindered CSA adoption by farmers at community level;
3. Identify analog geographical or administrative units (e.g. municipalities) with similar socio-economic and climatic conditions where scaling could have good potential;
4. Verify these conditions of one (or more) analog units to identify opportunities and obstacles for scaling.
5. Continue to adapt the methodology through repetitions in other units.

One of the conclusions was that the process of scaling needs to be two directional: from bottom to top to find funding sources, influence policies and institutions that can implement; and from top to bottom to build on local organizations and social dynamics that can guarantee sustainability (3). Unfortunately, the study does not describe how effective the methodology was in terms of scaling outcomes so it is hard to assess its utility.

How to scale versus what to scale: insights from My Loi, Vietnam

Building on the work in My Loi climate-smart village in northern Vietnam, ICRAF recently published the results of a study about lessons learned in the CSV. In particular, the study explored the scalability potential of CSA interventions piloted in My Loi, to Ky Trung commune in the same district and to other sites in the same province. The team identified five effective climate-smart agriculture models that can be implemented in a step by step way. The ICRAF study argues that the models include specific components that are context-specific and not scalable, but the technologies and the approach developed for identifying CSA practices can be generically applied.

One important conceptual distinction the authors make is between CSA technologies or *how* things are grown and CSA components or *what* is grown. When it comes to scaling, they argue that the former can be applied broadly, but the latter is context specific. As an example they give: contour planting, which can be done anywhere, while the specific trees and crops in such a system would depend on local suitability. The team identified four enabling factors that, in the specific context of the CSV, enabled adoption of CSA interventions: (1) gradual introduction of integrated CSA practices that provide some income during the establishment phase; (2) policy support for converting unproductive agriculture land into mosaics of permanent agroforestry; (3) access to investment or loans with low interest rate and longer return period; and (4) new drought-tolerant varieties and crops.

This study offers a useful conceptual refinement of scaling theory.

Scaling from the start: crowdsourcing crop variety selection

In a number of countries in Africa, Asia and Latin America, Bioversity International and partners have piloted a novel (vertical) scaling approach to climate change adaptation[11]. Based on the assumption that adoption of climate-smart agricultural options needs a constant and quick-paced process of discovery to identify locally appropriate solutions, researchers took insights from citizen science and crowdsourcing to design a new methodology named "tricot" (for triadic comparison of technologies) in which hundreds or even thousands of farmer are involved as citizen scientist or researchers (Steinke and van Etten 2016). The tricot approach allows for the participation of many more farmers in participatory trials than usually is the case, which has a direct effect on variety dissemination. Results are scaled using digital technologies and simple formats that allow for unsupervised participation.

Farmers receive packages of seeds with three different varieties and submit their feedback in a simple format, ranking the 'best/middle/worst' of each package for different traits. Each package contains a different combination of varieties (an "incomplete block"), which allows for testing a diverse set of varieties. The farmer-generated data are then combined with environmental and socio-economic data and analyzed with specific, novel statistical methods for ranking data.

[11] For more project information and a blog story: https://ccafs.cgiar.org/citizen-science-approach-climate-adaptation#.XBDYWdOWwcQ and https://ccafs.cgiar.org/blog/more-wiser-exploring-how-farmer-citizen-science-can-deliver-solid-results#.XBDW7dOWwcQ

The tricot approach has been able to demonstrate how varieties are differentially adapted to different growing conditions across large areas. The approach has already been adopted by a number of large-scale initiatives in South Asia, East Africa, e.g. the Integrated Seed Sector Development program in Ethiopia supported by the Dutch government), and Central America. ISSD-Ethiopia used the approach with 5,995 farmers, who subsequently shared seeds with others and created seed demand, affecting an estimated 1.3 million farmers (Bioversity International 2018).

Horizontal scaling: the Collaborative Participatory Plant Breeding Program in Central America (FPMA) –a non CCAFS example

In recent decades, a number of agricultural initiatives were implemented by international and national organizations, some of which were reviewed to develop the initial CCAFS program for Latin America.[12] However, with regard to lessons learned for scaling purposes, not much evidence could be found As an interesting example of such an initiative we present here a short review of one of the longest running agricultural programs in Central America with a reach of tens of thousands of farmers is the Central American participatory plant breeding programme. [13] This example points to two important insights: 1) horizontal scaling through a capacity development approach based on peer learning is feasible, but it takes much and continuous effort and a very long time to mature; and 2) scaling processes are embedded in and influenced by particular complexities of socio-economic and political dynamics.

The programme, first started in 2000, brings together a number of government and non-government research and development organizations from Costa Rica, Guatemala, Honduras and Nicaragua, Cuba and Mexico, to promote the improvement of staple crops (maize, bean, and sorghum in Nicaragua) and their conservation (including local potato varieties in Guatemala) through capacity development (e.g. agrobiodiversity schools based on the farmers' field schools model), field-trials, agrobiodiversity fairs and community seed banks.

