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Farmers, food and climate change: ensuring community-based adaptation is mainstreamed into agricultural programmes

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climate and development

REVIEW ARTICLE

Farmers, food and climate change: ensuring community-based adaptation is mainstreamed into agricultural programmes

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Climate change creates widespread risks for food production. As climate impacts are often locally specific, it is imperative that large-scale initiatives to support smallholder farmers consider local priorities and integrate lessons from successful autonomous adaptation efforts. This article explores how large-scale programmes for smallholder adaptation to climate change might link effectively with community-led adaptation initiatives. Drawing on experiences in Bangladesh, Mozambique, Uganda and India, this article identifies key success factors and barriers for considering local priorities, capacities and lessons in large-scale adaptation programmes. It highlights the key roles of extension services and farmers' organizations as mechanisms for linking between national-level and community-level adaptation, and a range of other success factors which include participative and locally driven vulnerability assessments, tailoring of adaptation technologies to local contexts, mapping local institutions and working in partnership across institutions. Barriers include weak governance, gaps in the regulatory and policy environment, high opportunity costs, low literacy and underdeveloped markets. The article concludes that mainstreaming climate adaptation into large-scale agricultural initiatives requires not only integration of lessons from community-based adaptation, but also the building of inclusive governance to ensure smallholders can engage with those policies and processes affecting their vulnerability.

Keywords: climate change; community-based adaptation; mainstreaming; agriculture; adaptation

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1. Introduction

Climate-related risks and opportunities play a prominent role in agricultural development, but are not always recognized in sector programming and investment planning. Climate change is now affecting crop productivity and the ability of farmers to harvest and process agricultural produce, with direct impacts on the nearly 70% of people in developing countries living in rural areas where agriculture is the main livelihood (Vermeulen, Campbell, & Ingram, 2012). In many rural areas, episodes of extreme weather interrupt access to markets, while restricted livelihood options and insufficiently diversified energy systems perpetuate the degradation of those ecosystems which are needed more than ever as natural buffers against floods, landslides and soil erosion. Climate-related disasters can disrupt social networks and wipe out years of financial savings, rolling back decades of development progress (Carter, Little, Mogues, & Negatu, 2007). Climate change materializes predominantly as a threat multiplier for poor rural households, adding new dimensions to the portfolio of risks, opportunities and longer term trends facing people whose livelihoods depend on agriculture.

Adaptation responses to these risks and trends have been distinguished in the literature between 'autonomous adaptation' at the individual, household or farm level and 'planned adaptation' usually at the level of national government. In reality these levels are functionally linked (Adger, Huq, Brown, Conway, & Hulme, 2003; Eriksen et al., 2011), but nonetheless the distinction between them provides a useful framework for distinguishing two contrasting mechanisms for mainstreaming community-based adaptation (CBA): either by 'bottom-up' scaling up or out from local community-driven, autonomous adaptations, or alternatively by being built into the design of 'top-down' planned adaptation programmes. Both of these mechanisms offer opportunities to integrate community-based approaches to climate change adaptation with larger agricultural planning and investment processes, thereby benefitting a high number of farmers at large geographic scales. As the impacts of climate change are felt

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locally, there is a growing body of research arguing that community-identified and -led activities are integral to effective adaptation for smallholder farmers (Heltberg, Siegel, & Jorgensen, 2009; Kansiime, 2012; Reid et al., 2009). However, as we elaborate below, the transfer of knowledge and practice from local adaptation experience appears to be rare, despite its potential value.

At present it is unclear to what extent CBA has been mainstreamed into agricultural programmes and funding agencies across different levels. The purpose of this article is therefore to use insights from four case studies to explore the barriers to and opportunities for mainstreaming CBA in agriculture at broader scales. The next section defines and explores the implications of key terms such as CBA, mainstreaming and scaling up, as well as summarizing progress at national and international levels. Section 3 summarizes four cases: two experiences of mainstreaming adaptation into agricultural planning in Mozambique and Bangladesh, and two local-level examples from Uganda and India in which community-based agricultural adaptation endeavours have made efforts to influence policy at higher levels (to scale up). We analyse the opportunities and barriers for community-based approaches to provide effective inputs to higher level policy or larger scale programmes, and for large-scale programmes to respond effectively. Section 4 considers the key role of extension as a conduit for two-way learning between the national and community levels, and concludes with some emerging suggestions for more effective exchange and co-learning.

