

# Investigating Climate Information Services through a Gendered Lens

Working Paper No. 42

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

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RESEARCH PROGRAM ON  
**Climate Change,  
Agriculture and  
Food Security**



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## **Abstract**

This paper explores access to climate change-related information through a gendered lens. Climate change is rapidly affecting the lives of farmers throughout the world, producing a need for adaptive agricultural livelihoods strategies. A central mechanism in the development of adaptive strategies to climate change is the strengthening and effective utilization of information channels. The more relevant and useful the information is to the user, the better the user may be able to adapt to changes in climate. Despite this critical need for accessing climate-related information, many of the people who are most vulnerable to climate change and environmental shocks are often on the periphery of receiving practical information. In this paper, we show that women farmers are overwhelmingly left out of many forms of communication channels. Thus, the purpose of this study is to identify instances in which methods of communication are missing women and how to overcome these gaps. What we propose is a context-dependent hybridization of traditional methods of communication, which are familiar to communities, and modern technologies, which can be expedient in sharing new scientific climate knowledge with farmers.

## **Keywords**

Climate change; information services; gender; ICTs; communication; development; social inequity; vulnerable groups; decision support

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## Acronyms

ICT            Information Communications Technologies

NGO           Non-governmental organization

## Introduction

"Sometimes we only hear a bit on radio about climate change and we do not really understand its causes and how to deal with it. That is why we are crying to relevant authorities to at least assist us with information on climate change so that we can use the same to empower ourselves,"

~ Ms. Tembo, a Zambian Farmer (Zulu and Sichikwenikwe 2011 p. 1)

This is all too common a story in rural communities throughout the developing world, where a rapidly changing environment is challenging the agricultural livelihoods that so many people depend upon. Farmers are adapting to these changing conditions in many different ways. Their ability to respond to severe climate events often depends upon the resources available to the farmer. These resources vary depending on geographic location, class, age and gender. It is thus imperative to understand the social context in which climate change is occurring, and the adaptive strategies which are being utilized by farmers throughout the world.

A central mechanism in the development of adaptive strategies to climate change is the strengthening and effective utilisation of information channels. Access to information resources can differ across various socio-economic factors. Particular types of information needs can also vary across socio-economic delineations. The more relevant and useful the information is to the user, the more easily the user may be able to adapt to changes in climate. Efficient dissemination of climate information can help farmers to evaluate risk at the household level, in order to make critical decisions about their crops. Despite this prescient need for accessing climate-related information, many of the people who are most vulnerable to climate change and environmental shocks are often on the periphery of information exchange.

In this paper, we show that women farmers are overwhelmingly left out of the communication channels critical to their ability to adapt to a rapidly changing climate. Thus, the purpose of this study is to identify instances in which methods of communication are missing women and how to overcome these gaps. What we propose is a context-dependent hybridisation of traditional methods of communication, which are familiar to communities, and modern

technologies, which can be expedient in sharing new scientific climate knowledge with farmers. First, we explore the literature on gender and climate change more broadly, focusing on the concept of vulnerability. We then offer contributions from three bodies of literature – social network analysis, adaptive capacity, and diffusion of innovations theory – to help us to build a framework for understanding gendered access and utilisation of climate information services through traditional and modern mediums. We look at these methods of communication through a gendered lens. Finally, through the use of case studies and a discussion of agricultural extension services, we conclude that the use of ‘hybrid’ communication methods is the most effective way of increasing women’s access and use of climate information services.



*"If we know when rainfall occurs, our seeds and effort will not be wasted," focus group discussion, Rehera village, Rupendehi, Nepal, 2013. Photo taken by Sarah McKune.*

## Social impacts of climate change

Climate change is currently considered the most immediate and far-reaching threat to the natural environment (Mearns and Norton 2010). Climate variations and changes present major challenges for communities. These challenges manifest themselves through flooding, droughts, and temperature changes that can impact crop production and management. These changes are compounded by and contribute to social, political and economic vulnerabilities of people and society (Ribot 2010). These vulnerabilities become more prevalent as long-term changes in ecosystems require additional resources to make necessary adaptive shifts in livelihood strategies.

Vulnerability is defined as an aggregate measure of human welfare that includes environmental, social, economic and political exposure to a range of potential volatility. Bohle et al. have written about the assessment of vulnerability through the concept of risk within poor communities. For the purposes of this climate change paper, we have identified three aspects of vulnerability as articulated by Bohle et al. First, the authors identify the level of “exposure” the community experiences to shocks and crises as greatly increasing their vulnerability (1994). In the context of climate change, we see that agricultural communities are overwhelmingly exposed to the risks of severe weather events (e.g., drought, flooding, typhoons) as their livelihoods greatly depend on more stable weather patterns.

Second, the authors evaluate the presence of coping mechanisms within the community to respond to shocks (Bohle et al. 1994). Again, in the context of climate change, poor rural farmers often do not have the economic resources to respond and adapt to a changing climate. Therefore, poor farmers are very vulnerable to climate change, as their livelihoods are at risk of exposure to shocks and they often do not have the resources to develop the coping mechanisms necessary to respond.

The third vulnerability is due to the risk associated with long-term recovery from shocks, which compound socio-economic hardships. For example, farmers who experience severe drought and are unable to adapt quickly and efficiently may experience income shortages which build over time. As a result, poor farmers are less prepared to respond to the next

environmental shock as each severe weather event leaves them exponentially more vulnerable (Bohle et al. 1994).

Vulnerability is always experienced locally, even though its causes and solutions may also occur at different social, geographic, and temporal scales. Structural and group characteristics such as gender, caste, race, ethnicity, and age are often closely related with vulnerability. According to Bohle et al. (1994), vulnerability permeates diverse sectors of society, particularly in developing nations. For example, rural smallholder agriculturalists are resource-poor and are particularly vulnerable to external shocks. Pastoralists use a range of ecosystems and are often sensitive to drought and pests. Without assets such as land, pastoralists are dependent upon their livestock. When extreme environmental shocks occur, pastoralists are highly vulnerable to food insecurity because of changes in the terms of trade between grain and meat at markets. Additionally, wage labourers often do not have agricultural livelihoods that they can depend upon for income resources and are, thus, susceptible to market and political failures. The urban poor are in similar circumstances to wage labourers, but they often can form a more visible vulnerable group with some power and access to the political economy. Finally, refugees, while often nearly destitute, acquire food through voluntary, national, or international assistance; ultimately, they remain dependent on the political economy for their subsistence (Bohle et al. 1994).

Among the most important impacts of climate change on the poor and vulnerable are greater variability in temperatures and precipitation over time and across space, and the impacts of this variability across asset types and households (Agrawal 2008; Agrawal 2010). Living with multiple risks, these groups have to manage the costs and benefits of overlapping natural, social, political, and economic hazards (Ribot 2010). Coping strategies may reduce household incomes before shocks arrive, and the shocks may then reinforce poverty by disrupting education, stunting the growth of economic development, destroying assets, forcing the sale of productive capital, and/or deepening the social differentiation among households. Poorer people experience greater obstacles accessing services, networks including kinship networks and economic networks, or land which makes them more susceptible to climate-related vulnerabilities and losses. People in areas that experience sudden-onset disasters have a range of coping strategies that are based on their available assets and social networks. In developing

countries, this is a clear indication that losses are likely to be shared among those in the community or group.