One of the methodologies used by partner organizations is the CIAL or Local Agricultural Research Committee methodology first introduced by CIAT in Colombia and then adapted to

[12] See for more information: http://repositorio.iica.int/bitstream/11324/6981/1/BVE18039823e.pdf

[13] This case is based on the answers given to our scaling questionnaire. The write up was done by Ronnie Vernooy.

Honduras and Nicaragua in later years. CIALs bring together women and men farmers interested in experimenting with new crop diversity (often combined with new management practices) in small research groups. They receive technical support from professional agronomists, breeders, social scientists or extensionists. In Honduras in particular, the number of CIALs has expanded and a number of CIAL associations have been formed (combining horizontal and vertical scaling). At the end of 2018, there were more than 165 CIALs spread across hillsides in nine or half of the country's 18 departments (Sally Humphries, personal communication).

The FPMA program has made use of a horizontal scaling or 'multiplication' (*el efecto multiplicador*, the concept used by the program, FPMA 2012) strategy through the building of connections to farmer organizations, local community leaders, and in Honduras, some leaders of municipal governments, with the aim to transfer knowledge and experiences and with the hope that these organizations start to implement similar activities (2016: 14). Among the difficulties this scaling has encountered are: weak organizational and entrepreneurial capacities of farmer organizations; no recognition and support from the government; poor participation of youth and women; limited access to capacity development; 'perverse' government seed donations; poor understanding and use of the theme of gender and no funds to implement gender related activities; and no formal collaboration agreements between the program member organizations and academic institutions (FPMA 2016: 15). It has also tried vertical scaling with government agencies, but this has proven very difficult.

An evaluation report of 2016 states that by then more than 100,000 farmers were trained, 28,500 farmers had directly benefitted from the community seed bank activities and 46,600 from the participatory plant breeding efforts (FPMA 2016: 16). It is very likely that these numbers have considerable overlap, but nonetheless they are impressive and speak to the power of horizontal scaling.

A mix of different scaling strategies - CATIE's Program on Ecologically-Based Participatory Implementation of IPM and Agroforestry in Nicaragua and Central America – another non CCAFS example

Another example of an agriculture initiative developed by a partnership of Central American organizations is the Programme MIP/AF, implemented by the Tropical Agricultural Research and Higher Education Center (CATIE), with the support of NORAD and ASDI, between

1989 and 2003. The programme contributed to the reorientation of the linear transfer-of-technology model prevailing in Nicaragua and other Central American countries to a participatory extension approach that links farm families, extensionists, researchers, trainers and decision-makers. Large scale implementation through training of technical staff in 45 institutions reached about 30% of coffee farming families in Nicaragua (8,000 participants) (CATIE 2002).

Garming and Waibel (2005) described two main intervention strategies of the programme. The "zig - zag" approach (CATIE 2001), different from Field Schools, which involves trainings and meetings of farm families, extensionists and trainers; with feedback routines at all levels during the crop cycle, from the preparation of the planting to the harvest. This allows for timely attention to perceived problems and the development of proposals to find solutions together with farmers. The second strategy was to support regional and national committees to involve decision-makers in planning of programme activities.

An evaluation report of the programme (Dumazert 2001) emphasized the preexistent organization level as a key factor so that producers are actively counterparts of the providers of technical assistance. Other factors that influence effective horizontal scaling are the economic capacity to innovate and the interest in intensification models (for example, coffee producers are more likely to adopt and disseminate new practices). A later evaluation report (Braun et al. 2002) stressed the importance of the integration of the regional and national committees to other areas (such as commercialization) to improve the sustainability and impact. This last report also pointed out the importance of advocacy in academia as a future scaling factor.

The role of capacity development

In a recent report on the assessment of CSA interventions in 33 countries in Africa, Asia and Latin America based on structured expert consultation rather than direct observation or monitoring and evaluation of technology implementation, one of the main conclusions in relation to adoption was:

“Capacity needs in the form of training and information was identified as the single largest barrier to CSA adoption across all regions, affecting almost 90 percent of all interventions. Investments in capacity building (for farmers, experts, and decision makers alike) and knowledge dissemination (through public extension services, universities and academia, or the private sector) are critical for ensuring the widespread adoption of CSA, particularly to enable the vital but complex implementation of integrated measures." (Sova et al. 2018: 6)

This study, richly illustrated with colorful but not so easy to understand figures and tables, illustrates the lack of consultation with farmers about their experiences with CSA interventions across the world and their views on the potential for scaling. A farmer focused assessment study of the CSV approach in one of the CCAFS sites in Vietnam, contradicts the aforementioned conclusion in the Sova et al. report and instead highlights that not capacity development is a major hurdle, but the availability of farm labor (Vernooy et al. 2017).