2. Mainstreamed versus community-based adaptation: from gaps to meeting points

Climate change mainstreaming is now widely promoted as a more effective approach than stand-alone interventions on climate change adaptation or mitigation. In its broadest sense, climate change mainstreaming entails incorporation of climate change considerations into public policy and practice, at all planning levels, across all sectors and involving public, private and civil society actors. Substantial practical guidance now exists for policy-makers and practitioners to mainstream climate adaptation into development policies and programmes, including specifically in the agriculture sector (CARE, 2009; FAO, 2012a; UNDP-UNEP, 2011).

Most of this mainstreaming guidance emphasizes the importance of engaging stakeholders from the start, including local stakeholders in affected communities, and being responsive to their expressed priorities and needs. Yet most guidance fails to clarify whether the mainstreaming process is envisaged as a bottom-up process through which successful CBA actions are replicated and scaled-up to reach new target groups and geographic areas, or as a top-down process in which large-scale government action plans deliver pre-determined adaptation benefits. This question is especially relevant as it helps to determine the ambition and institutional layout of a climate mainstreaming process: such a process could entail the comparatively straightforward dissemination of new technical information and know-how through established channels (such as extension services), or the more complex strengthening of innovative processes and institutional mechanisms through which relevant adaptation knowledge can be generated or internalized.

In principle, agricultural programmes that mainstream adaptation into their planning do not preclude community-based approaches, but there may be considerable challenges in reaching scale while also assuring local 'ownership' (control over decisions and resources) and accommodating the diversity that comes with differing local priorities. CBA can be defined as 'a community-led process, based on communities' priorities, needs, knowledge, and capacities, which should empower people to plan for and cope with the impacts of climate change' (Reid et al., 2009, p. 13). CBA builds on a long history of community-driven approaches to development, which rose to global prominence in the 1990s, following perceptions that large-scale centralized development programmes were performing poorly, and that poor people could and should be the central decision-makers in their own development (Mansuri & Rao, 2004). It has been suggested using farmers as the agents of change is more likely to be sustainable, while recognizing pitfalls relating to maladaptation, that is, potential negative impacts of adaptation across spatial or temporal scales (Vincent et al., 2013). While policies proliferate at the national level, which can lead to duplication, households tend to adapt to multiple stresses in an integrated way (Stringer, Mkwambisi, Dougill, & Dyer, 2010). Community-driven development, in which decisions are made and budgets are allocated locally, can deliver sustainable outcomes at lower cost than centrally managed programmes, while also conferring better governance in terms of local accountability, transparency and empowerment (Binswanger-Mkhize, De Regt, & Spector, 2010). Yet participation does not automatically guarantee success, which depends additionally on sustained facilitation and careful design (Blaikie, 2007; Mansuri & Rao, 2004) as well as an enabling policy environment.

Most CBA endeavours do not arise from large-scale programmes but rather from local innovation, either driven purely by communities or else prompted and facilitated by a non-governmental organization (NGO), development agency or research organization operating at the local scale. For these endeavours to reach scale presents a different set of challenges than for large-scale mainstreamed programmes to be responsive to community-level priorities. Some barriers identified from global experiences in scaling up community-driven development initiatives included hostile institutional settings, barriers to accessing

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finance, lack of compatible incentives, stakeholders with differing values, geographical or socio-political differences and logistical challenges (Binswanger-Mkhize et al., 2010). However, it must not be assumed participative processes are generating an effective and consensual output: the term 'participation' is often used to describe 'very rudimentary levels of consultation between professionals and community members' (Taylor, 2003, p. 122), in contrast to active engagement involving two-way information flows (Reed et al., 2009).

Arguably, a supportive enabling environment with participation of local communities is required to integrate adaptation into development (Sietz, Boschutzz, & Klein, 2011). Scaling up means more than just *physical scaling up* (mass replication); but also *social scaling up* (increasing social inclusiveness) and *conceptual scaling up* in terms of moving beyond participation to embedding empowerment in the entire development process (Binswanger-Mkhize et al., 2010). This links to the concept of 'procedural justice' in adaptation (Thomas & Twyman, 2005), leading us to seek not only mainstreaming of climate change adaptation into agriculture, but also inclusive governance whereby farming communities can engage with policies and processes affecting their vulnerability. Adapting our conceptual framework from Linn (2012), we argue mainstreaming CBA requires an 'enabling environment' with institutional, political, fiscal, market, resource, cultural and learning space for CBA to occur as a process. Mainstreaming CBA is more than scaling up of specific adaptation practices or knowledge, it is about mainstreaming institutional and organizational approaches that allow this knowledge to be generated.