The World Bank has identified several strategies for overcoming the risks and vulnerabilities associated with climate change (Raleigh and Jordan 2010). They recommend communities work to diversify their livelihood strategies, so that when environmental shocks do occur, farming households will have alternate income generating activities upon which to rely. Also, they explain that social investments, that is, the use of social networks, can be an important resource in responding to climate crises. The authors explain that social networks can be a resource which allows for geographic mobility and alternative livelihoods for one or many household members. These “social investments” can provide pathways for household members to seek employment in urban centres, thus providing an income to substitute for loss in agricultural productivity in response to severe weather events. The use of these strategies allows for more economic and geographic flexibility for the farmer, which in turn builds their adaptive capacity to respond to climate change. Yet, this is not a one-size-fits-all formula for climate change adaptation; recommendations to address adaptive strategies at the macro-level should acknowledge the nuances of micro-dynamics within local communities and households. In order to assist communities in responding to local complexities of climate change needs, development agencies must understand that climate change affects different members of the community differently. Therefore, it is critical that special attention is given to socioeconomic impacts, particularly with regards to gender, and that they become central to understanding community vulnerabilities and adaptive capacities to climate change.

## Gendered impacts of climate change

Gender analysis is an important means of critically exploring the social impacts of climate change. Environmental shocks illuminate gendered social inequities within households, as women are often poorly positioned to adapt to these events and their consequences. Skinner writes, “In many ways climate change acts as a magnifying glass which exposes and risks exacerbating pre-existing gender inequalities in women’s access to and control of resources and decision-making power, making poor women in particular more vulnerable to its effects and preventing them from participating equally in its solutions” (2011 p. 8). A gender analysis of productive and reproductive activities in the context of climate change reveals a critical need for further research and development.

Throughout the world, women are heavily involved in various forms of agricultural production and caring for livestock. Recent international statistics demonstrate that women in developing countries make up, on average, 43% of the agricultural labour force (Food and Agriculture Organization 2011). While many women are engaged in agricultural livelihoods, they often participate in the informal sectors of the economy and their contributions are often invisible. Because women are overwhelmingly engaged in the informal sector, they are also more susceptible to shifts in employment due to environmental and financial shocks (Kakota, Nyariki et al. 2011). Dankleman and Jansen explain, “The conditions many women work and the access women have to employment and productive resources, can differ considerably from men’s, with lack of safety nets, inadequate remuneration, safe conditions and disrespect of fundamental human rights” (2010 p. 30). The combination of these factors can create difficult burdens for women to overcome in the wake of climate change.

Furthermore, social inequities regarding women’s control over assets further inhibits women’s ability to adapt in the midst of changing weather patterns. For example, women’s lack of land ownership in developing countries greatly limits their decision-making power within the household over crop production (Skinner 2011 p. 2). As a result, women are not as equipped to shift agricultural practices in order to adapt to climate changes. Skinner writes, “gender inequalities in the distribution of assets and opportunities mean their choices are severely constrained in the face of climate change” (2011 p. 2). In addition, women’s inability

to accumulate and control financial savings in many developing countries makes them especially vulnerable to the impacts of climate change in ways that men are not. For example, women often do not have the resources to invest in improved technologies in order to increase crop yields. The financial status of most agricultural women in developing countries gives them limited control over whether to adopt new technologies; instead male family members who have access and control over income and credit make these decisions. Therefore, women are often not in a position to make substantial investments in livelihood changes in the midst of environmental and financial shocks.

Women often bear the double burden of productive and reproductive activities, which are likely to be greatly impacted by climate changes. Among reproductive activities are domestic responsibilities such as tending to the home garden, cooking meals, caring for children, and cleaning. Women and girls are usually responsible for collecting water and firewood, which may require them to travel for long distances by foot (The World Bank 2009). As environmental conditions such as drought become more common, these resources become scarcer; women must travel farther in order to collect enough water and fuel for the household. Consequently, in fulfilling these duties, women may not have the time to engage in income-generating activities, to pursue classes to further their education, or to assume leadership roles in the community, all of which serve to reinforce gender inequalities within the household and community (Skinner 2011). These extra time burdens have further social implications for women and tend to exacerbate gender inequities within the household.

## Adaptation: Why information matters

Changes in climate have broad reaching impacts on all sectors of rural women's lives –from agricultural production to domestic responsibilities; the impacts are a reality that has become intertwined in their everyday activities. Despite being vulnerable to the impacts of changes in climate, women are not passive victims to climate change. In many ways, women are agents for change and adaptation within the household. Skinner argues that “climate adaptation policies too often treat women only as vulnerable beneficiaries rather than as rights-holding citizens who need to be recognized for the agency, skills and experience they can contribute” (2011 p. 3). A crucial factor in enhancing adaptive capacities of women is ensuring that they have access to the information they need in order to respond to the everyday manifestations of a changing climate (e.g. delayed onset of rains, predictions of drought, etc.).

In the midst of these changes, farmers have to adapt in new and innovative ways in order to sustain agricultural livelihoods. While these adaptations have happened in a variety of different ways across diverse geographic regions and agricultural livelihoods, this paper seeks to broadly explore these adaptation processes through the gendered lens of information sharing. Information can be dispersed through many different channels, whether through methods of traditional social networks and oral communication or through more modern methods of Information Communication Technologies (ICTs), defined here as the use of technologies that are dependent on electricity. Improving access to climate and weather information, through these various methods, can empower women to perceive risks to their agricultural production and to perform the necessary actions and adaptations to mitigate those risks. Yet as Archer demonstrates in her article on weather forecasting services, having the technological tools to disperse climate information does not necessarily translate into use by farmers (Archer 2003). Therefore, in recognizing that women are key agents in adaptation to climate change and are in need of timely climate information, it is essential that we explore and understand the most effective ways of reaching these women with appropriate and relevant climate information.

## **Information sharing: How do communities communicate?**

Before discussing methods of information sharing, it is first critical to understand theories of information sharing and innovation. We explore contributions from three diverse fields of inquiry to inform our understanding of information sharing: social network analysis, diffusion of innovations theory, and concepts related to adaptive capacity. Blending key ideas from these literatures provides insight into how women, in the face of social and economic constraints, receive and communicate climate information. Social networks provide the avenues by which information and innovation are diffused. In this diffusion, local norms and practices alter the way new communication innovations are used. As women tailor the uses of these new communication technologies to local needs, they demonstrate their own adaptive capacity to respond to climate change and, thus, manage risk.