The Sova et al. report emphasizes that CSA options are highly context specific and recommends that it will be very important "to further develop and test location, and system-specific knowledge on CSA technologies as well as delivery mechanisms and required policy and enabling environments" (ibid: 29).

The role of institutions

Totin et al. (2018), in a recent global overview study, observe that there has been a gradual shift from a technology-oriented approach to climate-smart agriculture to a more systems-oriented approach that considers the complexity of farming systems. Using the innovation system framework, the study analyzed 137 peer reviewed CSA publications. They observed that interest in institutional perspectives of CSA technologies has gradually grown over the years.

Several studies conducted in the agricultural innovation domain have shown that when focusing on technologies alone, one overlooks the enabling and constraining factors that determine whether technologies are available, accessible, and are able to make a difference for farmers. They state that there has been little research to understand the role of local rules, historical legacies, cultural influences, social identities, and political competition in the uptake of CSA technologies. Many scholars argue that the institutional context in which a given technology is promoted is inevitably a component that shapes the uptake process (12).

Although the existing literature acknowledges the importance of some institutions in the uptake of CSA technologies (e.g., market), other perspectives such as the engagement of private sector in agricultural development have received less attention. Another major gap in the current literature is the poor attention to the role of the contextual factors—historical legacies, cultural influences, and political competition—in the scaling of CSA options. The review concludes that more attention is needed for the institutional and political dimensions of CSA technologies. Rethinking this approach to promote CSA technologies by building both on technology packages and institutional enabling context can provide potential opportunities for effective scaling of CSA options. Such knowledge is critical to improving the design of CSA research and supportive policy. (13)

The authors observe that in **Sub-Sahara Africa**, private sector support for agricultural development in general and for CSA technologies in particular is weak and often seen as a negative business practice. However, strong public–private partnerships appear to be a promising alternative to create business opportunities for upscaling CSA technologies. A recent innovative public–private experiment is being constructed with Manobi ©, a private company that offers a portfolio of integrated agricultural-climate services to the most vulnerable communities to cope with climate challenges (12).

Alliances and platforms[14]: promises and realities

In **Eastern Africa**, CCAFS partners have set up a learning alliance to build capacity under the umbrella of the so-called PACCA project. They key challenge to scaling is seen as capacity development. PACCA's research included an analysis of organizational networks and their roles in technology diffusion, and trade-off analysis of CSA options across scales. Veeger et al. 2017 argued that such alliances or platforms can be strengthened through the use of (scaling) scenarios. Bedmar Villanueva et al. (2016) unpacked the concept of learning alliance as a mechanism for scaling by critically analyzing how social and gender variables influence participation, learning and benefit sharing. Their critique points to the need to analyze how power relationships influence alliances and platforms (and their scaling activities) in practice, beyond the rhetoric presented on paper.

[14] In November 2018, CCAFS launched a learning platform for scaling housed by the University of Leeds in the UK: the cross-cutting Learning Platform on Partnerships and Capacity for Scaling CSA; see: https://ccafs.cgiar.org/seminar-and-discussion-scaling-climate-smart-agriculture-challenges-and-opportunities#.XBkNedOWwcS

Sartas et al. (2018) argue that such platforms can be effective in scaling, but not always so. They observe that multi-stakeholder platforms (MPSs) bring together a group of stakeholders working in different sectors. In the course of the MSPs, participating stakeholders, i.e. individuals, groups, and organizations, come together and "get things done". What is "done" depends on stakeholders' characteristics such as their capacity and motivation and how they integrate into multi-stakeholder innovation networks that give them access to different benefits such as information, markets, and finance. Integration into these innovation networks is effected through other stakeholders in these networks, i.e. innovation network stakeholders, and depends on the connections among them both in and outside MSPs (page 2).

Multiple factors influencing adoption

Ouédraogo et al. (2018) reviewed the adoption of CSA technologies in the context of the CCAFS program in **West Africa** in pilot climate smart villages (CSVs) in Burkina Faso, Ghana, Mali, Niger and Senegal. Since 2011, CCAFS supported researchers have tested a number of CSA technologies and practices tested in these CSVs: improved varieties of crops, soil and water conservation techniques (e.g. Zaï, half-moon, tie ridging), tree planting (agroforestry), farmer managed natural regeneration, integrated soil fertility management techniques (micro-dosing, use of organic manure /compost, crop association), etc. Findings indicate that (only) some technologies/practices have high adoption rates in some sites.