In policy and practice, there has been some progress in mainstreaming adaptation in agriculture. Under the United Nations Framework Convention on Climate Change (UNFCCC), many least developed countries identified agriculture as a vulnerable sector in their National Adaptation Programmes of Actions (NAPAs). Countries are now beginning to mainstream adaptation into agricultural policies and programmes through National Adaptation Plans (NAPs), which should enable the adoption of a 'participatory and fully transparent approach, taking into consideration vulnerable groups, communities and ecosystems' (UNFCCC, 2011, p. 80). Multi-lateral funds and financial agencies are in the early stages of integrating mechanisms for managing climate risks and trends into their programming. The World Bank has guidelines for mainstreaming of adaptation into agriculture and natural resources management projects (World Bank, 2010), while the International Fund for Agricultural Development (IFAD) recently established the world's single largest fund for adaptation in smallholder agriculture. IFAD's new Adaptation for Smallholder Agriculture Programme (ASAP) provides a new source of grant co-financing to scale up and integrate adaptation across IFAD's approximately US$1 billion annual new investments and introduces a systematic appraisal of climate-related risks and vulnerabilities into agricultural investment planning (IFAD, 2012a). ASAP investments under development at the country level include a range of CBA components, including participatory mapping and vulnerability assessment, delegation of priority-setting for spending of adaptation funds to community groups, and mechanisms for community-to-community learning across administrative and geographic boundaries.

3. Mainstreaming CBA in agriculture: insights from case studies

Case studies were selected that cover a range of different geographical regions and climate change vulnerabilities across four countries in Asia and Africa. Experiences are drawn from national-level experiences in mainstreaming adaptation into agricultural planning in Mozambique and Bangladesh using secondary sources, and from local (sub-national) level experiences in Uganda and India using primary data. Each case study introduces the relevant institutions, mechanisms and project activities (whether governmental or provided by NGOs), drawing lessons from these in terms of the success factors and barriers encountered in mainstreaming CBA into agricultural programming, and exploring the policy implications.

3.1. *Mainstreaming of CBA in agriculture in Bangladesh*

In Bangladesh, initial steps have been taken to mainstream processes and lessons from CBA, but there are various institutional and communication barriers. Experiences with mainstreaming climate change adaptation into agricultural planning under the 'Livelihood Adaptation to Climate Change' (LACC) project were reviewed using secondary literature and reports. Located in the low-lying Ganges–Brahmaputra delta, Bangladesh is at risk of increasing flooding, more intense cyclones and sea level rise in a warmer climate (Huq, Rahman, Konate, Sokona, & Reid, 2003). The LACC project under the Comprehensive Disaster Management Programme (CDMP) promoted livelihood adaptation among vulnerable communities, implemented jointly by the Department of Agricultural Extension (DAE) and Food and Agriculture Organisation of the UN (FAO) (Baas & Ramasamy, 2008). Project outputs included learning lessons from CBA. The project assessed existing locally specific risk-coping strategies and technologies, monitored local agro-meteorological data and downscaled climate scenarios (Baas & Ramasamy, 2008), intending to create an overlap between local and scientific knowledge (Torres, 2009). Due to the lack of reliable downscaled climate data, pilot projects focused on 'no regrets'

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options for field testing, such as drought-tolerant crops in the North-West (Baas & Ramasamy, 2008).

In the first pilot phase (2005–2007), mainstreaming and scaling up were not effectively addressed (Baas & Ramasamy, 2008), but in later stages, lessons were learnt and the broad-based reach of DAE's 12,000 agricultural extension workers were tapped (FAO, 2010a). An independent CDMP evaluation found that LACC was successful and proposed further embedding climate-related knowledge in forthcoming projects, but found that gender issues require further attention (Russell, Mahbub, Khan, & Islam, 2009). Political turmoil and staff continuity were also challenges (Luxbacher, 2011). A programme review recognized information and communication gaps, such as illiteracy and the bias towards production of printed materials, the underutilized role of information and communication technologies (ICT), and the absence of a communications plan (FAO, 2010a). To overcome these pitfalls, a deliberate effort was proposed to mainstream adaptation within national policy and development planning, including advocacy and policy briefs for law-makers and local officials, and better inclusion of communication activities at every level (FAO, 2010a). Collaboration with the Agricultural Information Service (AIS) and inclusion of climate change into education curricula were also recommended (FAO, 2010a). A continuing barrier was the reach of extension workers, with the ratio of extension workers to farmers at 1:12,000 (FAO, 2010a). General lessons were that integration of disaster risk reduction (DRR) and adaptation into operational local-level frameworks are crucial to initiate long-term processes, and there is no need to set up separate institutional structures within sectoral line agencies (FAO, 2010b). Adaptation was highlighted as a social learning process, and inclusive and participatory mechanisms can contribute to this learning (FAO, 2011).