### **Social network theory**

When conducting an analysis of stakeholder groups, the role that communication networks play in categorizing and understanding stakeholder relationships is often overlooked. For instance, stakeholders tend to be identified and characterized through a subjective assessment of their relative power, influence within the community, and legitimacy. Categorization schemes vary widely and include classifications such as primary and secondary, actors and those acted upon, strategic and moral. Such classifications are made from the perspective of the researcher or organization and may not necessarily be a strong reflection of community members and their perspectives. Because little attention is paid to the unique knowledge, interests, and characteristics of stakeholders, many initiatives fail. One solution to this problem is the utilization of social network analysis (Prell et al. 2008).

A social network is a structure made up of a set of actors who are tied to one another through “socially meaningful relations” (Prell et al. 2008). Social networks are an important source of knowledge for both individuals and groups, as knowledge is seen as embedded in social ties, not just formal channels. Through these social ties, individuals and groups can learn about innovations, opinions, perspectives and new tasks; this social conduit for communication can

then reinforce or question previously held ideas within households and communities (Prell et al. 2008).

These relations can be analysed for structural patterns that materialize among the actors. Analysts look at the relations among actors, how actors are positioned within the network, and how these relations are structured into overall network patterns. In some cases, actors who share a strong tie tend to influence one another more than those sharing weaker ties. Through the building of strong social capital, based on trust and reciprocity, communities develop a support system of social networks which can enhance their adaptive capacity to respond to environmental shocks. While these strong social networks can work to solidify trust and reciprocity within the community, they can sometimes become insular and segregated from external networks. Other studies have also shown, in contrast, that weak ties, often characterized by less frequent communication, allow for diverse information and the generation of new ideas. Thus diverse external ties can make networks more resilient and adaptive to environmental change but these ties also tend to be fragile (Bodin and Crona 2009; Prell et al. 2009).

Social networks are also important resources when evaluating risk and vulnerability within communities. Morgan's discussion of shared knowledge structures describes how social networks serve not only to disperse information, but also to shape the way individuals process and understand that information in a particular context (1986). Thus, social networks provide a framework with which to organize and assess knowledge of social situations and vulnerabilities. Gourash's (1978) survey of "help-seeking" literature reveals that individuals turn to social networks such as family members or neighbours before seeking professional advice in times of hardship. Furthermore, when individuals do seek professional help, they often rely on social networks to advise them about which professionals to consult (Gourash 1978). In the context of crises such as the environmental shocks caused by climate change, social networks can be an important resource in evaluating community vulnerability, as well as in developing adaptive strategies.

## **Diffusion of innovations**

Rogers defines diffusion as "the process by which an innovation is communicated through certain channels over a period of time among the members of a social system" (1987). He understands diffusion to be a form of communication; specifically, it is a "two-way process of

convergence” between people (Rogers 1987 p. 79). For Rogers, adoption of new innovations is based on five factors which include the perceived usefulness and ease of use for the innovation. Furthermore, adoption depends on “trialability,” the space in which an individual has the ability to become comfortable with the innovation through experimentation (Rogers 1987 p. 79). The innovation must be compatible with the values, experiences, and practices of the community. Finally, adoption is dependent upon whether others in the community are also able to observe the benefits of the innovation (Rogers 1987 p. 81-82). In each of these factors, communication operationalizes the diffusion of new technologies.

While there may be obstacles barring access to innovations (as described in more detail below), many scholars have attempted to theorize the development and usage of new technologies, investigating where they are successfully introduced into local settings. Others have written about the diffusion of innovations, analysing how usage of new innovations gains traction in communities. An important factor in the diffusion of innovations is what Ilie et al. calls the concept of ‘critical mass,’ a threshold at which adopters become numerous enough to produce a norm which influences non-users to adopt the innovation (2005). In agreement with Roger’s five factors of diffusion mentioned above, community acceptance and adoption of innovation is critical to the diffusion process. The more members of the community observe the benefits of a particular innovation, the more likely that innovation will be diffused and adopted.

Taking diffusion of innovations theory a step further, Rice and Rogers (1980) write about the reinvention process, which takes place as communities adopt new innovations. They describe a five step adoption process for new innovations. In that process, the steps include: 1) agenda setting, 2) matching, 3) redefining, 4) structuring, and 5) interconnecting (Rice and Rogers 1980 p. 500). It is in steps two and three, matching and redefining, that we see a relevance to climate change communication adaptation through innovations. Through these processes of reinvention, innovations are tailored and gain traction in the local community. Rogers and Rice explain that “matching the different abilities, resources, needs, and pressures of a particular system may necessitate adaptation of the innovation. An adoption which seeks to solve a local problem results from information searches which match a possible technological solution to the local situation, and often immediately entails reinventions” (Rice and Rogers 1980). What we will propose at the end of this paper is that such reinventions are a critical

step in community adaptation to climate change and serve to mediate between diverse methods of information sharing.

## **Adaptive Capacity**

Other scholars have developed the theory of diffusion of innovations further through the theoretical framework of adaptive capacity. In many ways, the process of context specific reinvention which occurs at the local level in Rice and Rogers' theory of diffusion of innovation is a critical component of adaptive capacity. Brooks and Adger define adaptive capacity as,

the property of a system to adjust its characteristics or [sic] behaviour, in order to expand its coping range under existing climate variability, or future climate conditions. In practical terms, adaptive capacity is the ability to design and implement effective adaptation strategies, or to react to evolving hazards and stresses so as to reduce the likelihood of the occurrence and/or the magnitude of harmful outcomes resulting from climate-related hazards. The adaptation process requires the capacity to learn from previous experiences to cope with current climate, and to apply these lessons to cope with future climate, including surprises (2004).

Thus, adaptive capacity speaks to the ability of the individual or community to utilize resources in a way that makes the diffusion and reinvention of innovations possible. Other scholars write about adaptive capacity as a function of social learning in response to climate change (Pelling et al. 2008; Collins and Ison 2009). These authors highlight the role of institutions in facilitating social learning processes and the ability of vulnerable communities to adapt.

Elements of social learning are deeply context specific and thus, variable. Ilie et al. demonstrate that there are significant gender differences in how communication innovations are used, adopted, and reinvented. They argue that two major factors increase the likelihood of adoption and usage of new information or communication technologies: the perceived ease and perceived benefits of the new technology (2005 p. 15). They write that the decision to adopt a new technology often is based on a "perceived compatibility" with the users "values, beliefs, and experiences" (Ilie et al. 2005 p. 15). It is here that research on the diffusion of

innovations and adaptive capacity is most conducive to gender analysis. Not only do values, beliefs, and experiences differ across communities, they also differ within communities through gendered life experiences and livelihoods. Women's values, beliefs and experiences are inevitably different than men's because their livelihood strategies are different from men's livelihood strategies. In the context of climate change, it is important to recognize that women have different responsibilities than men and, thus, different uses for communication technologies. Furthermore, women often have lower levels of education than men, indicating that their use of new communication technologies may differ from men.

Social network analysis, diffusion of innovation, and adaptive capacity are theories that help explain how communities access and utilize information. When considered together, they begin to provide a framework for conceptualizing and a discourse for describing the gendered differences in access and utilization of climate information. As described in the example below, information is often shared through social networks specific to men and women. These channels are adapted to local contexts and have the potential to provide women with greater access to climate information services.

