

IDENTIFYING THE INSTITUTIONS FOR CLIMATE-SMART AGRICULTURE

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Abstract: This paper reviews the central role of institutions for climate-smart agriculture, focusing on the role of institutions in promoting inclusiveness, providing information, enabling local level innovation, encouraging investment, and providing insurance to enable smallholders, women, and poor resource-dependent communities to adopt and benefit from CSA. We discuss the role of state, collective action, and market institutions at multiple levels, with particular attention to the importance of local-level institutions and institutional linkages across levels.

Keywords: climate change, climate-smart agriculture, collective action, institutions, property rights

1. INTRODUCTION

The confluence of the growing recognition of the need to reconcile environmental protection, invest in smallholder¹ agriculture, reduce carbon emissions, improve food production and productivity, and reduce vulnerability to the predicted impacts of climate change led to the emergence of a new paradigm at the global level: climate-smart agriculture. As defined by FAO (2010, ii), climate-smart agriculture (CSA) “sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation) while enhancing the achievement of national food security and development goals.” A growing number of actors, including the International Fund for Agricultural Development (IFAD) and the World Bank, have endorsed CSA as an agenda. These proponents highlight a number of key differences in the CSA approach. Firstly, CSA projects need to be based on better and deeper assessments of risk; these assessments should recognize that not only does climate change bring new risks, but that these risks interact with and magnify existing vulnerabilities (Grainger-Jones 2012; World Bank 2011). Secondly, that options that promise “multiple benefits” for sustainable agricultural intensification should be scaled-up; these options help to build climate resilience while also contributing to food security, development goals, and carbon mitigation. Additionally, climate change is “reshaping the architecture of public (and potentially private) international development finance, generating new opportunities for smallholder farmers” (Grainger-Jones 2012, 14). This new approach will require significant coordination and integration in order to scale-up to reach landscape levels, in order to better address the drivers of continued agricultural expansion while meeting food security and development goals (World Bank 2011, 9). Finally, some practitioners argue that CSA must not focus solely on adaptation, with an emphasis on the adoption of specific technologies and interventions, but rather with an emphasis on building the adaptive capacities of individuals, communities, and organizations to respond to climate change. Adaptive capacity and adaptation “impl[y] fundamental shifts in the way institutions and actors interact, value and use different types of information, how they make decisions and evaluate and respond to risks and uncertainties” (Steinecker 2012, 9).

¹ In this paper, “smallholder” refers to small-scale agricultural producers, including farmers, livestock keepers, and fishers.

A number of actors have criticized CSA as an agenda by challenging the ethical grounds for increasing smallholder participation in carbon markets and carbon mitigation, citing risks of land grabs and displacement of smallholders, placing emphasis on technology development and transfer, supporting conventional agricultural practices, and potentially excluding or marginalizing smallholder voices and priorities (Sharma and Suppan 2011; Actionaid 2012; Pearce 2011; Naess 2011).

What remains to be seen is how CSA as a concept is translated into a practice that successfully engages poor smallholders. Despite climate change being very much a global challenge, the nature of CSA will require very contextual solutions and approaches, that are “influenced by a whole host of local factors, including the climate, the crops grown, the livestock reared, available technologies and the knowledge and skills of individual farmers” (Pye-Smith 2011, 21).

Drawing on experiences from agricultural development, natural resource management, participatory community-led development, sustainable livelihoods, and disaster risk reduction, this paper identifies four key functions that inclusive CSA programs, projects, and practices will need to fulfill in order to engage and benefit smallholder farmers:

- **information** about changing climatic conditions as well as possible responses,
- **innovation** to develop and disseminate new practices and technologies,
- **investment** in physical infrastructure and/or in learning new ways, and
- **insurance** to cope with risks due to climate shocks and risks of adopting new practices.

This paper argues that in order to realize inclusive CSA, researchers, advocates, and practitioners must pay more attention to the institutions and institutional arrangements that facilitate the functions mentioned above. When considering institutions, analysts often focus on the institutions of states and markets. While state and market institutions must certainly play an important role in addressing climate change and operationalizing CSA, climate change will require innovative thinking at all scales and levels (Ostrom 2009; Ostrom 2010). In addition to state and market sectors, it is also important to consider the role of civil society, including community-based organizations, membership organizations such as cooperatives and federated producer groups, and other nongovernmental organizations (NGOs), especially those involved in agriculture or development assistance. Considerable evidence demonstrates that the institutions of collective action and property rights in particular play an important role in facilitating the adoption of many agricultural technologies or natural resource management practices (Meinzen-Dick et al. 2002), for risk pooling (McCarthy et al. 2000, 2004), and for enabling people to build assets that can help them withstand shocks (Di Gregorio et al. 2008). In addition, local-level institutions and institutional arrangements serve important functions in information gathering and dissemination, resource mobilization and allocation, skills development and capacity building, providing leadership, and creating linkages between decision-makers and other institutions (Agrawal 2008). They can also help smallholders overcome critical resource constraints for building resilience by providing access to financial assets, community organizations, political linkages, education, and opportunities for diversification. Yet, given the speed of predicted climatic changes, it seems likely that many of these institutions will be overwhelmed and unable (or unprepared) to manage the extent and severity of these changes. Regardless, the role of institutions will become more important in helping communities respond proactively to these threats (and opportunities). In these

circumstances, such institutions must be flexible, accountable, forward thinking, and able to bridge multiple scales.

Despite their potential in enabling smallholders to both mitigate carbon emissions and adapt to climate change, institutions and institutional arrangements are not always inclusive of the poor or gender equitable. Ensuring that local level institutions and institutional arrangements are pro-poor and gender equitable will require careful and thoughtful engagement with these institutions and a thorough understanding of their role in the livelihoods of small farmers. We therefore propose *inclusiveness* as a crucial evaluative criterion and lens through which to look at institutional arrangements at all levels, from the global to the national and local level. Such an emphasis on inclusiveness will help to ensure that poorer countries, disadvantaged groups within countries and even the local level, as well as both women and men can benefit from CSA.

In subsequent sections of this paper, we first examine what is meant by inclusiveness and then review the role of institutions in providing information, enabling local level innovation, encouraging investment, and providing insurance to enable smallholders, women, and poor resource-dependent communities to adopt and benefit from CSA practices, paying particular attention to the importance of local-level institutions and institutional linkages. We conclude by exploring the implications of a focus on institutions and institutional arrangements for future research and development projects to build adaptive capacity and enable smallholders to undertake and sustain CSA practices.

2. INCLUSIVENESS

Successful CSA will require institutional support, experimentation, and innovation at all levels from local to global. Both the success and the legitimacy of these efforts will depend in large part on the extent to which these institutions include the whole range of actors implicated in the program or policy. Policymakers and program designers should make particular efforts to include the voices and concerns of traditionally marginalized segments of the population such as women, the poor, ethnic minorities, lower castes, and migrants.