Drawing on lessons from the previous projects, the Disaster and Climate Risk Management in Agriculture (DCRMA) project aims to mainstream disaster and climate risk management in the DAE and strengthen its capacity. There is now collaboration with AIS in disseminating success stories from the grassroots level. In a current project 'Agricultural Adaptation in Climate Risk Prone Areas of Bangladesh', many lessons from the LACC are being built upon, including collaboration with farmer field schools, as well as improving community-based early warning systems and rural communication services (BCCRF, 2013). The project seeks to focus on community-based and field-level adaptive research and participatory extension approaches, as well as community-based seed and grain storage infrastructure, water harvesting and small-scale irrigation, drawing on local knowledge to develop regional agro-ecological databases and community-based DRR plans (DAE, 2013). Replication and scaling up of agricultural adaptation options are intended to occur through farmer clubs and water-management groups (DAE, 2013). It was argued there is no need to create separate 'climate field schools' because farmer field schools will iteratively adjust to climate-related changes like salinity, but communication may be needed to ensure effective innovation (AEC, 2011).

Overall, the case provides nascent evidence of mainstreaming of climate change into the activities of national agricultural institutions and programmes in Bangladesh, building upon years of progress in collaboration with FAO. Climate is also being integrated into the research priorities of the Bangladesh Agricultural Research Council, particularly the high-priority areas of climatic impacts on fisheries, water resources management, forests and disaster management (Hussain & Iqbal, 2011). However, while CBA approaches are articulated within project documents under the DCRMA, it is too early to explore whether these will be effective in practice. Insufficient capacity and lack of coordination among research scientists, extension workers and farmers remain key challenges for the forthcoming project (Rahman, 2011). Furthermore, biodiversity loss and inadequate use of indigenous knowledge in food-related contexts are additional barriers to adaptation (Mallick, Amin, & Rahman, 2012). Lack of inclusion of farmers in research and general lack of awareness about climate change are also barriers. Mainstreaming adaptation in agriculture is an on-going process in Bangladesh. Proposed ways forward include greater communication efforts, coordination amongst stakeholders and collaboration with existing organizations including farmer field schools.

3.2. *Adapting to climate change in semi-arid environments in Mozambique*

In Mozambique, experiences with mainstreaming CBA show that major challenges include the capacity of farmers' organizations and extension services, farmers' access to markets and coordination across implementing agencies, particularly at local levels. National experiences with mainstreaming adaptation into agriculture were reviewed using secondary reports and literature, with a focus on the three-year (2008–2010) UN Joint Program (UNJP) on Environmental Mainstreaming and Adaptation to Climate Change, which aimed to help Mozambique integrate climate change into national policy and set up pilot adaptation projects. The programme was designed to align with government planning and strategies, create synergies and avoid duplication. Pilot projects were implemented in Chicualacuala, Gaza Province (FAO, 2011). The activities arguably contributed to realization of Mozambique's NAPA (FAO, 2012b), which prioritizes early warning systems, increasing producer capacity and management of water resources. For example, to strengthen early warning systems, the UNJP assisted the government by rehabilitating and re-equipping a weather station and

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expanding the reach of the Chicualacuala community radio station. In an area where livestock is crucial to livelihoods, a network of trained community animal health workers (CAHW) was established. Taking actions at the community level meant problems could be identified more accurately and locally appropriate preventive measures could be taken.

An independent evaluation found that the establishment of community groups was highly effective, but the project's relevance was reduced by not fully responding to communities' market-related challenges (Eucker & Reichel, 2012). It was recommended that adaptation strategies ought to be flexible, with a greater focus on 'how' results are achieved (process) rather than 'what' is achieved (Eucker & Reichel, 2012). A further study in Gaza showed communities have multiple viable strategies for reducing climate risks, including livestock management and livelihood diversification, which could be expanded and strengthened through a greater service provision by the government, notably weather forecasts and climate information services (Sacramento, Matavel, Basílio, & Bila, 2012). Expert interviews revealed various institutional barriers to mainstreaming adaptation, including lack of human resources, insufficient data, lack of inter-institutional coordination and communication and scarce financial resources (Sietz et al., 2011). In Mozambique, underlying structural issues such as weak markets for agricultural commodities, poor infrastructure and limited access to micro-finance exacerbate difficulties for smallholder farmers (Osbahr, Twyman, Adger, & Thomas, 2008).