## **Communication methods**

This section will survey common methods for communicating information. Recognizing that they are arbitrary divisions, we first describe traditional and modern methods of communication, defining modern as those forms of communication that require electricity. Following this discussion, community information services and extension services are explored as methods of communication that hold potential for understanding and improving climate information services, particularly for women. We then analyse the gender gaps that are inherent to these communication techniques and finally, conclude with an argument for addressing the gender gaps through hybridization, or tailoring process, which acknowledges the strengths and weaknesses of the aforementioned communication methods. The tailoring of communication methods is strongly based on the framework and discourse provided in the three theoretical approaches discussed above.

### **Traditional methods**

Communication is an essential part of any society and how it functions. While we recognize that the spectrum of possible methods is not easily dichotomized, for our purposes, traditional methods of communication refer to any communication that does not require electricity. Most traditional methods of communication rely on oral transmission and may take many forms (drumming, singing, dramas, etc.), some of which are explored here. These traditional methods are used to communicate information to groups in such a way that anyone can understand, and they are particularly important in passing knowledge and experience across generations.

#### **Oral communication**

The simplest form of communication is through oral conversation (i.e., word of mouth). People exchange information by discussing topics of interest to friends, colleagues, and neighbours. In a formal setting, people will exchange information via seminars, conferences and workshops. Informally, people will exchange information while working on other tasks in small groups and/or at other types of gatherings. The advantage to oral communication is that people have the opportunity to discuss the issues as an iterative dialogue and receive

feedback. Having these conversations allows individuals to adjust their perspective on a topic. However, the inefficiency of oral communication in transferring information across large groups of people may be a significant disadvantage.

When considering information transfer, particularly in Africa, oral communication is still a powerful tool, and women are particularly comfortable with its use. This delivery method of information still predominates among rural populations (Claasen-Veldsman and Snyman 2005). There are other reasons to consider oral communication: many communities are accustomed to acquiring information through listening, there is a historical significance placed on orally transmitted information, and it allows illiterate populations equal access to information even though such information might be filtered by elites, elders, or others in positions of power (Thakadu 2010).

Folk media is the dissemination of oral information in a creative form through cultural and performance art such as drama, poetry, storytelling, riddles, puppetry, mime, song, and dance. Historically, this is the preferred method people use to communicate ideas to a wide audience as it constitutes a culturally embedded communication system that has existed before modern technology and mass media (Mushengyezi 2003; Hoivik and Luger 2009). Further, folk media tends to use local idioms, proverbs and beliefs which enable greater understanding of the topic at hand. According to Andries, “skills and attitudes [can] be introduced within a framework of existing knowledge, cultural patterns, institutions, values and human resources” that enable an audience to actively participate and understand the information being shared (2008 p. 56).

Recent research on communicating development messages has focused on the advantages of using traditional media, including being part of the rural social environment and being considered a credible source by locals. Traditional media allows for two-way communication and can generate grassroots participation and dialogue between performers and the audience. In 2009, the Food, Agriculture and Natural Resources Policy Analysis Network worked with women farmers to strengthen their capacity to influence agricultural policy through the Women Accessing Realigned Markets program. The Theater for Policy Advocacy was used as the medium of communication in order to explain agricultural policy to female farmer participants in Malawi and Mozambique. These women were trained in effectively communicating their needs, sharing their own stories, and mobilizing their communities to work toward solutions. Theatre groups were formed in five districts: three in Malawi and two

in Mozambique, comprised of both men and women. While the groups' messages were first and foremost aimed toward their communities, other interest groups also participated including government officials (e.g. officers from the Ministry of Agriculture and Food Security, district representatives, parliament members), farmers' association representatives, and NGOs. These performances have essentially improved linkages between development practitioners, government officials, farmers, and researchers by establishing appropriate avenues for stakeholder feedback (Sibanda and Mwamakamba 2012). Traditional media also has the advantage of reaching a broad-spectrum audience, even in the most remote areas, because it does not rely on expensive infrastructure that modern technologies often require (Hoivik and Luger 2009).

### **Strategic community members and groups**

Within communities, there are certain people and groups who have legitimacy with and trust of others. These individuals or groups may already transmit/share information into and across a community, but they may also serve as untapped resources for dissemination of information, including climate information services.

One such example is traditional leaders. Traditional leadership is firmly embedded into many cultures across the world. Historically, traditional leaders serve as governors of their communities and have the authority over all aspects of community life – ranging from social welfare to judicial functions. Having local buy-in from traditional leaders regarding different forms of climate information exchange can increase the credibility of the methods used to disseminate the information, as well as the content of those messages.

The griots of West Africa are historians, storytellers, praise singers, and musicians. Historically, these storytellers accompanied royals and were considered inseparable from them. Also, most villages had their own griot who was responsible for sharing the stories of the village and its history, including births, deaths, battles, and hunts. Griots retain their important roles in West Africa today. Their role in society essentially is to explain all things historical and can even touch on the political (Hale 1994).

Village criers, community gossips, or local chatterboxes - various names for individuals who are locally recognized as key sources of information - are ubiquitous in rural communities around the world. These individuals are essentially the broadcasters of information within the

community and may be used to transmit urgent or essential information from leaders to community members. These community members can be important in communicating daily weather reports, mobilizing community members when information about an upcoming event is shared, or bringing critical information about new crops to other members of the community.

Cooperatives are groups of people who voluntarily work together for their mutual social, economic, and/or cultural benefit. Cooperatives are another way to disseminate information though what kind of information and how it is distributed may depend on whether it is an all-male, all-female, or mixed-gender cooperative and the purpose(s) for which the cooperative was established. Studies suggest that in mixed-gender cooperatives, women were frequently excluded from accessing agricultural information (Doss 2001). Even if women form the majority of members in an organization, the leadership is often dominated by men (Gawaya 2008). Because women may be less likely to participate, possibly due to illiteracy, limited education, or various other constraints, dispersing information to and through cooperatives may be less effective since women may not be able to express their needs, be able to participate, or be able to use the information.

In addition to traditional leaders and other individuals mentioned above, identifying and utilizing key informants and groups that hold legitimacy within a community also may improve the dispersal of relevant climate information. It is important to understand the social networks of these individuals and groups in order to determine if and how information can most effectively flow within a community. Furthermore, these social networks can tell us how information is best diffused within the contexts of local communities and give us insight into how innovations are adapted to the needs of the people within those networks.

### **Modern communication methods: Information communication technologies**

In recent years there has been an increased interest in using Information Communication Technologies (ICTs) as an efficient means of sharing information to agricultural communities. Again, we conceptualize ‘modern’ to mean those methods which require electrical power, whether through batteries, electrical wires, or radio waves. ICTs can include use of radios, televisions, computers, mobile phones, and other media sharing devices. For the purposes of this paper, we will discuss the use of computers, mobile phones, and radios. Information can

be shared through texts, voice, video, numbers and diagrams, or images. Technologies such as cell phones and computers are becoming rapidly available in many rural areas, providing mechanisms of information sharing and new opportunities for agricultural extension and development workers to reach large numbers of people. With heightened access to communication resources, it is understandable that development programs look to incorporate these tools into agricultural extension. Yet, focusing primarily on ICTs has often had an adverse effect, excluding those farmers who do not have access to these new technologies or are unable to use them, thus exacerbating existing inequities. Just as traditional methods of information sharing are gendered, there are also gender factors to consider when analysing usage of ICTs. While information sharing through mobile phones, for example, may be a great way to reach men, it is not the most efficient way of reaching women farmers in all contexts. Below, we discuss the roles of ICTs by order of their prevalence in developing countries.

