17.1 INTRODUCTION

While the seasonal variability of weather is a major source of production risks (Fraisse et al., 2006), significant benefits have arisen from the use of seasonal climate forecasts. Nonetheless, it is now widely accepted that the existence of predictable climate variability and impacts is necessary but not sufficient to achieve effective use of seasonal forecasts (Podesta et al., 2002). The realization of such benefits has been shown to require deliberate efforts to design and implement effective mechanisms for using climate information in the service of society. Several empirical studies have identified theoretical and practical obstacles to the use of climate information and forecasts (for example, Mjelde et al., 1998; Stern and Easterling, 1999; Agrawala et al., 2001; Patt and Gwata, 2002). The obstacles are diverse, ranging from limitations in modelling the climate system’s complexities (for example, forecasts have coarse spatial and temporal resolution, not all relevant variables can be predicted, the skill of forecasts is not well characterized or understood, and contradictory predictions may coexist), to procedural, institutional, and cognitive difficulties in receiving or understanding climatic information. The capacity and willingness of decision-makers to modify actions may also play a limiting role.

There are many communities of potential users, including farmers, agribusiness, transportation entities, persons who are interested in reducing the off-farm impacts of agriculture, and so forth. Rijks et al. (2000) note that different groups of potential clients may exist within the same community, such as those who are aware of information and have access to it, but may need guidance on use; those who might know information exists but may need improved access; and those who may not be aware of existing information and the potential benefits of its use. Climate information is not yet widely used by farmers who make routine decisions about production in existing farming systems (Jones, 2003). This is partly due to the complexity of agricultural systems. In addition, there may be insufficient consideration of the actual conditions of the livelihood of farmers and thus of local adaptive strategies (WMO, 2003). In such cases, the result is usually development of inappropriate support systems (WMO, 2004a). Several place-based studies have highlighted communication as a key weakness in the ability of the climate information system to serve the agricultural sector. This weakness has been well documented for some time in the forecast applications literature, yet remains of critical importance.

Farmers face many challenges, including uncertain prices, access to needed inputs, governmental policies, marketing, pests and diseases, soil degradation and extreme weather. A common strategy is to employ surveys among farmers working with a particular crop or commodity, asking the respondents to list and prioritize the problems they face in production. During and after the 1997–1998 El Niño–Southern Oscillation (ENSO) events, many pilot projects were developed in which stakeholders were and are being engaged in dialogues with researchers and extension personnel on climate variability and the use of uncertain climate forecasts (Buizer et al., 2000). Vehicles for the communication of new information in agriculture include the media, agrometeorological bulletins, extension services, and the like. Significant work still remains before climate forecast information is routinely used throughout agriculture for making decisions aimed at reducing climate-related risks. This chapter reviews the challenges of effective communication and offers recommendations for bridging identified gaps. This is not simply a problem of rural underdeveloped areas. As Fraisse et al. (2006) note, even in more technologically advanced areas there is still the need for face-to-face, multidirectional communication and training among the extension agents.

This discussion focuses primarily on the communication of climate information for on-farm planning. Many of the concepts are applicable to supporting off-farm activities as well, however. Livestock planning and management are not addressed explicitly.

17.2 USE OF CLIMATE INFORMATION IN AGRICULTURE: FRAMING THE DECISION PROBLEM

It is widely accepted that researchers, information providers and practitioners (in this case farmers and agribusinesses) frame problems differently (Schon
and Rein, 1984). “Framing” refers to the way a particular problem is presented or viewed. Frames are shaped by knowledge and underlying views of the world. This is related to the organization of knowledge that people have about the world in the light of their underlying attitudes towards key values, their notions of agency and responsibility, and their judgments about reliability, relevance, and weight of competing knowledge (Jasanoff and Wynne, 1998). Researchers, policymakers and practitioners (public and private) operate on different timelines, use different languages, and respond to different incentive systems. These frames lead to different definitions of what constitutes the critical components of a problem, different approaches to problem-solving, decidedly different recommendations for action and differing criteria for appraisal. The most important learning involves the basic “framing” of issues in terms of the relevance and importance of particular conditioning outcomes.

The degree of acceptability of information and trust in the providers dictate the context of communicating climate information. The following questions frame effective communication (Jones, 2003; Pulwarty et al., 2003):

(a) Is the information relevant for decisions in the particular agricultural system?
(b) Are the sources/providers of information credible to the intended user?
(c) Are farmers receptive to the information and to research?
(d) Is the research accessible to the policymaker or decision-maker?
(e) Is the information compatible with existing decision models and farming practice?
(f) Do decision-makers have the capacity to use information?