Inclusiveness, as we use the term here, connotes several interrelated ideas. One notion of inclusiveness concerns the processes of decision making involved in CSA efforts. All parties potentially affected by a CSA initiative should be represented in the process of design and implementation. Truly inclusive institutions go beyond the perfunctory exercise of merely offering formal opportunities for participation; they actively encourage it by taking positive steps to solicit the voices of those whom the formal and informal processes of decision making often act to exclude. A second aspect of inclusiveness concerns the distribution of the various costs and benefits associated with CSA activities. Inclusive CSA should strive to distribute costs and benefits equitably among participants, and to ensure that neither are costs disproportionately borne nor benefits disproportionately captured by any particular actor or group of actors.

A focus on inclusiveness takes different forms at different levels, and thus carries different institutional implications. At the global or international level, it is important that international efforts to address the causes and consequences of climate change consider not just the interests of both the Global South and North, but also the range of agricultural producers and consumers

within those categories. Different actors are sure to have different priorities among CSA's three goals of adaptation, mitigation, and food security. Wealthier countries and individuals, for example, are more likely to be food-secure and to have the necessary resources to enable short-term adaptation, so they may view CSA primarily as a means of promoting mitigation measures. Poorer countries and individuals, meanwhile, are more likely to prioritize food security and adaptation. Inclusive international institutions will ensure a CSA agenda that strikes an appropriate balance between these varying priorities rather than allowing the richer, more powerful countries to bend the agenda disproportionately toward their interests.

Questions of inclusiveness are also relevant to the financing of CSA activities. An inclusive consideration of the costs and benefits of global investments in CSA would have to acknowledge that while the whole world stands to benefit from successful efforts to curb GHG emissions, strengthen adaptive capacity, and increase food security, the industrialized economies have contributed more to the problem of climate change than the developing economies. From a standpoint of equity, wealthier countries should be expected to contribute more to solutions like CSA than poorer countries. More locally, initiatives intending to advance the goals of CSA, such as national technology promotion efforts and PES schemes must be designed in such a way as to avoid excluding women and marginalized groups and to ensure that potential benefits are distributed equitably among participants.

Whether explicitly or implicitly, CSA efforts inevitably interact with state, market, collective action, and property rights institutions. Many training and technology-promotion programs are designed to intervene at the level of community groups or cooperatives, and often require or encourage a level of cooperation between individuals and groups of various sizes, as well as with government programs and market agents. Almost all CSA activities assume that individuals or groups can make decisions about how to use land, forests, water, and other resources (property rights). A detailed understanding of these institutions can help ensure that such programs are truly inclusive.

The question of whether state, market, NGO, and collective action institutions for CSA promote inclusion of small-scale producers, marginalized ethnic groups (such as pastoralists), women, and youth should be an empirical question, rather than based on prior assumptions about each type of institution. Government-run programs are often set up to serve all, or even focus on disadvantaged groups, but in practice access may be determined by wealth, status, or political connections. For example, many extension programs focus on "progressive farmers", giving preference to men with large land or livestock holdings. The private sector may be expected to focus on wealthier producers, but corporate social responsibility or "bottom of the pyramid" strategies may target smallholders or women.

Collective action institutions such as cooperatives offer the potential for smallholders to join together to gain economies of scale and bargaining power, but they often exclude certain actors through such mechanisms as culturally-rooted gender and ethnic biases, unaffordable monetary or in-kind contribution requirements for participation, and differentials in power and social links to powerful people (Mwangi, Markelova, and Meinzen-Dick 2012). Even within a group structure, the processes through which a group functions may have the effect of marginalizing or disregarding certain members, particularly women (Agarwal 2001). A number of examples

demonstrate that it is possible for credible external actors who are willing to devote time and resources to processes of understanding, dialogue, and negotiation to help mitigate these exclusionary pressures and bring about more inclusive and equitable outcomes (see, for example, Ratner, Halpern, and Kosal 2011; Komarudin, Siagian, and Colfer 2012; German et al. 2012). Those who design and implement CSA initiatives should seek to understand the exclusive characteristics of the groups with which they interact and commit resources to overcoming these obstacles to inclusiveness.

An inclusive notion of property rights is also crucial for CSA to succeed in delivering benefits to the poor. A PES scheme that recognizes only statutory ownership rights, for example, will systematically exclude producers who manage land or forests under customary use and access rights but hold no legal title. Interventions to promote CSA should not assume that the holder of a property right is an individual or a family. Communities often hold land, forests, and water as common property. Many rights derive not from the state but from local traditions, religious authorities, the rules of development projects, and the language of international treaties (Meinzen-Dick and Pradhan 2002). Interventions designed with a poor understanding of the local property rights regime(s) risk not only excluding less visible holders of rights, but actually contributing to their expropriation from the resources on which they rely by creating incentives for more powerful actors to claim exclusive use of more resources. Similarly, gender-blind programs and those that assume ownership at the level of the household may systematically exclude women and deliver benefits disproportionately to the (usually male) “head of household.”

Rather than assuming that one sector or type of institution is most inclusive, it is important to empirically ask whose interests are being met by each. While poorly designed interventions may fail to reach poorer and marginalized producers or even be harmful to their interests, well designed CSA programs can actually help to secure land rights for communities, families, and individuals. Researchers in Indonesia, for example, used the incentive of potential payments under REDD to catalyze a process through which communities enhanced their rights over local forests and overcame problems of elite capture to deliver benefits more equitably among community members (Komarudin, Siagian, and Colfer 2012). Achieving such inclusive outcomes and avoiding the pitfalls of exclusion and undermining existing property rights requires an affirmative commitment to inclusiveness as an end in itself, not just as a means of achieving other CSA goals.

3. INFORMATION

Climate information and knowledge play a central role in CSA strategies. However, for smallholders, the costs of searching for information on recommended practices, inputs, and implementation, are significant barriers to the adoption of practices that may reduce risk and vulnerability (McCarthy, Lipper, and Branca 2011). Information, in the context of climate change, includes a wide variety of climate and weather-related information, from historical trends, to forecasts (of varying scales and time periods), real-time monitoring, and climate change scenarios (Ngigi 2009), as well as advice on specific technological interventions and advisory services. Information provision for CSA must move beyond simply “providing ‘packages’ of technological and management advice to, instead, supporting farmers with the skills they need to choose the best option to deal with the climate uncertainty and variability and to make informed decisions about if and how to engage in new markets for carbon emissions” (Davis 2009, 2). Information provision

and dissemination should be coupled with a commitment to building and improving farmers' capacities and skills for "planning, problem solving, critical thinking, prioritizing, negotiating, building consensus, and leadership skills" (Davis 2009, 2). The goal is to shift from thinking about providing information to enabling access to knowledge that can catalyze change and lead to more informed decision making by end users of climate and advisory services (Levine, Ludi, and Jones 2011). Institutions are central to this effort, for they play a key role in how information, and ultimately knowledge, is generated, produced, accessed and used.