Communities involved in the programme identified that the human resources most important for their livelihoods were health, education, farming skills and extension services (farm and veterinary) (FAO, 2012b). Farmers' organizations also provided social capital for adaptation (FAO, 2012b). The National Directorate of Agrarian Extension (DNEA) is the main institution responsible for agricultural extension. It does not have any climate-specific programmes, demonstrating that adaptation is insufficiently mainstreamed at present. However, Mozambique's Third Poverty Reduction Strategy (PARPA III) identified some climate-related activities, including water-management and improved seed varieties. One challenge is that Mozambique's extension services are relatively new, formed only in 1987 amidst a challenging political environment (Gemo, Eicher, & Eclemariam, 2005). It is difficult to finance extension services in subsistence and semi-subsistence economies without taxable agricultural exports (Eicher, 2004). The majority of farmers face challenges accessing extension services, with some 2000 extension workers covering a rural population of over 14 million (FAOSTAT, 2012). This demonstrates a need to scale up existing extension services to increase farmers' food security and resilience. Adaptation is now being integrated in the ASAP-supported value chain development project in Mozambique, with extension services recognized as a barrier, as well as gaps in financial services and smallholder market access (IFAD, 2012b). Building the capacity of farmers' organizations is another key priority (IFAD, 2012b). Overall, although Mozambique has a supportive national-level legislative environment and awareness among donors is high, there is still limited institutional capacity for mainstreaming initiatives at provincial and district levels (Sietz et al., 2011). In spite of the decentralization process, lack of communication, coordination, funding and poor information dissemination impede mainstreaming adaptation at local levels.

3.3. *Climate-smart adaptation research in Rakai District, Uganda*

In Uganda, the main finding is that non-functional policies and regulations at national or sub-national levels inhibit mainstreaming of CBA. Participatory research has been undertaken by the International Institute of Tropical Agriculture (IITA) with producers in assessment of vulnerability and evaluation of adaptation options, as part of the Climate Change Agriculture and Food Security (CCAFS) research programme. Climate change threatens to decrease yields, reduce farm revenues, worsen food insecurity and deepen rural poverty (Nabikolo, Bashaasha, Mangheni, & Majaliwa, 2012; UNDP, 2013; Waithaka, Nelson, Thomas, & Kyotalimye, 2013). Participatory vulnerability assessments were conducted in Rakai District to capture interactions among biophysical, social, political–institutional, socio-cultural, economic and environmental variables. Twenty focus-groups were conducted in 10 different zones, 2 per zone, separating men and women to capture gendered differences in perceptions. Participatory discussions were held on climatic and environmental changes that have occurred in the last 2–3 decades, changes to farming practices, climate constraints experienced and adaptation practices farmers use to cope with climate challenges. In addition, in-depth key informant interviews were conducted with selected smallholder farmers, political leaders, public extension entities, NGOs and businesses (agro-produce marketers and agro-input dealers). Furthermore, a formal survey that utilized structured questionnaires was administered to individual farmers selected randomly from sites, to complement the analysis and interpretation of findings (Kyazze & Kristjanson, 2011). The research aimed to analyse collected information, and generate and present different climate-smart scenarios to male and female producers to help them evaluate their applicability and sustainability. Smallholder farmers took centre stage in developing 'climate-smart' options on the premise that effective participation of vulnerable communities is likely to enhance design, adoption and ownership of adaptation.

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Although what works in a pilot might not necessarily work elsewhere, lessons so far learnt from the project provide useful insights by highlighting success and constraining factors that could be applied by large-scale programmes that intend to scale up CBA. The participation of a broad range of stakeholders enabled shared learning and fostered commitment to undertake actions. Since the climate-smart options agreed upon measure up to realities on the ground, their adoption has relatively higher chances of sustainability. Sustainability strategies have been weaved in right at the start to avoid over-dependence, including identifying the right stakeholders for institutional support, building relevant capacities of different stakeholders, specifying roles for different actors and securing commitment from them to deliver on roles.

Various factors may constrain adoption of climate-smart options if they are not dealt with. In focus group discussions, it emerged that local policies exacerbated farmer vulnerability; for instance in the past farmers had access to communal grazing lands which were utilized during periods of fodder scarcity. Similarly, farmers used to produce crops in wetlands during droughts and return to their upland plots during the rainy season (Turyahabwe, Kakuru, Tweheyo, & Tumusiime, 2013). Yet communal grazing lands and wetlands were leased out by the district land board to a few well-off farmers, who have either fenced them off or used them to establish commercial eucalyptus woodlots (Ampaire, 2013). As a result, poor smallholder farmers no longer have access to these resources. In addition, planting of eucalyptus in the wetlands resulted in lowering of the water table and drying of community wells (Ampaire, 2013). Women and children were particularly affected as they have to travel up to four kilometres to fetch water during the dry season. There was little incentive for adopting 'climate-smart' practices such as agroforestry, as the land is limited and farmers cannot accommodate the time lag on the return on investment.