All studies to date show that rainfall distribution over a season is the key variable for all farmers throughout the tropics (Phillips et al., 2001). This information translates into the following key information needs, depending on the particular crop being cultivated: adequacy of rainfall amounts and deficits and excesses, as the case may be; and “early warnings” of potentially poor seasons to inform key actions for general planning questions, such as when to start planting, knowing how much to diversify, knowing which crops to plant, and the likelihood of meeting or failing to meet quotas.

This calls for a much closer inter-institutional collaboration among national meteorological and hydrological services and agencies that directly intervene in rural areas, such as extension services, development projects, and community-based organizations and non-governmental organizations (NGOs).

Farmers and information providers should be able to evaluate the outcomes of alternative actions (Hammer et al., 2000; Meinke et al., 2001). Crop models and simulation approaches provide means to explore the consequences of a broad range of decisions. Simulation studies have shown associations between El Niño phases and yields of peanuts in Australia (Meinke et al., 1996), corn in Zimbabwe (Phillips et al., 1998) and Argentina (Ferreyra et al., 2001), as well as mixed crops (Messina et al., 1999; Hansen et al., 2001; Fontana and Camargo, 2002). Crop models are the preferred choice of analysis because of their ability to simulate yield response to alternate management conditions, such as planting date, row spacing, plant population, irrigation and cultivar choice, over many years of historical weather records (Boote et al., 1996, 1998; Meinke and Hammer, 1995). The traditional ENSO forecasts still lack the capability to characterize intraseasonal rainfall variability, and without knowing the rainfall distribution, it is difficult to correctly forecast crop yields (S. Jagtap, personal communication, 2006). Idealized estimates of the economic value of information (including forecasts) form difficult benchmarks to achieve in practice. It is important to complement the use of such models with an understanding of the impacts of previous climatic and other events (for example, different types of ENSOs) on farming practice, and favourable or poor outcomes depending on the crop being considered. To enable effective responses, farmers should have tools such as access to extension advice, inputs, markets and credits to allow them to make farm investments, and a functioning communication infrastructure (accessible roads, markets and extension advice).

Creating a favourable environment for the effective use of climate information requires asking the question, “What conditions must be in place before farmers can benefit from seasonal climate forecasts?” (Hansen, 2002). The vulnerability and capacity assessment literature provides a useful typology for structuring capacity to respond to climatic risks (Pulwarty and Riebsame, 1997):

(a) Physical/material resources: What physical climate risks, social skills and productive resources exist?
(b) Social/organizational capacity: What are the relations and organizations among information providers and users?
(c) Behavioural incentives: How does the community view its ability to create change?
There has been a growing emphasis on devolution of risk management to the community level and greater recognition of varying degrees of effectiveness of community-based management. This requires that the information management community develop and legitimize innovative approaches for the application of emerging communication technologies in agricultural management. Differing goals, problem criticality, institutional barriers, basis for decisions, usability and capacity, appropriate entry points for information, and experience or tradition shape the use of existing climate information, including forecasts, in the context of other issues affecting productivity.

Benefits arise when prediction of climate fluctuations leads to decisions that reduce vulnerability to impacts of climate variability. It is increasingly recognized that improved decisions depend on communication and that the process depends on institutional support in an appropriate policy environment. Hansen (2002) proposed five preconditions for successful forecast application:

(a) Decision-maker vulnerability and motivation. Forecast information is useful only when it addresses a need that is real and perceived. Decision-makers must be aware of climate risk and its impacts and motivated to use forecasts to manage this risk.

(b) Viable forecast-sensitive decision options. Benefits are conditioned upon the existence and understanding of decision options that are sensitive to incremental information in forecasts, and compatible with goals and constraints.

(c) Predictability of climate fluctuations. Relevant components of climate variability must be predictable in relevant periods, at an appropriate scale, with sufficient skill and lead time for decisions.

(d) Communication. Use of climate forecasts requires that the right audience receives, understands and correctly interprets the right information at the right time, in a form that can be applied to the problem(s) that require a decision.

(e) Institutions and policy. Sustained operational use of forecasts requires institutional commitment to provide forecast information and other support, and policies that support provision and use of climate forecasts.