### **Computers**

One technology which has been much less pervasive in developing countries, particularly in rural areas, is the personal computer. In 2001, there were six personal computers for every 1,000 people in India, as compared with the United States which had six personal computers for every 10 people (Chin and Fairlie 2007). There has been great variation across sub-Saharan Africa with regards to adoption of computer based ICTs (Oyelaran-Oyeyinka and Adeya 2004). Affordability plays a significant role in the accessibility of such devices. New technology, including low cost computers and smartphones which provide internet access, is changing affordability of personal computers and internet access. However, for rural areas of developing countries where much of the population is earning less than \$1 per day, for the moment, personal computers simply cost too much.

Internet cafes have become an avenue by which some are able to access and utilize computers (Oyelaran-Oyeyinka and Adeya 2004; Wahid et al. 2006), but these are primarily located in urban areas (Wahid et al. 2006). In Indonesia, about two thirds of the internet users access through public terminals such as internet cafes. In India, that percentage is as high as 67%, and in Peru internet cafes are the primary access point for 75% of internet users (Wahid et al. 2006). Poor infrastructure, including connectivity, affects the prevalence of internet cafes throughout developing countries, particularly in Africa but also in Asian countries such as

Indonesia (Mutula 2003; Wahid et al. 2006). This results in a concentration of Internet cafes in urban centres. While this is a rapidly developing technology it is not as pervasive as radio and mobile phone use in rural communities.

### **Mobile phones**

A recent strategy for development programs has been to target delivery of information to communities through the use of mobile phones, and with good reason. As noted above, most people do not have a home computer. Access to mobile phones and cellular service has rapidly expanded throughout the developing world at an accelerating pace throughout the past decade, providing a new entry point into communities and a new avenue for dissemination of information. The number of mobile phones per 100 persons in Asia, Africa, and Latin America has increased between 100 and 400 per cent between the years 2000 and 2005 (Rashid and Elder 2009 p. 1). Rashid and Elder report that nearly one out of every five Africans now owns a phone (2009 p. 1). Aker and Mbiti report that cellular phone service in Kenya tripled in size between 2006 and 2009 with over 17 million people now connected to the cellular network (2010). Furthermore, the number of mobile phone owners within Kenya increased by 74% in this same period, with 47% of the population owners (Aker and Mbiti 2010 p. 212). In many ways, this recent boom in mobile phone usage has been due to the overall rapid growth of the industry, which recognized the need for telephone communication in rural areas of developing countries and a new opportunity to expand wireless networks. Where obstacles of infrastructure and geography have prevented expansive landline phone networks from reaching rural areas, cellular towers have provided a wireless opportunity to reach customers in rural communities (Rashid and Elder 2009 p. 3). With this new network, the rural villages and urban centres are connected in new ways that have provided new opportunities for development.

In recent years, mobile phones have been used to inform communities about public health (e.g. HIV/AIDS awareness and treatment campaigns in South Africa (Leach-Lemons 2009) as well as agricultural education and extension (e.g. Help Line program in Bangladesh (Raihan 2005)). A study of the Grameen Bank mobile phone program in Bangladesh conducted by Bayes (2001) reveals the benefit of mobile phone usage is overwhelmingly felt by the poor. He writes, "The lion's share of the phone calls made by the poor group deal with economic and health considerations" (2001 p. 256). His report demonstrates that poor farmers use

mobile phones for market information, which is often centred in urban areas. Instead of having to incur costs for travel (time, income, and production) in order to share and receive business information, mobile phones provide an efficient channel for information sharing.

Due to these recent technological developments, mobile phones seem to be at the forefront of development outreach strategies. Thus, it is important to acknowledge the potential opportunities they bring to climate change awareness and adaptive management. Internet service through mobile phones is changing the context of communication for rural farmers, extension officers, and development practitioners to reach out to rural farmers. Additionally, agricultural content such as weather updates, market prices, and video training have been made more accessible to those farmers who have access to mobile phones. Their growing accessibility in rural areas makes this an appealing tool to utilize as development practitioners. However, socioeconomic barriers to accessing this tool, particularly gendered socioeconomic barriers, should be considered and will be addressed below.

## **Radio**

Another medium of information transmission has been through radio. In many ways, this has been the most common source of communication in sub-Saharan Africa for decades. Myers notes that, while many development workers have been attracted by the potential of high-tech gadgets such as mobile phones, access and usage of these resources are limited in many rural communities, particularly among women. Myers's study finds that only 12% of internet users are women in Senegal; in South Africa, only 19% of women use the Internet (Myers 2009). Myers attributes this usage to mainly a small population of educated urban elite women, not the communities of rural agricultural women greatly in need of climate change information. She explains, "It can be exciting to contemplate the possibilities for interactivity, information provision and advocacy offered by the Internet, e-mail and mobile communications. But let it not be forgotten that radio access far outstrips computer and mobile phone access throughout the population of sub-Saharan Africa" (Myers 2009 p. 14). Cherotich et al. find in their study that Kenyan women (68.5%) overwhelmingly prefer to use radios to receive climate information (2012). It is for this reason, as we will describe below, that radio has been at the centre of development programs for information sharing with regards to climate change. Because this medium of communication is so prevalent within rural households, it can be a

means of transmitting information to women and engaging them in a climate change dialogue with other women and rural farmers.

## **Community information services**

Community information is “survival information, the kind of information necessary for participation as a full and equal member of society” (Martin 1984 p. 385). Community information services, most often provided by community libraries established in rural communities, are

...services which assist individuals and groups with daily problem-solving and with participation in the democratic process. The service concentrates on the needs of those who do not have ready access to other sources of assistance and on the most important problems that people have to face...(Library Association 1980 p. 1)

This information often targets underrepresented populations within culturally and ethnically diverse groups on livelihood topics such as health, education, or the environment, while also preserving and promoting cultural and ethnic heritage. Community information services can offer marginalized communities information that assists local needs and empower communities (Becvar and Srinivasan 2009).

Still, there are constraints to utilizing community information services. This is especially true in developing nations where indigenous communities and development practitioners have established hierarchies that dictate the “appropriate” ways that information is accessed and disseminated (Becvar and Srinivasan 2009). Over the last decade, much research has been conducted on participation, highlighting that participatory approaches may often conceal social and political differences and may not always be explicitly beneficial to the majority of farmers. Participatory approaches and stakeholder consultations do not resolve larger imbalances in access to and control of information (Roncoli et al. 2011). In terms of using information services toward climate change, Roncoli et al. discuss the multiple challenges and uncertainties farmers face. They suggest that the utilization of climate information is hindered by barriers including the degree to which forecast parameters correspond to “farmers’ information needs, the extent to which alternative management options and resources are

available to farmers, and the process where forecasts are translated into messages directed and delivered to farmers” (Roncoli et al. 2011 p. 124).