The authors conclude that these may be the ones ready for scaling. However, in the region, (wide) adoption of agricultural innovations is constrained by several socioeconomic, institutional, infrastructural, biophysical and political factors, including high illiteracy among farmers, their poor technical capacity, low dissemination of information on CSA options, limited availability of inputs and equipment for implementing CSA. The study argues that removing these barriers will require actions towards capacity building of farmers and the provision of agricultural credits and subsidies to deliver required agricultural inputs and organize logistics. One opportunity is to link CSVs to development programs in the region and to policies.

Combining scaling approaches

Westermann et al. (2015), in a CCAFS working paper, making use of 11 case studies **from around the world**, conclude that multi-stakeholder platforms and policy making networks are key to effective upscaling, especially if paired with capacity enhancement, learning, and innovative approaches to support decision making of farmers. They note though that these novel approaches still face challenges of promoting uptake, which remain contextualized and thus require a certain level of local engagement (the need to scale down), while continuously paying attention to farmer's needs and situations (34). They note that scaling up of CSA technologies and practices, in particular, brings its own issues, given considerable uncertainty, incomplete or contradictory knowledge, and massive stakes for billions of people.

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 (14). Authors conclude that scaling up often needs to have some element of local engagement ('scaling down', in effect), and while this may be a trade-off we have to live with, the approaches used can help to address this. (33) The expanded range of partnership brings some challenges, however, particularly in the area of integrating the different types of knowledge that different partners may have. None of the three approaches appear to have addressed this issue as yet. (33)

They used the following 'analytical' framework for their review (p. 25):

1. Demand-led or supply-led: taking the product to the customer (supply-led), or motivating the customer to seek out the product (demand-led)?
2. To what extent did the project pay attention to farmer's objectives and attitudes
3. Cost: what were the direct costs of the project to date
4. Type and innovative nature of the delivery mechanisms that the project used, and its reach;
5. Ways in which the project addressed policy, institutional and economic barriers;
6. Ways in which the project directly addressed the context specificity of CSA in relation to targeting
7. Partnerships and alliances that were put in place;
8. Capacity development activities that were undertaken;
9. Type of cross-level methodologies that were used; and
10. Nature and degree of learning in the project.

The authors group the scaling used in the 11 cases as follows:

Value chain approaches: provide a mechanism for linking multiple actors around a common objective by creating space for dialogue, knowledge exchange, capacity building and strengthening negotiation capacities. Value chains can act as a delivery mechanism for government and private extension services, credit, and subsidy programmes. They provide market-driven demand (currently, often towards green and more organic products) that may provide a demand-led strategy for adaptation of CSA technologies and practices. Scaling up already climate smart value chains (e.g. coffee, cacao) or introducing CSA practices and technologies into existing ones may thus be an efficient way to reach large numbers of farmers with reduced transaction costs. (19-20)

ICTs and agro-advisories: effective delivery mechanics and knowledge sharing methods that can contribute to improving access to information and awareness about climate change and CSA practices and technologies. ICTs can provide a wealth of different types of information: market prices, transportation options, weather information, commodity and stock market prices, information and analysis, meteorological data collection, advisory services to farmers for agricultural extension, early warning systems for disaster prevention and control, financial services, traceability of agricultural products, and agricultural statistical data gathering. (21-22)

Policy change: implies the creation of appropriate and effective institutional and governance mechanisms to co-generate information, ensure broad participation and harmonize policies. 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. Creating a policy space 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. (23-24)

Part 4: Conceptual and methodological shortcomings −scaling through the eyes of critical academics

Critique on the concept of climate-smart agriculture

Some authors have identified **conceptual weaknesses** of the climate-smart agriculture concept and, one could argue by default, its notion of scaling.[15] Taylor (2018) points out that climate smartness is defined by a triple win paradigm: increased productivity, adaptation, and mitigation. However, according to the author, it is blind to other important dimensions. One is political: who has access to the resources to produce food and how is food distributed? Taylor argues that market integration is not by definition a good thing, but can lead to less autonomy and more coercion (Taylor 2018, p.101). As second dimension is economic: what kind of value chain is CSA connected to and how is food consumed? (p.95). In brief, CSA thinking falls too easily into the trap of environmental determinism and ignores power differences, inequities and exploitation (ibid)[16].

A second criticism is the lack of precise metric (indicators) to measure (scaling) success. This is compounded by the lack of careful cost/benefit analyses; by the absence of analyses of aggregated effects, e.g. the impact on biodiversity and water cycles, the foreclosing of common property, and the polluting of neighbors (ibid 97). Taylor describes this as a lack of analysis of CSA and ecosystem functions at scale (emphasis added). In addition, Taylor observes that CSA assessments have a bias towards 'success' stories and close the eyes to inefficiencies and ambiguities. He describes this as weak causal analysis (ibid 100).