Cash et al. (2003) provide a useful framework for assessing whether information is likely to be useful to actors, based its perceived salience, credibility, and legitimacy. Salience implies that the information should be clearly relevant to the decisions that people are making. Global climate forecasts with wide variance in predictions over 20 years, for example, are unlikely to be salient to farmers in their decisions about what varieties to plant in the next season. More localized and immediate weather information is more likely to be salient for such decisions. Credibility refers to whether the information is believable by the recipient or decision maker. For example, Valdivia et al found that when faced with competing knowledge from "scientific" and traditional sources, farmers in the Bolivian altiplano are more likely to rely on their own knowledge and more traditional knowledge systems (Valdivia et al, 2010). In addition, farmers with more formal education may find so-called "scientific" information to be credible while others rely more on experiential knowledge. However, as Hansen et al. (2011) argue, projects that "extended interaction between farmers and researchers and reduced communication barriers, have reported reasonably high rates of use and benefits from responding to forecast information" (217). Legitimacy deals with the source of the information and its perception that it has been produced in a way that reflects divergent values and beliefs. For example, Brewer (2000) describes how seasonal forecasts of water availability provided by the irrigation department in an irrigation system in Sri Lanka were not acted upon by the irrigators with senior water rights, who did not want to curtail their water use in one season; after their crops failed, the forecasts were taken more seriously in future seasons.

State institutions have traditionally provided weather and technical information through government extension and advisory services, as well as serving as facilitators of interaction between local institutions, such as farmer organizations, and other relevant market actors, such as credit facilities, input providers, and transport agents (see, for example, Davis 2009). National Agricultural Research Services (NARS) are critical to the production of information and technology central to improving smallholder livelihoods and practices, as are state meteorological institutes for the production and distribution of weather and climate services. Because much weather-related information has a public good nature of low exclusion and low subtractability of benefits, the private sector may not become involved in its provision, but there are an increasing number of private sector actors in extension services advising on agricultural or livestock inputs and marketing.

At the local level, practitioners and researchers note the strong potential for collective action institutions, such as farmer organizations and rural producer groups, to take a lead role in encouraging information production and dissemination by: (1) creating a space to consolidate and disseminate farmers' know-how and innovations developed by the farmers themselves; (2) establishing specific support mechanisms, often with external funding; and (3) ensuring that the

priorities of smallholders are represented in research and agricultural extension agendas (Denis, Pierre, and Bosc 2006). Even in the absence of formally organized collective action institutions, informal social networks are important sources of information and technology transfer (see, for example Matuschke 2008; Newsham and Thomas 2011). In their study of climate-related indigenous knowledge in Uganda, Orlove et al. (2010) find that such knowledge is a highly social process, and as a result, is an ongoing process of evaluation and reevaluation as new information is shared and exchanged and integrates many diverse components. In this traditional system, and other similar ones, farmers are active participants in the process of creating and understanding the forecasts and weather information, not just passive recipients.

While knowledge and information may be important intangible assets, their use and ability to be employed interacts with decision making rules and power relationships that exist within the community (see the framework developed by Di Gregorio et al. 2008). Social norms, processes, and relationships determine how costs and benefits are calculated and weighed, which sources of information are trusted and valued, and ultimately which resources are mobilized to take action (Roncoli, Orlove, et al. 2010). Thus collective action institutions, including both formal groups like extension groups or water users' associations and social networks are important not only for the dissemination of information and knowledge, but also for its ability to be transformed into an action resource.

Several key institutional barriers may prevent information from being produced, accessed, and used by smallholders, in particular, poor and vulnerable smallholders.

First, the information produced by the existing institutions may not fully meet the needs of smallholders, damaging its salience, credibility, and legitimacy. A recent review of development interventions in Ethiopia, Uganda, and Mozambique found that, "at first sight, a great deal of [climate and advisory] information was being passed on to farmers in the research sites," but that, from an adaptive capacity lens, the information was "prescriptive, precluded choices, was unreliable, was limited to a narrow range of issues, excluded uncertainty, was not forward looking, and lacked medium- and long-term analysis" (Levine, Ludi, and Jones 2011, 25). Previous critiques of government advisory services have noted similar failings, observing that the government extensionists promoted technologies and interventions "ill-suited for local agro-ecological conditions"; advocated for technologies that are unaffordable or offer significant barriers to entry (Warburton et al. 2011, 2); and ignored the processes through which local people evaluate and make decisions (Newsham and Thomas 2011). Climate information provision has been marked by comparable failings; there is a noted divergence between farmers' needs and preferences and the scale, format, accuracy, and content of available products (see for example Vermeulen et al. 2012). Hansen et al. (2011) attribute the difficulty in meeting the climate information needs of farmers to "institutional arrangements that have given the agricultural sector too little ownership or effective voice in climate information products and services" (221).

Examples do exist of information and knowledge-generating approaches that actively engage farmers in the learning process, but these require institutional flexibility, a commitment to two-way engagement with end-users (and co-producers) of climate and advisory information, and a willingness to move from the role of information provider to facilitator of access to locally produced and absorbed information and knowledge (Warburton et al. 2011; David and Asamoah

2011; Davis 2009). Knowledge that is generated in such a way will necessarily ensure its salience, as well as its legitimacy in the view of end users. Farmer field schools (FFS), and Climate Field Schools, for example, which emphasize farmer-led experimentation and knowledge co-production, help to engage farmers in the process of identifying their solutions. Such experiential learning helps to improve collective perception of community challenges—and improves communities' capacity to respond (Suarez et al. 2012). These processes and other similar methods that engage end users, co-producing knowledge “through the interaction of people with local agro-ecological knowledge and people with agricultural scientific knowledge” (Newsham and Thomas 2011). Such co-produced knowledge has the benefit of being relevant not only to local agro-ecological conditions, but also produces knowledge that complements the existing livelihood system, which has been proven to be necessary for adaptation of new interventions (see Bayala et al. 2011). This knowledge, with its greater connections between end users and scientific analyses, would improve the credibility, salience, and legitimacy by ensuring that end users have a central role in the production of this information (Kristjanson et al. 2009). Yet these require commitment of funding and capacity building on behalf of state institutions to provide facilitators and to incorporate and respond to community-level feedback and demands (David and Asamoah 2011). More importantly, they require a commitment to the polycentric production of information and knowledge, which “ha[s] the advantage of using local knowledge and learning from others who are also engaged in trial-and-error learning processes,” and helps to reflect local priorities and enhance learning (Ostrom 2010, 552). These practices complement the emerging learning on what Cash et al (2003) and others have termed “boundary management” of the interface between communities of experts and communities of decisionmakers; the boundary management function must be supported by institutional arrangements that view this as a serious commitment, put in place measures to increase accountability, and allow for the creation of collaborative efforts/outputs (boundary objects).