Based on these insights, a more detailed study was conducted to understand policy formulation and implementation processes and constraints to CBA. A range of national-level policies and regulations currently exist on the paper to guide access to and use of natural resources, but these are almost non-functional at local levels (Rwakakamba, 2009). Examples include the Uganda Forestry Policy (2001), National Environment Act (1998) and National Wetlands Policy (1995). Findings affirm that CBA is constrained by lack of policy implementation, which is brought about by multiple factors, including exclusion of implementers in the formulation process, inadequate knowledge about policies (Glass, 2007), poor coordination among actors, lack of clarity in roles, limited resources and political interference, coupled with corruption. In addition, land tenure is insecure and the Uganda National Land Policy was only recently approved in 2013, following prior allegations of land grabbing from land owners, media and civil society. At present, smallholders feel helpless as there are no laws implemented to assure their access to land and other natural resources. Climate-smart solutions will only be effective if there is political will among national and local leaders to address constraints jointly. IITA and partners are planning policy engagement actions at national and sub-national levels, and sharing evidence both on technical issues, such as 'no regret' climate-smart technologies in coffee–banana systems, and on institutional issues, such as gender inclusion and resource access. While it is too early to explore whether specific measures will be mainstreamed at national levels, the aim is to enable more inclusive implementation of natural resource use policies.

3.4. *Participatory research and mobilization of young farmers in Karnal District, India*

The key lesson from India is that CBA can mobilize young farmers and provide a platform for scaling out adaptation technologies. The International Maize and Wheat Improvement Centre (CIMMYT), under the CCAFS research programme, is conducting participatory action research with farmers in Karnal, an agriculturally vibrant region of Haryana state (Aggarwal et al., 2010). This case study draws on primary data including household surveys (Singh, 2013) and participatory technology evaluation trials undertaken in the climate-smart villages, in which data were collected by CIMMYT–CCAFS (Table 1). Since the mid-1960s, increases in agricultural productivity, rapid industrial growth and expansion of the non-formal rural economy have quadrupled per capita Gross Domestic Product (GDP), and markedly reduced poverty. However, securing these gains is becoming a challenge in the context of soaring food and fuel prices, volatile markets, global economic downturn, diversion of human capital from agriculture, soil degradation, shrinking farm sizes, depletion of water resources and overarching effects of climate change (Ambast, Tyagi, & Paul, 2006; Humphreys et al., 2010; Jat et al., 2012). Climate change is projected to lead to uncertain onset of monsoons and more frequent extremes of weather (Aggarwal, Joshi, Ingram, & Gupta, 2004). Also, other competitive sectors and schemes such as 'MNREGA' (Mahatma Gandhi National Rural Employment Guarantee Act) have diverted farm labour. Conventional agricultural technologies, farming practices and linear out-scaling approaches (Swanson, 2008) under emerging climatic risks further exacerbate the challenges and make farming unattractive to farmers in general, and youth and women in particular (GCWA, 2012).

Conservation agriculture (CA) management technologies offer some solutions to the emerging challenges of climate change across the Ganges River basin, including Haryana, by maintaining soil fertility and water-holding capacity in conditions of unpredictable monsoons

Table 1. Climate-smart technologies adopted and disseminated, and their monetary advantages.

	Technologies adapted and disseminated	Climate-smart category	Yield gains over local farmers' practices (kg ha^{-1})	Monetary gains over local farmers' practices (US$ ha^{-1})	Number of farmers who benefited
1	Laser land levelling	Water smart	480	144	250
2	No-till wheat with residue retention (turbo seeder)	Carbon, energy and water smart	600	174	60
3	Direct dry seeded rice	Water and energy smart	00	180	60
4	Site-specific nutrient management, nutrient expert decision support tool rice–wheat system	Nutrient smart	550	127	82
5	GreenSeeker sensor guided nitrogen application	Nutrient smart	275	72	10
6	*Diversification/intensification*				
A	Relay mungbean in wheat	Carbon smart	855	217	5
B	Dual purpose wheat		1230	313	5
C	Introduction of maize replacing rice	Water smart	[a]	315	2

[a]Two different crops, hence comparisons of yield are not made.

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(Erenstein, Farooq, Malik, & Sharif, 2008; Gathala et al., 2011; Jat et al., 2009). Out-scaling (replication) of these relatively knowledge-intensive technologies and practices is more difficult than Green Revolution technologies (new seeds, fertilizers and irrigation). Significant efforts are being made on development and dissemination of new technologies through various institutions, but adoption remains slow. Major bottlenecks include the increasing average age of farmers, traditional mindsets, youth moving out of farming, individualistic and linear technology development, adaptation and dissemination.