A third criticism is that CSA tends to ignore the larger picture of agriculture in the world order: millions of farmers rely on agriculture for subsistence, maintain the resource base and deliver economic, social and ecological contributions to the community, but their livelihoods are negatively affected by the pursuit of profitability (ibid 97). As an alternative, Taylor proposes the concept of climate wise agriculture that combines productivity, equity and sustainability.

[15] The claim that CSA interventions can contribute to adaptation + mitigation has been contested. See, for example, a series of articles in volume 45, issue 1 (2018) of the Journal of Peasant Studies (Forum on: Climate-smart agriculture). https://www.tandfonline.com/toc/fjps20/45/1?nav=tocList

[16] The same points are made by Karllson et al. 2017.

Newel and Taylor (2018) further elaborate on the political blindness of proponents of climate-smart agriculture, arguing that the promotion of the concept is a smart move by private-led transnationals, FAO, WB and the CGIAR to distract the public from key issues around sustainable agriculture and to avoid the question who will benefit from it and who will not? They argue that the (what could be seen as the scaling) agenda proposed by these actors of reduction of emissions through technology (fixes), land consolidation, reinforcement of property rights and the reinvention of GMOs as climate-smart technology, is highly political. The agenda denies alternative solutions, such as trading access to technology and innovation, redistribution of land, and the collective sharing of rights (108-129).

FAO's views on scaling

Newel and Taylor (2018) did not mention that FAO's comprehensive sourcebook about CSA (2013) actually included a careful and comprehensive scaling approach. FAO argued that the scaling up of climate-smart practices will require appropriate institutional and governance mechanisms to disseminate information, ensure broad participation and harmonize policies. It may not be possible to achieve all the CSA objectives at once. Context-specific priorities need to be determined, and benefits and tradeoffs evaluated. FAO warned that CSA is not a single specific agricultural technology or practice that can be universally applied/scaled. It is an approach that requires site-specific assessments to identify suitable agricultural production technologies and practices (FAO 2013: X).

This 'nuanced' approach promoted by FAO (page X):

1. Addresses the complex interrelated challenges of food security, development and climate change, and identifies integrated options that create synergies and benefits and reduce trade-offs;
2. Recognizes that these options will be shaped by specific country contexts and capacities and by the particular social, economic, and environmental situation where it will be applied;
3. Assesses the interactions between sectors and the needs of different involved stakeholders;
4. Identifies barriers to adoption, especially among farmers, and provides appropriate solutions in terms of policies, strategies, actions and incentives;
5. Seeks to create enabling environments through a greater alignment of policies, financial investments and institutional arrangements;

6. Strives to achieve multiple objectives with the understanding that priorities need to be set and collective decisions made on different benefits and trade-offs;
7. Should prioritize the strengthening of livelihoods, especially those of smallholders, by improving access to services, knowledge, resources (including genetic resources), financial products and markets;
8. Addresses adaptation and builds resilience to shocks, especially those related to climate change, as the
magnitude of the impacts of climate change has major implications for agricultural and rural development;
9. Considers climate change mitigation as a potential secondary co-benefit, especially in low-income, agricultural-based populations;
10. Seeks to identify opportunities to access climate-related financing and integrate it with traditional sources of agricultural investment finance.

Critique on the push approach of scaling

Another strong theoretical critique on scaling has been made by several authors who point out that studies of innovation and diffusion (scaling) often use an overly prescriptive view of technologies (they should be used as an input) while ignoring their suggested use (one could say, they should be seen as an idea) allowing adaptions by users (Akullo et al. 2018).

Wigboldus et al. (2016), at Wageningen University and Research, most likely have the developed the most coherent and strongest critique on simplistic, ahistorical and mechanical views of scaling arguing that it always is a social, non-linear process of fine-tuning things along the way. Assuming that what works in site A will work in site B overlooks the multiple dimensions of societal change, including economy, health, environment, technology, culture, infrastructure, knowledge management, communication and organization, and policy.

“Scaling up and out is less of a straightforward concept than we might expect it to be, given the ease with which so many use it in pleas and proposals. When we unpack the concept, we find it loaded with associated processes and dimensions and linked to a range of possible approaches and other concepts. There appears to be a tendency towards linear thinking and an instrumentalist take on the concept and practice of scaling (up) in the context of international development. In many of these cases, where the term ‘scaling up’ is used, the term ‘scaling out’ would have been more appropriate. We quite regularly come across the idea of scaling up “what works” or “best practices”. The idea of ‘roll-out’ is very much related to this kind of thinking. In the context of AR4D this seems not to provide the full picture because of two important fallacy concepts concerning scale: the ecological fallacy (what works at one scale will work at another), and the composition fallacy (what is good for one person is good for everyone).” (Wigboldus and Leeuwis 2013: 13-14.)