To date, despite the investments made in providing information services to smallholder farmers, there has been remarkably little research on the information gaps that exist and the reasons behind these gaps (Glendenning, Babu, and Asenso-Okyere 2010) and this poor understanding of how farmers receive and value different sources of information has led to inefficiencies in outreach and low adoption rates of technologies (see, for example, Adolwa et al. 2012). In terms of climate and weather information, there is a need to understand how information needs vary depending on age, sex, and other social characteristics, as well as what sources of information are trusted most (Chaudhury et al. 2012). This requires that smallholder voices are represented in all stages of agricultural research and extension outreach (Meinzen-Dick et al. 2011). Such two-way understanding of information needs will help to produce tools and resources that are actually able to meet the needs of smallholder farmers, but requires shifts in the institutional arrangements linking farmers with information providers. At heart, this recognizes that the “root of smallholder vulnerability lies in the marginalization of farmers, pastoralists, and other rural groups in power and decision making” (Grainger-Jones 2012, 7).

Providing information and knowledge does not guarantee that all in the community have equal and sufficient access to these sources. Individuals have different degrees of institutional linkages that are often related to social characteristics, such as ethnicity, wealth, and gender. These institutional linkages are critical because they “affect the flow of resources and influence amongst themselves and to households and social groups” (Agrawal 2008, 29). Institutional access measures the degree

of participation and decision-making that individuals have in local institutions; this will influence and directly affect the nature of benefits that they receive from these institutions. Additionally, institutional articulation, the linkages between institutions, affects how information is shared and resources flow between institutions, at different scales; institutional articulation is necessary for CSA in order to coordinate cross-scalar action, access more resources, and build social capital. These two measures profoundly shape both the quality and type of information that households receive (Agrawal 2008).

Increasingly, for reasons of efficiency and ease of reaching larger audiences, development interventions rely on social networks and group-based approaches to distribute information and make knowledge available to a wider public (see, for example, Crona and Bodin 2006). Yet groups and social networks produce highly differentiated results in terms of information and knowledge sharing and often fail to inspire collective action. In Mozambique, development interventions assumed that group-based distribution of information would benefit everyone; however a review found that the main challenge was the dissemination of information to the wider public because volunteers appeared unwilling to distribute and pass on information without accruing clear individual benefits. Researchers found that “knowledge garnered political and economic importance—and may not be exchanged as much” (Arnall 2011, 27). Similarly, in Burkina Faso, gender, ethnicity, and politics influenced the distribution and flow of information generated at a participatory forecasting workshop (Roncoli et al. 2008). In Peru, individuals with access to climate information demanded payment for access, impeding the dissemination (Pfaff, Broad, and Glantz 1999). Yet, in certain circumstances, group-based dissemination has proven effective in distributing information and provoking collaboration and discussion, among group members (Faysse, Sraïri, and Errahj 2012; Ludi et al. 2011). Thus, information can be effectively and more inclusively shared under certain circumstances, highlighting the need for understanding what institutional arrangements can help facilitate this.

Finally, information can be shared both formally, through organized public meetings and trainings or through informal sharing and networks. Formal organized sharing platforms, such as farmer field days, discussion groups, demonstration plots, and exchange visits, increase institutional articulation and knowledge co-generation, but there may be significant barriers to participation (see, for example, Hoang, Castella, and Novosad 2006). In addition, a long literature suggests a gender bias in access to extension services; cultural practices and norms dictate women’s access to information through other community institutions, such as community-based organizations, cooperatives, and groups (Meinzen-Dick et al. 2011; World Bank and IFPRI 2010). Those that are excluded from such formal organized methods may be forced to rely on informal networks and exchanges, which limit the knowledge and information sharing. Research results from a study tracking farmer-to-farmer sharing in western Kenya found that informal networks were more effective at sharing seeds than information and knowledge (Kiptot et al. 2006).

Even with improved access to and dissemination of appropriate agricultural and climate knowledge, negotiating and enabling its use encounters institutional and collective action barriers at a household and community level. Adato and Meinzen-Dick (2007) found differing levels of trust in government and NGO sources of information in Bangladesh, Mexico, Zimbabwe, and Kenya. This may be compounded by gender, age, and levels of education, affecting whether individuals are more likely to trust “scientific” or experiential knowledge. Even where people have

and trust information, it may not be used. For example, in Uganda, women may attend trainings, but women do not put into practice what they have learned because they need permission from their husbands (Chaudhury et al. 2012). In addition to norms and informal rules concerning use and access to resources, these decisions at the household and community level are influenced by resource and cognitive constraints, including lack of access to credit, insecure tenure arrangements, opportunity costs, risk aversion behaviors, lack of access to necessary infrastructure, and governance failures (McCarthy, Lipper, and Branca 2011; Roncoli, Okoba, et al. 2010; Jones and Boyd 2011). Effective use of climate information also requires management skills that may be new for smallholders; climate information providers need to be able to work with smallholders to develop and build these skills to enable the use of these new services and products (Hansen et al, 2011). These complex relationships and institutional arrangements govern how climate knowledge can become an action resource.

4. INNOVATION

Innovation plays a central role in agriculture, for achieving economic, social, and environmental goals (Klerkx, Hall, and Leeuwis 2009). Around the world, the ability to innovate and the capacity to foster innovation (and accept failure) varies greatly (Levine, Ludi, and Jones 2011). Innovations are “workable” ideas, practices, products, or changes to processes or rules; they “involve the extraction of economic, ecological, and social value from knowledge” (Asenso-okyere, Davis, and Aredo 2008, 2). Table 1 shows that there is a substantial (and growing) list of potential technologies and interventions that might qualify as CSA and offer significant benefits. The challenge of CSA for practitioners and researchers is to ensure that systems, communities, and households have the ability to ensure that innovation is a process and not an endpoint (that is, adoption of an innovation). In dealing with climate change, scientists and researchers can play an important role, but communities will need to be able to continually adapt, experiment, and evaluate what solutions prove to be most effective. Formal research, development and extension (R, D, and E) systems are important, but need to be conceived as including the producers themselves (Meinzen-Dick et al. 2011).

Much emphasis of late has focused on the exploration of innovation systems, which have been defined as “networks of organizations and individuals that are focused on bringing new products, new processes and new forms of organization into social and economic use. The institutions and policies that affect their behavior and performance are also part of the innovation system” (Hellin 2012, 144). The actors in this innovation system are linked by the exchange and production of knowledge, making their interactions important, for they determines what type and what access individuals have to these knowledge resources (Spielman et al. 2010). Thus, the “capacity to innovate is a function of the behavior of systems for producing, absorbing, and using knowledge” (Asenso-okyere, Davis, and Aredo 2008, 3). Many of the same institutional arrangements and changes that produce the necessary information and knowledge for CSA are essential for enabling innovation and experimentation at the household and community level. The institutional arrangements that facilitate such innovation brokering are those that value and negotiate such position for others within the institution who do not feel that such a role has intrinsic value. Moreover, to ensure credibility (from Cash et al 2003), there is a need to act as neutral

intermediary, “one who connects different actors but does not have a strong normative orientation” (Klerkx, et al. 2012, 58).