Discussing with communities the ways to break the impasse, CIMMYT decided to undertake technology development with young farmers in the belief that engaging young farmers in CBA will facilitate adaptation and adoption of new technologies. CIMMYT also recognized the advantage of bringing young farmers together to influence policy-makers to support technology promotion, targeting not only adaptation and mitigation but also improving farm profitability and generating alternate employment for rural youth through technology-led business opportunities. The other perceived benefit was to develop suitable institutional mechanisms for buying and sharing assets such as expensive farm machinery, and for using resources more precisely at community-level. CIMMYT interacted with a group of young farmers from Taraori village, Karnal District. The response was overwhelming. During the interactions, farmer groups showed keen interest in new-generation technologies to resolve problems of seeding rice with less labour, precision in levelling to save irrigation water, residue management towards improving soil fertility and water-holding capacity, eliminating tillage to save on fuel, energy and water, and improving nutrient-use efficiency. All of these actions enhance rural livelihoods by increasing farmers' incomes, thus reducing vulnerability (Aggarwal et al., 2004), and enabling adaptation benefits such as ability to respond rapidly and cost effectively to delayed and unpredictable start of the growing season, or minimizing crop losses during dry periods.

Enthusiasm was so high that a group of 20 young farmers from the village took the initiative to form a society registered as 'Society for Conservation of Natural Resources and Empowering Rural Youth'. Since the inception of this society, policy-makers have visited and interacted with these farmers to learn more about resource-efficient, climate-smart and profitable technologies. Also, as farmers' participation in technology development and adaptation is critical, the CCAFS research programme established a participatory strategic research platform at the village level to serve as a capacity-building awareness-creation platform for different stakeholders. As summarized in Table 1, adaptive technologies were demonstrated and disseminated to a large number of farmers in the local area, and more widely across Haryana. Input and output data were collected from selected farmers using a simple checklist, and subsequently market prices for input costs and crop production were used to calculate net returns.

Farmers of the society have been active in publicizing the technologies through print and electronic media, including local and national newspapers, on television, and participation in various state, national and international level meetings. Recognizing the innovative contributions of these young farmers, the State-level Innovative Farmer Award was presented to them by the Chief Minister of Haryana in December 2012. The Chief Minister also announced state-wide incentives for community-based

climate-smart and resource-efficient technologies, primarily CA and resource-efficient mechanization, providing evidence that CBA is being mainstreamed at the sub-national level. The new Haryana State Agriculture Policy, adopted in 2014, recognizes emerging threats due to climate change, and emphasizes adaptive measures to minimize these consequences (ADH, 2014). The fact adaptation actions were community-based captured national media and political attention. This village became a role model for rural youth in five more such young farmer cooperatives. CBA built the capacity of young farmers so they not only adopted new technologies but also provided services to other farmers to earn money. An important element of this was the participatory approach and non-linear flow of information. In traditional extension systems, different organizations work in isolation and often deliver conflicting messages to farmers, but in this approach, farmers formed a common platform to debate and reach consensus on the new technologies.

4. Discussion

There are emerging evidence adaptation programmes and strategies for agriculture and are more likely to be effective if they directly involve communities that are innovating and implementing CBA at local levels. In India, the enthusiasm of young farmers in community-based organizations enabled the adoption, piloting and subsequent wider dissemination of adaptation technologies, overcoming social barriers to adaptation. It is perhaps unsurprising this successful case study has targeted younger farmers, who are most likely to be interested in the long-term future of farming. In Uganda, a participatory approach to assessment of climate-related risks and vulnerabilities and development of profitable climate-smart options captured the priorities and preferences of different categories of local stakeholders and created local ownership. These insights are particularly relevant when we consider the locally specific impacts of climate change and the uncertainty about how impacts may manifest themselves. Local perceptions by farmers about climate can also be matched up with meteorological data at national weather stations, as has been done in Uganda (Osbahr, Dorward, Stern, & Cooper, 2011). Recognizing adaptation as a process of social learning (Collins & Ison, 2009), policy-makers will do well to recognize the value of locally specific knowledge from CBA, through farmer field schools and other means.

The major opportunity to bring social learning on adaptation to the national level is via existing advisory services rather than creation of new networks and institutions. Extension services provide a vital social learning role (Eicher, 2004) and are a medium through which farmers access climate-relevant information, including market information and technologies, and so through which CBA could potentially be scaled out. But in many cases, including Bangladesh and Mozambique the current reach of extension services is limited. For example, in Mozambique, extension services are available only to a minority of farmers (from 4% in Inhambane to 7% in Maputo province; IFAD, 2012b). Furthermore, extension services usually target relatively wealthier households and thus may not reach the most vulnerable (Cunguara & Moder, 2011), presenting a challenge for scaling up CBA.