Often within local communities, information is held and transmitted through hierarchal structures (Alemna 1993; Becvar and Srinivasan 2009). This means that those who hold the knowledge have power over the content and the recipients. Kempton suggests these power relations create dissatisfaction among community members with their traditional information sources and thus are compelled to find other means of obtaining the information they seek (Kempton 1986). Community information services provide a participatory forum that is community-driven, enhancing traditional methods of communication with other supplementary methods provided by libraries or other facilities.

Kempton suggests that community information services should be a two-way channel for sharing information; local communities should also be able to provide proper feedback on how policies and programs that affect the community work (1986). Climate information services may be able to learn from this concept. Information providers often assume that if information is disseminated to the community, the community will know how to use it accordingly. This is further exacerbated if the information is not comprehensible at the level in which it is intended – meaning that information should be delivered in local languages of targeted communities and even disseminated in multiple ways to cover ranges of literacy in the community (e.g., written, pictures, etc.). However, without proper feedback to the agencies providing climate information, the agency may not understand how to accommodate or tailor the information to make it locally useful. In addition, without feedback from the community, agencies may not understand how the climate information affects (or not) women differently from men.

Community information services describe the need to interact with communities in more engaging and participatory ways. It also highlights that there are nuances which must be identified in order to be more effective in communication. This is where social network theory, among other theories, can be beneficial. Understanding how individuals within communities communicate will enable climate information and advisory services to reach the appropriate people more effectively.

## Extension

Extension agents are often responsible for disseminating information to farmers in rural and remote areas. Davis defines agricultural extension services as, “the entire set of organizations that support and facilitate people engaged in agricultural production to solve problems and to obtain information, skills, and technologies to improve [the] livelihood and well-being” of farmers (2008 p. 16). There are approximately 500,000 agricultural extension personnel worldwide as of 2005, with the majority working in public agricultural extension systems (Aker 2011). Extension was originally designed as a service to extend research-based knowledge to the rural sector in order to improve the lives of farmers including “components of technology transfer, broader rural development goals, management skills, and non-farm education” (Davis 2008 p. 16). Today, extension is expected to go further to include assisting the formation of farmer groups, engaging the market, and partnering with a broad range of service providers (Davis 2008).

As often as they are used, however, they are also criticized for not being effective since extension services work best when farmers have access to information that is appropriate for the farmer’s issues (Vogel and O'Brien 2006). Research indicates that women farmers are not currently being reached by extension services, underscoring the need for female extension agents. A study in Tanzania documents that by having more women village extension officers, more women were reached as targeted beneficiaries of the extension efforts (Doss 2001). The research also found that female farmers preferred the female extension officers (and men do not object them) because they were perceived as providing better information. The study goes on to suggest that male extension officers became more effective at reaching female farmers when working with female extension officers. In addition to the gender of community members, income levels may influence the effectiveness of extension work since studies have noted that extension services are less likely to reach poor farmers because they often have less land, have inadequate labour and capital and do not use inputs. Thus, the ineffectiveness of the extension efforts may be exacerbated by the overlapping impact of poverty and gender, as women are overrepresented among the severely poor (Doss 2001). Unfortunately, the literature on the role of extension in helping women make decisions, and the possible asymmetries that exist as barriers to their accessing information is rather limited (Eicher 2007).

In order to adopt new agricultural practices successfully, farmers require different types of information during each stage of the agricultural production process. These information needs include, but are not limited to, weather forecasts, pest attacks, input management, cultivation practices, pest and disease management and prices (Aker 2011). Farmers obtain this information from a number of sources including extension, their own trial and error and from members within their social networks. It is important to note that access to information through extension is rarely equally distributed in developing countries, partly because of the high cost of obtaining information via traditional methods (e.g. costs associated with travel, radio and print materials). Therefore, information asymmetries are an important barrier to agricultural technology adoption (Aker 2011). Similarly, while extension services can help to bridge traditional and modern methods of communicating information, information asymmetries can still present barriers to information if not carefully addressed at the community level.

## **Analysing the gaps: Where communication falls short**

### **Gender gaps of traditional methods and modern methods**

Traditional methods of communication have been important for development in local communities. These communities share local knowledge among familiar networks in a language and format that is familiar and accessible. Additionally, these types of communication are particularly favourable to women who often rely on traditional methods and networks to receive agricultural information. Despite the fact that these networks are essential for local communication, they can be limited in their reach. In the context of changes in climate, the need for rapid communication of information to a widely dispersed rural population often cannot be satisfied by traditional methods alone. Further, women seem to favour receiving information by, and from, other women because they relate better, may have a common language, and understand their needs. Getting information to women by women can be difficult when women are not in leadership positions to diffuse information. And although there may be a preference for women-to-women information sharing, evidence exists to indicate that men can transmit information to women if they understand the issues and constraints (see extension example above). Equitable access to and utilization of ICTs can also be greatly compounded by factors such as age which can limit one's knowledge- and resources to effectively gain the necessary knowledge to use these tools (Cherotich et al. 2012). There may be gendered implications to this as well, as elderly men may be more exposed to environments where ICTs are being used, for example, public social spaces such as cafes or markets. Elderly women may not be as likely to engage in these social spaces and may thus be less likely to encounter newer methods of climate information transmission. Cherotich et al. find that 83% of elderly women prefer to use informal networks and more traditional methods of communication in order to access climate information (2012). Thus, age in conjunction with gender can further illuminate social inequities in the access and use of climate information services.

ICTs can be a useful medium for sharing climate information, and with women constituting between 60-80% (depending on the country) of the agricultural workforce in developing countries, it is critical that development programs and extension projects target them as integral partners for adaptive change. Despite the potential of new technologies,

socioeconomic conditions of women may greatly limit their access to tools of adaptation. “In general, women in low income countries are 21% less likely than men to own a mobile phone. South Asia has the widest gender gap in mobile phone ownership, a record 37%.” (Wong 2012). Some authors argue that the prominence of ICT’s as a development tool can have the effect of further disempowering the poor. Megwa writes, “As new ICTs have become inevitable and indispensable and their effects and impact on society have become inescapable, it appears that poor and rural communities have less access to these technologies and their products” (2007 p. 50). This is because socio-economic conditions can often present barriers to accessing new technologies for different subsets of the population. Olatokun writes, that the “range of variables affecting access and use of Internet and other ICTs include sex, socioeconomic level, ethno-cultural group, rural/urban location; level of education, and age” (2007 p. 28). In an attempt to break down these statistics and understand gender in determining the ultimate use of climate information and advisory services, the next section explores factors that inhibit or enhance access to and utilization of ICTs.