Table 1: Possible CSA Interventions

Crop Management	Livestock Management	Soil and Water Management	Agroforestry	Integrated Food Energy Systems	Infrastructure	Access to Climate Information
<ul style="list-style-type: none"> • Intercropping with legumes • Crop rotations • New crop varieties • Improved storage and processing techniques • Greater crop diversity • Value chain and marketing 	<ul style="list-style-type: none"> • Improved feeding strategies • Rotational grazing • Fodder crops • Grassland restoration and conservation • Manure treatment • Improved livestock health • Animal husbandry improvements 	<ul style="list-style-type: none"> • Conservation agriculture (e.g. minimum tillage) • Contour planting • Terraces and bunds • Planting pits • Water storage (e.g. water pans) • Alternate wetting and drying (rice) • Dams, pits, ridges • Improved irrigation (e.g. drip) • Rehabilitation of degraded landscapes 	<ul style="list-style-type: none"> • Boundary trees and hedgerows • Nitrogen-fixing trees on farms • Multipurpose trees • Improved fallow with fertilizer shrubs • Woodlots • Fruit orchards 	<ul style="list-style-type: none"> • Biogas • Production of energy plants • Improved stoves 	<ul style="list-style-type: none"> • Develop climate proof infrastructure for storage • Retrofit rural infrastructure to cope with climate risks, such as flooding or water shortages 	<ul style="list-style-type: none"> • Use of climate analogues to predict future changes • Support farmer exchanges • Develop local expertise in climate science and agriculture • Introduce forecasting and scenario planning

Source: adapted from (Neufeldt et al. 2011).

Both public and private sector are important actors in generating CSA options. In general, we would expect private firms to be more involved in R, D and E on crops, livestock, and agroforestry where there are private benefits to be captured (for example, through sale of improved seeds, machinery, or inputs). The public sector certainly invests in such types of innovations, but public sector and NGOs are more likely than the private sector to invest in formal research on landscape-level adaptations, natural resource management practices, or other innovations with less excludability.

Like the provision of information, state institutions and alternative extension service providers (NGOs, private sector) can and do have an important role in enabling innovation, through the types of extension service they provide. As mentioned previously, an emphasis on extensions systems that facilitate social learning, incorporate feedback loops, and iterative interactions (Davis, Ekboir, and Spielman 2008) and employ different types of learning (learning by doing, learning by using, learning through formal means, and learning through self-education) (Asenso-okyere, Davis, and Aredo 2008) are thought to enable local level innovations (Ludi et al. 2011).

Institutional arrangements that recognize and value local autonomous adaptations and innovations are necessary for enabling future innovations (Levine, Ludi, and Jones 2011). While much attention has focused on the technologies adopted from the outside, less attention has been paid to the local innovations, including socio-economic and institutional innovations for gaining access to resources and organizing marketing activities (Waters-Bayer et al. 2006). Recognizing and valuing these local innovations helps researchers and practitioners understand the processes of change and demonstrate to smallholders the critical importance of their autonomous adaptations. For example,

the Grassroots Innovation Augmentation Network works to help identify innovations made by smallholders and other individuals, and create opportunities for them to get resources to develop and disseminate their innovations.² The creation of platforms that allow for sharing ideas, between farmers, researchers, and other actors can be an effective tool for enabling innovation at the local level (Waters-Bayer et al. 2006). Yet as discussed above, group dynamics and micro-politics may result in differential access to such fora. Additionally, institutional support is necessary to provide social safety nets to allow innovators to fail and to reduce the costs of such actions (Ludi et al. 2011). Prolinnova, a multistakeholder program that promotes local innovation in ecologically oriented agriculture and natural resource management, has advocated for the use of Local Innovation Support Funds to encourage—and reward—innovative experimentation and sharing among farmers.³ Local committees comprised of a mix of stakeholders select recipients of small grants for farm-level innovations. Recipients are then required to track and report back on the successes—and failures—of their innovation in community settings. Social protection programs that provide starter packs of seeds, access to credit, or asset protection, as well as access to common property, may also help to facilitate adaptation to climate change by enabling households to adopt new practices and diversify livelihood strategies (Davies et al. 2009; Jones et al. 2010).

The role of collective action in encouraging innovation has not been well documented in the literature (Hellin 2012), but it has the potential to enable innovation as well. Necessary elements for local-level innovation include individuals with a sense of agency, access to information and knowledge, and resources to implement changes (Ludi et al. 2011); collective action institutions and social networks can help to ensure the provision of these elements. Additionally, at the local level, institutional arrangements, such as property rights, cultural views towards innovation, and gender norms may inhibit the development of vibrant, local-level innovation systems. Experiences from FFS in Mozambique found that institutional barriers existed that precluded the experiential and social learning processes from inspiring community collective action; while FFS offered participating farmers individual benefits and strengthened their relationships, it did not translate into effective outreach into the community beyond group members (Dzeco, Amilai, and Cristóvão 2010).

In order for innovation and experimentation to continue, there is a need for forging partnerships and increasing institutional articulation (Waters-Bayer, Wettasinha, and van Veldhuizen 2007). External organizations, so-called bridging organizations, can play a key role in ensuring that local institutions have access to the resources necessary to build local adaptive capacity (Ensor and Berger 2009; Biermann 2009). These bridging organizations can also assist in “creating civic arenas or forums as well as social and political spaces for deliberation,” leading to policy changes and enhanced representation (Folke et al. 2005, 450). More immediately, though, these organizations can facilitate linkages with local agencies and government offices. One example from Sri Lanka illustrates this potential. A participatory rice selection project connected farmers with a local research NGO to carry out field experiments to determine which variety of rice would tolerate the increasing salinity of the water. The benefits were twofold. First, the community gained access to the research NGO and was able to use the NGO’s resources and technical expertise to increase its adaptive capacity. Second, the process of experimentation introduced a new approach to problem solving, increasing local knowledge and capacity to make informed

² <http://www.gian.org>

³ <http://www.prolinnova.net/lisf>

development decisions (Berger, Weregoda, and Rathnabharathie 2009). Communities need social networks and linkages that are both “strong” and “weak,” for both can enable innovation in systems (Spielman et al. 2010). Strong and weak ties serve different functions in the innovation process; weak ties between institutions and individuals help in the search for information, while strong, dense ties are important for discussion of more complex subjects, experimentation, and exchange of ideas (Darr and Pretzsch 2008). However, as mentioned in the previous section, social cleavages and unequal access to these networks can create and reinforce disparities in terms of access to these necessary elements for innovation.