Scaling always depends on actors’ views on scaling practices and their perceived capacities to support it. Building on the work of Geels (2002), these critics propose a nuanced, systemic analytical framework in which the interplay and trade-offs between different forces are taken into consideration and unplanned and unintended consequences are factored in. This framework is called the PRactice-Oriented Multi-level perspective on Innovation and Scaling (PROMIS) and has 14 aspects or dimensions (Wigboldus et al. 2016: 46). The framework is useful to develop an operational theory of change/scaling that addresses two key questions: how scaling is expected to happen? and what will happen if this goes to scale (both positively and potentially, negatively)?

Towards responsible scaling

Wigboldus further developed these ideas for a theory of responsible scaling in a paper with Leeuwis (and 2013) and another paper with Brouwers (2016) and, more recently, in his PhD thesis (Wigboldus 2018). Responsible scaling requires addressing four dimensions: opportunities (what and for what); societal values and interests; capacities and conditions; anticipations (effects of and on scaling). These dimensions can be assessed by asking 15 questions along the unfolding scaling process (adapted from table 20, Assessment of readiness for responsible scaling, page 87, Wigboldus and Brouwers 2016). The questions are:

<u>Design phase</u>

- Is there clarity of vision on what value addition is aspired to?
- Is there clarity of vision on the core element of (aspired) success?
- Have a number of variations on the (success) theme been explored/developed?
- Is there clarity of connections to relevant stakeholder perspectives and energies?
- Is there clarity of conditions of success in the envisaged application contexts?
- Is there an articulation of assumptions underpinning the Theory of Scaling?

Change process phase

- Is there enhanced variability in relation to core success factors?
- Is there stakeholders' connectivity towards convergence?
- Is the nature of the scaling perceived as collaborative by key actors/stakeholders?
- Are the original assumptions underpinning the Theory of Scaling correct?
- Have the scaling pathways been adapted based on new insights?

Evaluation phase

- Do the available options align with user preferences?
- Is there improved access to options?
- Are there improved tailored options/variations on common theme?
- Is there stakeholders' agreement about value addition?

Gargani and Mclean (2017), working on the other side of the Atlantic (in North America) propose something similar to Wigboldus et al. They argue that what is needed is a dynamic, non-linear scaling theory of change (emphasis added) that has three basic components: a path to scale, a response to scale, and partners for scale. They argue that scaling is not only about numbers and commercial success, but about ethics and social impact. Their definition of scaling impact is "a coordinated effort to achieve a collection of impacts at optimal scale that is only undertaken if it is both morally justified and warranted by the dynamic evaluation of evidence." (p. 36) One of their main arguments is that chances of successful scaling increase when the actors affected by it will be meaningfully involved because ultimately they will be the people best placed to assess scaling success. The authors observe there are very few scaling/innovation models that do this well. A second argument they make is that scaling usually has an optimum level, which is seldom the maximum. Scaling usually implies trade-offs (a key point Wigboldus et al. make as well).

The scaling scan

Building on the concept of responsible scaling (although not discussed in detail), the PPB Lab Food and Water in collaboration with CIMMYT recently launched a tool called the scaling scan, a practical tool to determine strengths and weaknesses of a particular scaling ambition or proposal. This planning and *ex ante* self-assessment tool consists of 10 "ingredients" or elements that together define the potential and challenges of a particular scaling ambition (PPB Lab Food and Water and CIMMYT 2018). Users can score –based on their best of knowledge– these 10 elements based on answers to a series of guiding questions. The ingredients are:

- **Technology/Practice** - An effective and efficient solution for the issue at stake
- **Awareness and Demand** - A wish and readiness for the consumer or producer to use the solution
- **Business Cases** - Attractive financial/economic propositions for users and other actors to respond to the demand
- **Value Chain** - Effective links between actors to pursue their business cases
- **Finance** - Effective financing options for users and other value chain actors
- **Knowledge and Skills** - Capacities at individual and institutional level to use, adapt and promote the innovation
- **Collaboration** - Strategic collaboration within and beyond the sector to scale the innovation
- **Evidence and learning** - Evidence and facts underpin and help gain support for the scaling ambition
- **Leadership and Management** – Effective coordination and navigation of the scaling Process
- **Public Sector Governance** – Government support to reach the scaling ambition

The authors caution that the scaling scan is not meant to design a scaling strategy or scale a project or program, but only to assess the scaling potential of specific innovations.

This tool is useful to reflect about the importance of context, although it remains heavily supply oriented.