### **Dimensions of access and utilisation of ICTs**

There are many barriers to access, all of which influence individual users uniquely depending on their own life context. In many ways, barriers to access are related to gendered control over assets within the household. Financial barriers are one example of how control over income can inhibit women’s access to ICTs. As men usually are primary (or exclusively) the income providers for the household, they control how that income is used. Oyelaran-Oyeyinka and Adeva argue that low income sectors of society are less likely to access ICTs such as the internet. They write, “knowledge acquisition will, for this reason be constrained by low income and low levels of education due to unequal access and more so because of unequal utilization of technology” (2004 p. 68). This socioeconomic disparity places women at a disadvantage when it comes to ICT access and usage. Women often face financial obstacles to acquiring new technologies such as computers and mobile phones. This is largely due to the fact that, in developing countries, women often have little control over income and assets; they therefore are less empowered to spend household income on communication technologies that they determine useful for them (Wong 2012). Ultimately, women must depend on their husbands to purchase ICTs such as radios or mobile phones. Because men are often responsible for purchasing this equipment, they also often control who gets to use the

technology, as well as when and how it is used. While climate information may be entering the household, it does not always mean that women are included in the sharing of this information. Roncoli et. al. (2009) find in their study from Burkina Faso that, in communities where climate information was made available to household members, this did not necessarily ensure that women in the household would receive this information (Roncoli, Jost et al. 2009). Their findings show that more concerted efforts must be made to ensure that women are receiving, understanding, and utilizing climate information in order to adapt to climate change impacts.

Other barriers to access are based on demographics, as women are more likely to live in rural areas and less likely to live in areas that have infrastructure such as telephone lines and internet service (Gurumurthy 2004). Furthermore, because women tend to live in rural villages, many travel great distances to access internet cafes or libraries for such resources. This requires spare time for travel, a luxury that agricultural women in many developing countries do not have. Thus, traveling to Internet and computer centres can place a high demand on women's resources as they must either pay for transportation, or walk several miles to access these resources. Cultural factors can further compound these access barriers for women, as social norms may prohibit women from using such technologies in public spaces. Internet cafes can often be a place of socialization for men, which may intentionally or unintentionally create gendered social norms about who can use the space and technology; it often becomes a space for men that exclude women. Other cultural norms may require women to be accompanied by a male family member in order to travel to internet cafes. These restrictions, again, make women dependent upon men in order to access and use ICTs in public settings (Huyer and Sikoska 2003).

It is not only the barriers to access, however, that should be attended to with a gendered lens. Development practitioners tend to pay more attention to the physical barriers, like those mentioned above. Some scholars have recognized that this narrow focus on physical access has prevented development practitioners from reaching women. Megwa writes,

This situation is compounded by the narrow definition of and policy response to the concept of 'access', which is often seen only as a physical phenomenon- being able to use a computer. This orientation disregards other definitions of access that entail intellectual access...This systematically

contributes to the widening of the digital divide by excluding those who have the most to gain through ICT expansion-rural and poor communities (2007).

As Megwa argues, this approach misses an important gender gap in access to ICT resources. As noted in the box below, women experience many obstacles to utilization of ICTs. These include educational barriers such as illiteracy and innumeracy. In developing countries, women tend to have lower literacy rates than men; constituting fully two-thirds of the world's illiterate population (Huyer and Sikoska 2003). Furthermore, people with higher levels of education have more access to information about new technologies, and thus are able to adopt these adaptations more readily. This is an important factor in determining the accessibility of ICT's. While women may be able to access a mobile phone physically, it may be difficult for them to understand text messages sent to them regarding climate information if they are unable to read. As women are overwhelmingly less educated than men in developing countries, women tend to have less knowledge of emerging technologies and thus less likely to incorporate them into their adaptive livelihood strategies in the context of climate change. As discussed above, issues of time and location also become obstacles for utilization, as time to travel and attend classes for ICT use are often inconvenient for women (Gurumurthy 2004). Additionally, women are more likely to speak and read local dialects than national languages, thus are unable to read much of the printed or electronically transmitted material. Much of the information transmitted on websites (BRIDGE estimates 70% of all internet content) is in English (Gurumurthy 2004). This works to disempower many non-English speaking users of ICT's, and it more heavily disempowers women (Mutula 2003; Gurumurthy 2004).

Even when content is translated into local languages, it is important to recognize that the content should be relevant to women's experiences, interests, and livelihoods. Developing a language that relates scientific terminology of climate change to the actual agricultural experiences of women, allows a space for women farmers to cognitively process and make relevant this information in the context of their own lives. If the goal of practitioners is to make the accessibility of information socially equitable, then it is critical to produce information that is relevant to the needs of both men and women. Gurumurthy writes, "priority needs to be given to content that is developed by women and reflects their knowledge and perspectives, and which helps them with their immediate survival needs, aspirations, their well-being, and that of their families" (2004 p. 43). Consequently, there is a

responsibility for scientists to produce information that reflects the contextualized needs of farmers.

As ICTs have become the dominant method of communication between scientists, extension agents, and farmers for climate change information, it is crucial to understand where these methods fall short. It is critical that the barriers outlined above are acknowledged when overcoming the gender gap in women's access and utilization of ICTs. It is not just important to overcome obstacles to physical access, it is also critical that information is relevant to women, and that they are able to receive, process, and then utilize the information. When development practitioners fail to recognize these different gender barriers, women are often excluded from the communication circuit. When scientists present information through the use of ICTs without recognizing these barriers, women – who make up such a substantial amount of the agricultural labour force – miss critical information which would help to develop adaptive strategies for climate change.

## **Bridging the gaps: Hybridization of information sharing strategies and practices**

The success of developing and implementing effective adaptive strategies to climate change is clearly linked to how effectively modern technologies are tailored to a specific context.

Archer explains that climate information services should be “end-user focused”, accounting for the social nuances present in various communities, and then constructing outreach based on those local resources and needs (Archer 2003 p. 1526). As new climate patterns affect agricultural production, gender constraints become crucial in determining the vulnerability of populations and their ability to develop adaptive strategies. Effective communication through modern technologies and traditional methods are instrumental in this adaptation process.

Harvey et al. note, “This is a challenge for communicating climate change research for adaptation which...depends both on harnessing indigenous knowledge held in communities and facilitating spaces for dialogue and knowledge co-creation” (2012 p. 33). It is therefore critical that development practitioners understand where each of these methods benefits communities and where they fall short. We have tried to do this in the gender analysis above, identifying the obstacles many women face in their attempts to access information. In many ways, traditional methods make up for where new ICT innovations are lacking in gender awareness. Traditional methods utilize strong social networks that have a historical continuity within the community. Traditional methods of communication also provide a familiar means of communication, particularly among elderly community members. Roncoli et al. (2009) find that in Burkina Faso, 65.2% of their respondents receive climate forecast information through conversations with people in their community. Additionally, 50.6% of the respondents received climate forecast information from local community meetings, where training participants from an extension program shared their knowledge with other community members (Roncoli et al. 2009). But what these traditional methods cannot do, in this time of rapid change in climate, is reach large networks of people quickly and efficiently. Thus it is through the hybridization of both traditional and modern methods of communication, tailored to the particularities of a given context, that effective adaptation and management of risks associated with climate change can occur.