At times, existing institutions, cultural norms, beliefs, and practices may impede the adoption of certain innovations and make it more difficult for individuals to experiment and try new activities. These include decision-making patterns, traditional authorities, gender biases, as well as traditional risk aversion behaviors. For example, gender norms and relationships may impede local level innovations. In Western Kenya, men suggested that traditionally and culturally, women were not innovative, making men less likely to support women’s investment in changing farm practices or investing in income generating activities (Bernier et al. 2013). In Ethiopia, there is strong opposition to individuals changing the sowing dates in light of changing weather patterns (Levine, Ludi, and Jones 2011). In Zambia, traditional free-grazing arrangements and hunting methods prevented smallholders from adopting improved natural resource management practices; using traditional authorities, researchers and communities were able to enact changes to the bylaws to protect investments and enable communities to adopt these practices (Ajayi et al. 2012). These institutional innovations enabled the protection of vulnerable households, especially women and the poor; it also suggests that these cultural norms and behaviors are dynamic and evolving, creating opportunities and challenges to ensure inclusive benefit sharing. In Indonesia, farmers’ collective decision-making concerning planting timing and varieties made it impossible for individual farmers to alter planting decisions; approaches that targeted individual farmers to use seasonal forecasting did not succeed (Siregar 2010). Understanding how communities can affect institutional change—and the institutional changes that impede innovation—will help researchers and practitioners scale-up CSA.

Moreover, CSA may offer new opportunities for smallholder farmers, through carbon finance, climate adaptation funding, or through improved agricultural productivity from climatic changes. In order to take advantage of such opportunities, new institutional arrangements are needed to connect smallholders with global markets, actors, and information. These new arrangements, particularly those that bring together local institutions to global actors or markets, face a number of challenges, including the need to link across scales and to overcome significant transaction costs while ensuring benefits for smallholders (see Shames et al. 2012 for more complete discussion). A number of studies are tracking how these new opportunities and funding sources that can enhance livelihood diversification of smallholders are developing (Shames et al. 2012; Gosset and Neufeldt 2012).

5. INVESTMENT

Any change in agricultural practices requires some form of investment. At a minimum, people need to invest in learning new ways of doing things. Many CSA technologies and practices also

require more material investments. In the case of crop or livestock interventions, the main investment required may be money to buy seeds or livestock. Many of the soil and water management interventions require equipment (which may be bought or rented) and often also require substantial labor investments. Agroforestry requires some investment in the tree seeds or seedlings, but also considerable time and labor until the trees produce and may require setting aside land from other production. Most integrated food and energy systems require an investment in some kind of equipment (whether stoves or biogas). Infrastructure may require the most concentrated investment of money, labor, or both, with the investment being made by the state or collective institutions.

Whether smallholders can make these investments will depend on the spatial scale, costs, and payback period of the investments. Each of these has institutional implications, as illustrated in Figure 1. Actions at the individual level (such as planting a drought-resistant annual crop or building a farm pond) generally do not require much in the way of institutions for coordination. As we move up the scale to actions that operate at the group or community level (such as a pond or small reservoir to serve a group or community), some form of coordination becomes necessary. At this local level, collective action institutions are often the most appropriate for such coordination, although some state institutions may also be relevant (for example, giving technical advice to a group of farmers digging or operating the reservoir). As we move higher on the spatial scale, local government or other state agencies become increasingly important for coordination (such as when the panchayats coordinate investment in watershed management or other public infrastructure under the National Rural Employment Guarantee Act, or NREGA, in India), although collective action institutions may still be relevant (for example, Nepal's national federation of forest user groups). The relative roles of state and collective action are illustrated by the triangles on the right hand side of Figure 1. In general, if the relevant scale for policies or action is global, then international institutions are required, either employing existing arrangements (UN agencies, for example) or creating new institutions (such as the carbon credit exchanges formed post-Kyoto Protocol in 1997).

Figure 1. Role of institutions in climate change responses



Source: Meinzen-Dick, Markelova, and Moore 2010. Note: Location of climate change responses is approximate, and will vary depending on the exact nature of the CSA techniques as well as farm sizes. Responses listed in orange are adaptation; those in green are mitigation responses

Although not noted in Figure 1, markets can also play a coordination function, ranging from the global to the local. Examples include private sector distribution of new seed varieties, or carbon markets and other mechanism as payment for environmental services. The question of when markets (rather than state or collective action) institutions are appropriate depends not so much on scale but on issues of transaction costs and attitudes toward markets. Working with many small suppliers of carbon “services” entails higher transaction costs than working with a few large-scale suppliers, which means that markets tend to favor plantations, for example, over smallholder agriculture or forest communities. Asymmetrical information, either about the actions of farmers or the benefit streams they could tap will mitigate against market-based coordination. Finally, the acceptability of private sector investment will depend on values and attitudes toward resources and toward markets. This has been especially evident in the recent debates over large-scale land acquisitions or “land grabs.” The investment needed for many forms of agricultural development, along with purported economies of scale, have contributed to governments seeking private investors or investors seeking agricultural land in developing countries. However, the loss of land and lack of clear benefits for many of the existing land users have created opposition to these types of land deals in many countries (Anseuw et al. 2012).

In practice, many investments require action at multiple levels and sectors. For example, new crop varieties seem at first glance to be a matter of adoption by individual farmers, but the seed systems that disseminate the new varieties involve a combination of companies and private traders, informal social networks, and formal farmers' organizations to distribute the seeds and provide seed banks to ensure their availability for the future; national and international public and private agricultural research institutions are involved in the development of new varieties, with individual farmers and farmers' groups playing a role in providing germplasm and information about land races, and adapting varieties. In the case of livestock CSA, introduction of dairy goats in Kenya does not only require that farmers invest in the goats, but also a group of farmers to share a buck, and a federation of groups to ensure that the bucks can be circulated, along with public or private veterinary services and changes in feeding practices (Place et al. 2002). Effective REDD agreements will require international market mechanisms to match those who wish to pay to offset their emissions with those who will sequester carbon; national governments that will broker agreements, for example through a Designated National Authority (DNA) as currently employed for CDM agreements; and collective action groups to monitor compliance among local smallholders. While local collective action can provide an effective means of measuring and ensuring compliance, whether they execute this role effectively on an ongoing basis will depend on whether there is an incentive to do so. The latter is more likely if the group has been involved in the negotiations, has had a say in setting the rules, and receives a substantial benefit, either for the group or its members.

A range of central and local institutions, public and private, is therefore needed. Rather than focusing exclusively on any single type of institution, policies need to develop polycentric governance arrangements with in which multiple institutions each play a role (Ostrom 1999). This also calls for coordination among different institutions. In this paper we focus primarily on collective action institutions at the local level (which may be federated up to higher levels). The relevance of higher-level institutions of the national and global levels is noted, but topics that have primarily state or global level action are not dealt with in detail in this paper.