Part 5. Conclusion

"Climate-smart agriculture has shown promise at the local scale, but it has still not reached scale in most countries." (Aggarwal et al. 2018)

- *What is exactly meant by scaling in the CCAFS literature? How does CCAFS know that the technologies and practices that it wants to scale are effective (e.g. defined in technical, economic terms, social terms) beyond the pilot sites they have been tested in to some degree and with the involvement of some farmers?*

The predominant meaning of scaling seems to be to push so-called proven CSA interventions to more people, more places and into development policies, programs and projects. Although a good amount of critical scaling thinking has taken place in recent years in academic and research circles, including under the umbrella of at least one CGIAR CRP (Innovation Systems for the Humid Tropics), it seems that CCAFS programming has only adopted a few of the conceptual, methodological and practical insights gained. That seems a missed opportunity. Apart from societal factors that may hinder the scaling of CSA (some of them mentioned by Aggarwal et al. 2018), there may also be an important conceptual barrier. Although the work at local level is done by means of various forms of participatory stakeholder engagement (for which a number of manuals are available, e.g. Andrieu et al. 2018), CCAFS seems largely to promote a simple, linear, supply driven approach and view on scaling (out and up) as evidenced by many of the examples reviewed in this working paper. The scaling focus has been mostly on 'instruments' (e.g. agro-advisories, funding mechanisms, policy advice, as summarized in the Westermann et al study), but very little on the societal processes (the theory of scaling) that could make scaling work or hamper.[17]

A major bottleneck has been that sound scientific evidence (which is not the same as expert opinion) that the CSA interventions at local level are effective (that is, "smart" according to CCAFS's own 'triple wins' paradigm) is not always available in CCAFS work. Recognizing perhaps this problem/challenge, some CCAFS researchers have contended that it may be time

[17] A recent CCAFS study (Howland et al. 2018) analyzes socio-economic factors of CSA adoption at local level in Colombia. https://ccafs.cgiar.org/publications/understanding-socioeconomic-aspects-influencing-csa-adoption#.XE-qvVVKjIU

for new and innovative scaling ways. A more nuanced view on scaling in the CCAFS literature is the recent analysis of scaling by ICRAF in Vietnam where a distinction is made about the how and what of scaling. One could say between the principles and the technologies, whereby the former can be subject to scaling, but the latter not by definition. Along the lines of the ICRAF study, Wigboldus (2018) argued that what is perhaps more needed than scalable things (interventions) are replicable design principles that can be used in context specific situations by groups of stakeholders who are interested and committed to work towards common goals. Such principles could include the search for multiple, complementary scaling strategies (up, out, down, future scaling[18]) instead of opting for one single strategy.

The lack of "borrowing" from social sciences seems surprising because critical thinking and writing about agricultural innovation processes have been easily accessible for some time. Just as an example, Klerkx et al. (2010) identified six types of uncertainty related to the spread of innovations that caution against simplistic views on scaling processes: technological, resource, competitive, supplier, consumer, political uncertainty (391). Other, equally critical analytical studies of the spread of innovations have been carried out from which much could be learned, e.g. Sidibé et al. 2018 on multi-scale governance in agricultural systems; and Amapaire et al. 2017 on institutional challenges to climate change adaptation. Admittedly, some of these studies are of recent date.

Mascia and Mills (2018) argue that diff usion of innovation theory can provide novel insights into spatial and temporal dynamics of conservation policy and practice. So far, although scientists have previously examined the roles of geographic, ecological, demographic, economic, and political variables, the conservation literature lacks a theoretical framework and hypotheses to explain these fundamental dynamics.

- *How does CCAFS define its scaling targets? Are targets defined quantitively or qualitatively or both?*

The targetting is mostly done by the CCAFS programme. According to the CCAFS website, the primary target beneficiaries of CCAFS' work are climate-vulnerable, food insecure and

[18] By this, we mean integration in curriculum development of all kinds and at all levels.

poor men and women smallholder farmers in 21 focal countries. Very recent, CCAFS claimed that the ultimate goal of the CSA work is to reach 500 million smallholder farmers around the world. As an example already given, in Central America the aim is to reach all smallholder farmers.

The targeting, globally and regionally, seems overly ambitious considering that in each of the regions there are only a limited number of CSVs/climate smart territories (e.g. in Central America, there are three climate-smart territories with the one in Guatemala involving about 20 active farmer households). CSA interventions are tested on a very small scale, although they are complemented with a set of other CCAFS project activities more or less interconnected and to various degrees supportive of local CSA activities. Scaling targets conceptualized in a coherent combination of other terms (not necessarily expressed in numbers), such as improved income, reduction of socio-economic inequity, (perceived) improved wellbeing and health, are not evident in most of CCAFS scaling.