Mainstreaming CBA in agriculture faces particular institutional, social, policy, market and financial barriers. In Mozambique, there are barriers to national-level mainstreaming related to non-alignment of policies, strategies and plans, poor institutional coordination, and limited human and financial resources. In Bangladesh, key problems identified were lack of inter-agency coordination, communication barriers and literacy gaps. These barriers to CBA, including communication and literacy gaps, are highlighted in other studies (Spires, Shackleton, & Cundill, 2014). Proposed solutions that may be cost-effective as well as institutionally feasible include: farmers' organizations and low-cost platforms for shared learning on adaptation, particularly across local and national levels; better use of non-print communications media to overcome literacy gaps, in particular verbal communications by radio, mobile phones and face-to-face exchange; as well as tackling market barriers through trade reform, improved transport and storage facilities.

Furthermore, CBA activities implemented in these case studies were not necessarily responding to climate change but also to other challenges, such as conserving fuel and water in India. Climate factors may have less influence than other socio-economic stresses in shaping agricultural livelihoods (Mertz, Mbow, Reenberg, & Diouf, 2009; Ziervogel, Bharwani, & Downing, 2006). Successful adaptation policy in agriculture will thus need to create synergies with agricultural development to enhance adaptive capacity, while recognizing that 'modern farming' can have both positive and negative impacts on adaptive capacity (Dixon, Stringer, & Challinor, 2014).

In the Ugandan case, gaps in the implementation of existing land and forestry legislation made farmers more vulnerable to climate risks. Overall, CBA can be constrained by both lack of policy implementation, and by policy implementation. Existing institutions may not be inclusive or community-focused, limiting the extent to which local-level CBA can mainstreamed (scaled up) into national policies. These findings support the view that scaling up requires an enabling policy, political and institutional space, as well as financial and market space for an initiative to grow (Linn, 2012). Mainstreaming CBA needs to move beyond identifying and promoting best practices, towards tackling drivers of vulnerability and institutionalizing an enabling environment for CBA to occur as a process.

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5. Conclusions and implications

This article draws upon large-scale and local-level cases in Bangladesh, Mozambique, Uganda and India to appraise the opportunities and barriers for community-based approaches to provide effective inputs to higher level policy or larger scale programmes, and for large-scale programmes to respond effectively. Extension services and farmers' organizations are highlighted as mechanisms for linking between national-level and community-level adaptation, while success factors include participative and locally driven vulnerability assessments and tailoring of adaptation technologies to local contexts, mapping local institutions and working in partnership across institutions. Barriers include weak governance, gaps in the regulatory and policy environment, high opportunity costs, low literacy and underdeveloped markets.

Mainstreaming CBA in agriculture raises issues of what constitutes 'additionality' in adaptation. Is it sufficient to mainstream treatment of climate risks into existing agricultural development programmes and extension services, or is there need to extend such services in climate-vulnerable areas? The evidence from Bangladesh and Mozambique suggests mainstreaming adaptation into existing services may not be sufficient to reduce vulnerability, and additional investment is required to scale up support. The new ASAP-supported IFAD programme in Mozambique recognizes that access to technology, extension and infrastructure alone does not demonstrably increase household incomes if these efforts are isolated from access to value chains (IFAD, 2012b), and is thus investing in the fundamentals of rural development (infrastructure, market access and information). Implicit in this is an understanding that the key to building adaptive capacity is to address the existing 'development deficit' (Parry et al., 2009). Crucially, mainstreaming must not become a 'ploy by developed countries' to avoid providing additional adaptation finance (Klein, 2010, p. 45).

Since CBA encounters barriers at both national and sub-national levels, approaches or policies may be needed to overcome these gaps at different scales. Further research is needed on policies and reforms to strengthen adaptation as a social learning process, recognizing that it may be necessary to address barriers at broader scales (institutions, regulations or markets) in order to overcome local resource constraints. Creating space for both development partners and farmers to convey their adaptation priorities to policy-makers is a novel and potentially important modality for adaptation mainstreaming in agriculture, again a social learning process (Kristjanson, Harvey, Van Epp, & Thornton, 2014). It may be prudent to consider a broad interpretation of mainstreaming, to include improvement of structural and legal frameworks towards the objective of reducing the underlying vulnerability of all farmers. The experiences reported in this article demonstrate that mainstreaming adaptation in agriculture needs to go beyond 'climate-proofing' agricultural development, towards tackling the underlying drivers of poverty that exacerbate vulnerability and constrain adaptation.

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