The time frame for actions also provides indications of the nature of institutional arrangements needed. In general, Knox, Meinzen-Dick and Hazell (2002) point out that agricultural investments that have a long time horizon require greater attention to property rights because those without tenure security will not have the incentive—or sometimes even the authority—to make the investment. Agroforestry presents a classic case: tenants or women without secure rights to land may even be prohibited from planting trees because this is seen as creating too much of a claim on someone else's land—even if the land “owner” is a husband or his clan (see Place 1994; Fortmann, Antinori, and Nabane 1997; Kiptot and Franzel 2011). Similar issues are likely to arise for terracing, which requires long-term investment; where tenure is insecure, contour planting that has lower investment requirements and shorter payback periods may be more likely to be adopted. After reviewing land tenure studies in eight West African data sets, Fenske (2011) adds that while tenure security is generally adequate to enable investment, such security is conditional upon use; for CSA, this means that options that require fallowing land will make it potentially vulnerable to expropriation and loss.

Some forms of CSA will show results in the short term (a year or two, for example), others over the medium term (two to ten years), and others have a much longer time horizon. The longer the

time between actions taken and seeing results, the more difficult it will be to gain and maintain support, and to monitor progress. Some actions such as responses to crises like drought or flooding will only be intermittent. These call for some kind of basic institutional work for preparedness and ability to respond quickly. Although these do not require full-time arrangements, efforts are needed to maintain preparedness (for example, inspecting dykes against flooding), and these may be more difficult types of institutions to maintain.

The investment requirements for CSA are one of the most pervasive factors that restrict smallholders, especially the poor and women, from being able to adopt many promising approaches. Conservation agriculture, for example, requires machinery that may be affordable for a large farmer to buy. Good rental markets or collective ownership by a group can make the machinery available to small-scale farmers. For those with cash constraints, even purchasing new seeds—let alone new animals or equipment—are problematic, and poor households or individuals may not be able to afford to forgo annual production on land while trees grow to be productive. In addition to the necessary investment capital, some practices may pose significant opportunity costs that smallholders are unable to manage. Magnan, Larson, and Taylor (2012), for example, argue that the value of crop stubble as a livestock feed in Morocco acts as “powerful deterrent” for crop-livestock farmers to adopt soil conservation practices that incorporate crop residues (13). These opportunity costs and competition for on-farm resources are likely to vary across sites and production systems, with varying levels of intensification (see for example Valbuena et al. 2012). Valdivia and Gilles (2003) find that some Andean farmers, through community education and noting gradually changing weather patterns, have developed a knowledge of climate change and its potential effects on their productivity. These farmers have expressed desire to adapt their practices, but cannot due to asset constraints. Even if cash is available at the household level, not all individuals may have control over sufficient cash; women or youth may thus be limited in their ability to invest in CSA.

Credit can help ease cash constraints for such investments, but even formal credit institutions may not be available in rural areas or unwilling to lend to smallholders. Microfinance institutions and rotating savings and credit groups provide an alternative but the latter require collective action, and are not always inclusive of the very poor. For example, participatory poverty assessments in Bangladesh differentiated among categories of the poor and extreme poor based on whether someone would be included in a microfinance group (Nabi et al. 1999). Where critical assets are required for investment, some form of external assistance to build those assets may be needed to enable the very poor, or women, to engage in CSA.

6. INSURANCE

Climate change increases the risks and shocks that smallholders face as weather becomes less predictable. Some form of insurance is required to help withstand the shocks, as well as to encourage innovation and investment. Downside risk is a recognized constraint to adoption of new technologies and practices (Binswanger 1981; Feder, Just, and Zilberman 1985). This implies that people are more likely to take risks if they have some form of assurance or fallback mechanism. The forms of insurance range broadly, from formal to informal. Crop or livestock insurance is not often available to individual smallholders, especially in developing countries, because of the high

transaction costs of monitoring crop losses and avoiding moral hazard across many small holdings, but index-based insurance that is keyed to local weather stations has lower monitoring costs, and can be sold in varying amounts so that small-scale producers can buy in (McCarthy 2003; IFAD 2011; Barnett, Barrett, and Skees 2008; Alderman and Haque 2007). Even landless agricultural laborers—who are also hit by droughts or floods—can buy index-based insurance. Although these forms of insurance are still not widely adopted, these again illustrate the need for multisectoral and multilevel institutional coordination, with public sector provision of such insurance, backed by reinsurance that is often provided by the private sector.

Beyond such formal insurance, there are a variety of groups, social networks, assets, and public programs that can provide alternative insurance mechanisms. Externally-organized microfinance groups and locally-organized groups may provide some sort of insurance. Dercon et al. (2012) examine how Ethiopian funeral societies (*iddir*) have expanded into providing health insurance. Quisumbing, McNiven, and Godquin (2012) examine the role of social and familial networks in cushioning shocks in the Philippines. Both note that these social institutions are capable of dealing with some idiosyncratic shocks (like illness). For covariate shocks that affect a whole community, a local group or network is unlikely to be able to provide much insurance because all the members would be affected, but social networks with others outside the community (such as migrant family members) are likely to be more effective. Jodha, Singh, and Bantilan (2012) similarly find that in semiarid areas of India, the commons has provided important fallback for households, but with climate change and increasing demographic pressures, this important safety net is being eroded. Spatial mobility and socially-mediated “access options” that enable pastoralists to use the land and other resources of other groups (via reciprocal arrangements with other pastoralist groups or through exchange with agricultural communities), as well as carrying extra animals that can be disposed of in times of drought, have historically provided forms of risk mitigation for livestock keepers in many semiarid and arid regions (McCarthy et al. 2000). It is thus interesting to note that CSA moves away from such customary insurance mechanisms toward more intensive care of fewer animals with stall grazing or restricted animal mobility. In some cases, social capital may act as a deterrent to investing in more resource intensive CSA practices; Di Falco and Bulte (2012) found that increased kinship ties reduced the incentives to invest in soil conservation in Ethiopia, as households are able to rely on community sharing and coping patterns in times of need. However, it is likely that the trends of covariate shocks from climate change will undermine the more traditional and informally based insurance trends; in these scenarios, public programs, such as disaster risk reduction and social protection, as well as insurance, will become increasingly important.

Assets provide a form of insurance for many households. Irrigation reduces the vulnerability of cultivators to fluctuations in rainfall. Other assets may either protect against weather-related shocks (as through storage facilities) or can be liquidated as a coping strategy, as with sale of livestock or jewelry to cover expenses when crops are lost or illness strikes (see Quisumbing, Kumar, and Behrman 2011). Burton, Soussan, and Hammil (2003) state that livelihood resilience is determined by the assets possessed by the household and the services that are provided by external infrastructure and institutions. Thus, there is an important role for one additional form of insurance: the state and even international programs often step in to provide employment (as under the NREGA program in India) or provide emergency food or other supplies (as during severe droughts or floods). The latter are especially last-resort insurance, and for disaster management.