Hybridization allows social networks, so instrumental in traditional flows of information, to become effective tools in the reinvention process of diffusion of innovations. Theories of information sharing become woven together in a way that produces effective micro- and macro- level communication systems that can be particularly sensitive to gender disparities. Rice and Rogers discussion of reinvention processes within diffusion of innovations is highly dependent upon the inclusion of local conditions (1980). Social network theory helps us to understand the way in which these new ICT innovations and climate information become diffused through traditional networks (Ahmed and Fajber 2009). In recognizing which mediums of information sharing are comfortable for women, practitioners can work with communities to tailor functional uses of new technologies to their particular livelihoods, thus increasing relevance, accessibility, and utilization in rural agricultural communities.

One way that this bridge between traditional and modern methods of communication can be introduced is through agricultural advisory services. When extension agents use ICT's in conjunction with local networks, knowledge can be shared efficiently and comprehensively. One such example is underway in western Kenya to train volunteer farmer trainers. Spearheaded by the Kenya Forestry Research Institute, Kenya Agricultural Research Institute and the World Agroforestry Centre, volunteer farmers receive free training, seeds, and seedlings to set up demonstration plots in their communities. The goal is to utilize these farmer trainers' social networks to disseminate new technologies, knowledge, and experiences. These trainings include at least one third female trainers and at least two thirds of the trainees were female. Upon evaluating the program, farmer trainers were found to be instrumental in mobilizing and training fellow farmers, hosting demonstration plots, and bulking and distributing planting materials though they were not as effective in follow-ups and seed bulking (Lukuyu et al. 2012).

Another example of successful hybridization can be observed through a mobile phone program in Bangladesh called Help Line (Raihan 2005). This program offers primarily health, legal, and agricultural advice to women in rural communities through a call-in hotline. The key to the success of this hotline and the transmission of information to women through ICT's is what the program calls the 'info-mediary'. This woman is responsible for traveling from door to door throughout the village with her mobile phone, assisting women in making calls and accessing the information they are seeking. In many ways, this 'info-mediary' resembles

the town crier method of communication. In this way, the program uses local knowledge and social norms to disseminate information through face-to-face interactions between women. Furthermore, it uses that social arena of daily visits from members of familiar social networks to introduce and teach other women about new technologies and to extend the social network. This form of hybridization also overcomes the affordability barrier that many women face by providing communal access to a single mobile phone. This Help Line program also considers obstacles of language and education, as women teach other women in a common and familiar language how to use these new communication tools. Finally the functional role of the ‘info-mediary’ helps to bypass male ownership and control of the mobile phone which often inhibits women’s access to information. It is this attention to local norms and conditions which allows an effective implementation of ICT usage and access.

This process of hybridization has been further explored in the context of climate change through the use of community radios. Given that radio is such a prevalent tool among rural farmers, and particularly women farmers, it can be an effective participatory method of sharing climate information services. Harvey shows how new technologies are tailored through diffusion of innovations in order to provide a communicative tool for climate information sharing. Community radio is an essential component of what Harvey calls ‘knowledge production’; the process of community involvement in radio transmission “involves moving the radio beyond the role of information transmission, into the process of knowledge production” (2011 p. 2039). It is here that the traditional, local level knowledge and language of information is communicated through modern technologies of phones and radios. Community members can listen to the radio and then respond in a dialogue through mobile phones. This creates a participatory forum for discussion on local issues, in which communities can learn about and modify solutions to local problems in real time.

Megwa also discusses the use of community radios as a tool for community involvement with public health issues, employing the sample of HIV/AIDS in South Africa. Megwa argues that while this is a promising avenue for development, it has not yet reached its full potential in South Africa, as infrastructure is not sufficient to incorporate those in rural communities who could benefit from the radio program. She argues that “community-owned and -operated radio stations are capable of creating a real development space for their rural and poor communities to meaningfully benefit from the positive manifestations of the new ICTs” (2007 p. 64). A

hybridization of communication, such as those found in these examples of creative use of community radios, provides feedback loops where social learning and reinvention of innovations can occur. Furthermore, it creates a dialogue through which reinvention of climate change ICT's are localized, contextualized, and incorporated into strategies which increase communities' adaptive capacity. It is important to recognize that the key actors in this hybridization process are the information producers themselves.

While this paper has focused primarily on the users of information, it is important to recognize that the producers of information have a responsibility in recognizing what information rural women need, and engaging in this reinvention dialogue. Roncoli argues that in order for a participatory dialogue to occur, scientists should not fixate on the goal of 'technology adoption' but instead engage in a more integrated discussion of technology adaptation and reinvention (2006 p. 94). She writes that this "entails a reformulation of goals, from facilitating the 'uptake' of climate forecasts, to understanding how climate information can interact with other resources and capabilities to empower rural producers to make decisions and enact strategies that reduce their vulnerability to climate risk" (2006). Nelson and Stathers further explain that because climate change is not happening at a linear and steady rate but in sometimes unpredictable ways, society must also adapt in a similar manner. Adaptation to these changes is not linear, but requires feedback loops by which community members can reflect upon which methods work best for their particular context (Nelson and Stathers 2009). By introducing new technologies into traditional networks and means of communication, practitioners may be able to extend the reach of their climate information services and help more vulnerable communities to adapt to these environmental changes. In essence, hybridization is able to occur when scientists integrate local level feedback into the formulation of information and innovations.

Hybridization through the tailoring of traditional and modern methods of communication technologies requires further exploration. In the wake of global food crises and environmental catastrophes, the stakes for effective communication could not be higher. In the global reality of changing climate, communication is crucial so that communities may effectively evaluate risk, and adopt appropriate adaptive strategies.

## Conclusion and recommendations

Climate change is expected to have transformative impacts on agricultural societies throughout the world. In developing countries, where livelihoods are greatly dependent upon successful crop yields, there is much at stake. The accessibility of climate information is a critical factor in whether agricultural communities will be able to adapt to these environmental shocks. Understanding the socioeconomic factors that inhibit access to information is a critical step in improving accessibility in developing countries. We have shown that special attention to gender is essential to this endeavour. It is important to understand how women access information as well as what types of information they seek. Furthermore, as the introduction of ICTs become more prominent instruments of climate information services, it is important to understand what barriers prevent women from accessing and utilizing them. When communication of climate information becomes more accessible, those farmers who are most vulnerable to environmental crises will have more resources to make critical decisions over the agricultural production. With this climate information, farmers will be able to assess the risk of severe climate events affecting their crop productivity, and better equipped to mitigate these impacts. As women farmers are often invisible, it is the responsibility of researchers, practitioners, and extension officers to tailor communication methods to women's needs so that they also can benefit from climate information services and adapt their agricultural practices to the changing climate.

This paper has shown that participatory dialogues between practitioners, scientists, and community members provide contextually tailored communication innovations that are more available to women. Community information services and extension officers provide important channels for these dialogues to occur. While some studies have begun to explore this hybridization, more research is necessary to understand how this hybridization works in practice, who benefits from it, and how it can be better employed to maximize reach and depth in information sharing.



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