- *Have possible negative, unintended and/or hard to anticipate consequences that may result from scaling been analyzed?*

Although recently a more nuanced scaling discourse has emerged (Koerner et al. 2018)[19] and efforts have been stepped up to develop a CCAFS gender and social inclusion strategy[20], the prevailing CCAFS approach so far represents a strategy of straightforward replication and adoption (a push approach) without a clear theory of scaling. It seems based on the belief that scaling something "good" will produce more "good" things. The possibility that "bad" things could result from the scaling seems to be overlooked. Authors have called this kind of thinking the fallacy of generalizations. It is informed by the lack of (critical) capacity to anticipate positive and negative outcomes and impact (Wigboldus 2018). How scaling is supposed to be done/happen in a stepwise and not necessarily linear process –as many societal processes unfold (including conflicts and struggles)− remains in a black box.[21]

[19] Koerner et al. (2018: 2) observed that: "There is still poor conceptual clarity on what scaling is, which results in a narrow focus on numbers, with the assumption that a certain adoption rate at a defined time, usually the end of the project, will lead to the desired impact, in a sustainable way. But is more always better?"
[20] See: https://ccafs.cgiar.org/flagships/gender-and-social-inclusion
[21] Wigboldus (2018) contends that CGIAR programming *at large* lacks a clear theory of scaling.

Overly simplistic views of scaling ignore the fact that technology development, adoption and adaptation are part of a social process imbedded in larger societal configurations and processes. These configurations and processes are usually the result of a long history characterized by competition, conflicts and struggles over resources (e.g. land, capital, knowledge), but also by forms of collective action, coordination and cooperation. For CSA technologies to work in a given context they need to be "aligned" with existing natural resource management (including agricultural) practices of farmers and the institutions in which these practices are imbedded. What seems to work well in a given context may not work at all in another one. In the CCAFS literature, one finds very little mention of conflicts over resources, adoption and adaptation uncertainties, technology setbacks and trade-offs of scaling of climate-smart agriculture technologies, services and practices.

Variability in development processes, although recognized as important in some CCAFS studies, is inadequately theorized. As van Etten et al. (2016) observed:

"A common strategy to scaling in agricultural innovation has been to focus on interventions that are expected to be beneficial to very large groups of beneficiaries. Due to variation, complexity and instability in ecological and socio-economic conditions, this strategy is unlikely to address the challenge of global change. Agriculture can only cope through a quick-paced process of constant, massive discovery of locally appropriate solutions incorporating relevant environmental and socio-economic information (options by context). It is far from clear if this increased demand for context-specific innovation can be addressed by current agricultural research and development (R&D) capacity."

- *Do the researcher and managers of CCAFS involve others, in particular farmers and farming communities (according to CCAFS, the ultimate targeted practitioners of climate-smart agriculture) in defining the scaling agenda? If so, how are these perspectives and interests communicated? Are they integrated in programming?*

Selected farmers are involved in the local CSA/CSV activities to pilot test innovations in more or less community-based ways and scale their experiences and results with other farmers (e.g. through the so-called innovation platforms in Colombia and Honduras[22]). In

[22] For Colombia, see: https://goo.gl/GzQum3

other regions where CCAFS operates, the term innovation platform is not used. We could not find much evidence that farmers are involved in scaling debates there. Our ongoing study in Guatemala about CCAFS scaling (Vernooy and Bouroncle 2019) is a systematic (although small in scope) attempt to ask local stakeholders about their views and interests in scaling and the development of a demand driven approach. This differs from asking development experts about their views and interests. Such a scaling approach aims to develop a shared perspective on (the options for) scaling among stakeholders. Wigboldus identifies 12 scaling spaces or domains that need to be analyzed through stakeholder engagement: environmental, political, cultural, social, analytical, partnership, legitimacy, competency, management, facilitation, financial and learning (2018: 168). The scaling scan method, borrowed from Wigboldus, has 10 interrelated analytical elements (see section 4) offering a holistic and responsible scaling approach. One suggestion is to pilot the scaling scan method in Guatemala where there is still ample scope to design a scaling approach that takes into account the emerging lessons learned from other regions.

For Honduras, see: https://ccafs.cgiar.org/publications/innovation-platforms-climate-smart-agriculture-honduras#.XE-qzVVKjIU and https://ccafs.cgiar.org/node/55647#.XE-q1lVKjIU

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Annex 1. Questionnaire about scaling

1. What scaling strategy or approach did your program/project have at the start?

2. Was this strategy/approach informed by a particular theory or by one or more previous practical scaling experience(s) or by both? If so, how?

3. What scaling target or targets did the program/project have in terms of verifiable numbers, e.g. number of farmers or communities that benefited, number of hectares covered, number of varieties released etc.)?

4. Was the scaling strategy or approach changed during the course of the program/project? If so, how?

5. Looking back, was the scaling strategy/approach used effective? If so, why? If not, why not?

6. Was the numerical target or were the numerical targets achieved? How was this measured?

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