As with coordination for investment, insurance can be provided by the state, markets, or collective action institutions. Private sector is most likely to be involved in formal insurance programs, although even then, there has not been much interest on the part of private insurers to cover smallholders in developing countries, owing to the high transactions and monitoring costs and the high likelihood of payout. The state and even the international system provide disaster relief, emergency coverage and rural employment guarantees. Collective action institutions provide group-based insurance and social network support, but as noted above, these are more likely to be at the local level, and cannot insure against covariate risk. As noted by Di Gregorio et al. (2008, 20):

collective action has been shown to be very effective in insuring against frequent and, to some extent, less frequent events, particularly when such events affect households differentially. Local collective action is much less effective in reducing exposure to generalized shocks—either natural or economic—simply because, by definition, such shocks affect a large portion of households. These shocks require tapping into external resources, such as from government, market, or international NGO assistance. However, collective action can be used to assert political voice, and could potentially ensure that local peoples are receiving the appropriate type of assistance at the right time. It is also possible that local collective action can feed into the process of designing disaster relief programs.

Hybrid models and institutional arrangements to provide insurance will likely become important. One experimental model in Ethiopia is attempting to link insurance provision with credit providers; the state is playing an active role in encouraging private sector involvement in this sector⁴. In the future, it seems likely that such hybrid institutions will need to be involved to deliver the necessary insurance products to smallholder farmers.

The poor are most vulnerable, because even relatively small shocks can have severe consequences and they lack the resources to self-insure. CSA can help reduce vulnerability by stabilizing or even increasing production, but in many cases very poor people cannot take the risk of adopting new approaches without some form of insurance to provide fallback mechanisms. Even many insurance mechanisms are biased against the poor: the high transaction costs and lack of cash of the poor makes them unattractive to formal private sector insurers; those with influence and political connections often receive priority in government programs such as disaster relief; and many social groups and networks exclude the very poor. India's NREGA is promising in that it provides a safety net for all households, but is targeted to the poor because it requires people to provide manual labor in order to receive employment. At the same time, it offers livelihood diversification away from dependence on agriculture alone, which is another important adaptation strategy for the poor.

Increasingly, social protection programs are being viewed as having the potential to contribute to increased resilience to climate change. A wide variety of social protection and disaster-risk reduction programs help smallholders reduce their risks and exposures while increasing the assets and resources that they have available to them (see previous discussion in investment). While no single form of insurance is likely to suffice, cultivating multiple forms of insurance is likely to

⁴ The intervention is still ongoing and results forthcoming. For more information, see: <http://atai-research.org/projects/interlinking-weather-index-insurance-credit-alleviate-market-failures-and-improve-agriculture>

offer the greatest extent of coverage for the poor. Moreover, multiple forms of insurance recognize that smallholders both perceive risk differentially and have different preferences for insurance and risk management options. Understanding risk perceptions—and insurance needs—will help state and market institutions create insurance forms that respond to and address the felt needs of vulnerable farmers.

7. IMPLICATIONS

CSA aims to increase the resilience of livelihoods and ecosystems through combinations of technologies and practices and improved access to and use of weather and risk forecasts and through the sustained support of innovations, both local and external. Although the focus is often on the technical components of CSA, the institutional aspects are absolutely vital, both for the adoption of CSA and as a contribution to resilience in its own right. As Kasperson, Kasperson, and Turner (1995) and Adger (2003) note, financial, physical, human, and natural capital, social networks, and institutions are critical for resilience, providing asset entitlements, coping resources, and social capital that provide organizational support following a shock. As climate shocks become more extreme and unpredictable, these aspects of institutions and institutional arrangements will become even more important.

This paper (and the workshop where it was presented) makes the argument that institutions and institutional arrangements are of critical importance to the adoption of CSA practices. A new agenda for practitioners and researchers should address the following issues:

- In order to encourage the adoption of CSA practices, local institutions will potentially need to take on new roles and responsibilities. Funders, government organizations, NGOs, and other actors will also need to take on additional roles as network brokers, facilitating access to resources and information. Much investment is needed to build the capacity of all actors to fulfill these roles.
- Institutional arrangements need to do a much better job of including end-user and local-level perspectives in order to facilitate the use and production of climate and agricultural information and insurance products that represent the complexity of smallholder livelihoods.
- Social safety nets are important adaptive strategies and may help smallholders have the capacity to innovate and adopt new practices. Smallholders need access to hybrid insurance mechanisms that bridge both formal and informal strategies.
- Climate change requires institutional changes at all levels; such polycentric action will require coordination across and between scales.
- In some cases, new institutional arrangements will be necessary to ensure that smallholders are able to take advantage of new opportunities from climatic changes or new funding sources; institutional evolution is also possible.
- Collective action institutions can play an important role in enabling adaptation to climate change; better understanding what kinds of arrangements facilitate CSA adoption is a goal of the research agenda.
- Exploring CSA practices for the commons may be a way of ensuring that some of the poorest can benefit.

- Recognize that inclusivity needs to be a guiding principle, so that these programs do not worsen social differences; well-designed CSA programs can be pro-poor and gender equitable.

Institutional responses to climate change are often driven by the urgency that arises from an unpredictable threat. These responses, when they occur without careful considerations of possible outcomes, both immediate and long-term, often result in unforeseen consequences. Among other reasons that careful thought must be paid to the different spheres affected by climate change, is the fact that great inequity already exists among those who are most affected by climate change and those who are not. These inequities may be under these different guises of natural resource dependency (Thomas and Twyman 2005), gender (Lambrou and Piana 2006), or asset-possession. The responses to these inequities can exacerbate or diminish the risks posed by climate change and the vulnerability of those communities, and institutional capacity, organization capacity, social networks are institutions could be weakened, rather than aided, by responses. Thomas and Twyman (2005) state three reasons that equity is important to consider in climate change policy responses: (1) the amount of evidence already gathered that demonstrates that the poorest and most vulnerable groups are most at risk for suffering the most dire consequences of climate change; (2) those communities that are most natural resource dependent will also suffer greatly; and (3) through their recognition of the diverse interests that must be represented in climate change response policy, international organizations are demonstrating their acknowledgement of the imbalance.

Although local institutions are critical, they are not sufficient to ensure the adoption of CSA, let alone to all the solutions to the problems of climate change. Rather, governmental policies and international mandates would be more effective if they established ecological and human rights standards and otherwise support and fund a diverse variety of institutional strategies, allowing local organizations to select the strategy that is most compatible with the needs and context of their community. The responses used by communities to mitigate and adapt to climate change and the institutions that are necessary to facilitate them places an emphasis on the harmonization between the spheres and sectors. Large overarching goals at the highest level, with more detailed, task-oriented programs at the national level, to complex and distinct programs at community levels are better able to tailor to the diversity of circumstances and needs. There is a need for connectivity between pockets of social capital within communities and higher level organizations. Through the different scales of networks and combinations, the harmonization of strategies can be implemented successfully, managing diversity of solutions within each distinct community.

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