17.2.1 Communication channels

In addition to the nature of forecasts themselves, the research community has identified several impact aspects of forecast communication, such as communication channels, stakeholder awareness, key relationships, and language and terminology. There is a significant disparity in communication infrastructure across countries and across different kinds of agricultural user groups. While among the scientific and technical community there is a great deal of enthusiasm to make use of emerging communications technologies to share real-time information, as well as local knowledge and experiences, extension agents most responsible for managing farmer linkages have to rely on rather conventional means of communication. Low bandwidth and poor computing infrastructure impose serious constraints. On a national and regional level, this calls for conscious integration of emerging and conventional communication technologies. While disparities in communication infrastructure do exist, there are significant local innovations that need to be harnessed and integrated with new technologies. The use of local cable television for Internet access and of phone booths for Internet kiosks in India, as well as wireless Internet access in Laos, are some examples of local innovation that can be exploited for communications in disasters. In some areas, farmers have identified local-language radio programmes as credible and accessible mechanisms to deliver forecasts if they need to be issued, along with follow-up meetings with extension agents or other intermediaries (Konneh, 2006). Radio broadcasting could ensure widespread and timely coverage, while follow-up meetings would enable farmers to ask questions and receive technical advice. This latter point of following up is non-trivial and merits special attention, as discussed below.

One illustrative assessment of follow-up needs (see Ziervogel, 2004) and several examples from Southern Africa outline the limitations of the present modalities for the communication and dissemination of climate information. Country-identified limitations include:

(a) Zambia: Dissemination of climate information to outlying farming areas is weak.
(b) Namibia: Communication strategies of the climate information system do not serve the communal farming sector.
(c) Lesotho: The flow information from the meteorological service through extension to the farmers is poor.
(d) Swaziland: There is excessive reliance on radio as a tool of dissemination; this “one-way” modality for communication is thought to be inadequate for agricultural applications (for example, farmers are not able to ask further questions regarding the information provided).
(e) Mauritius: The provision of forecasts is restricted. More intensive use of the Mauritian media would be needed so that climate information can reach the entire population.

(f) Mozambique: At present the forecast is provided too late for planting decisions in parts of southern Mozambique.

Several countries (Lesotho, Mozambique and Swaziland) found that timely issuance remains a key weakness in climate information systems, especially for communication passed on to the National Early Warning Units (NEWUs).

Channels of communication typically take the form of (WMO, 2004b):

(a) Workshops and meetings (shared scenario construction, shared model building);
(b) Presentations and briefings (including locally organized events, for example, hearings);
(c) One-on-one technical assistance;
(d) Coordination with other ongoing projects;
(e) Work with the local media;
(f) Website development and maintenance;
(g) Courses on climate impacts and adaptation (see below);
(h) Media (mass media and information, teleserials (soap operas) and the like).

Successful interactions rely on open decision-making processes that recognize multiple interests, community-based initiatives, and integrative science, in addition to traditional science. Weaknesses and gaps identified by earlier and concurrent diagnoses of forecasts and early warning and/or climate information systems still persist. All of the above issues point towards the need for increased training and use of extension staff as tools for communication and dissemination, and the need to improve relations with the print media. Such stakeholder interactions should concentrate on the incorporation of new knowledge or experience into existing models and decision processes, and also on media representation.

17.2.2 Capacity development for effective communication

Several countries (for example, Argentina, Brazil, Ethiopia, Peru, South Africa and Zimbabwe) have ongoing programmes within either their meteorological institutions or agricultural research systems that support the use of forecasts by agricultural decision-makers. Other programmes have targeted particular countries as well as groups of countries in a manner that allows comparison across countries. A sampling of some of the programmes and projects that have a strong research approach to user applications is given below:

(a) In Australia, there is a strong network of institutions that support agricultural application of seasonal forecasts. The Agricultural Production Systems Research Unit (APSRU) and the Queensland Centre for Climate Applications (QCCA) are the best known.

(b) The Florida Consortium, now called the Southeast Climate Consortium (University of Florida, Florida State University and University of Miami), first worked in Argentina, then in the south-eastern United States, leading to the development of a programme in the state of Florida on climate applications cooperatively implemented through Florida's agricultural extension service.

(c) Climate Prediction for Agriculture (CLIMAG)–West Africa is a consortium of institutions in West Africa and Europe that explore seasonal forecasts for early warning applications at the farm level and are focused on the prevention of food insecurity in Mali through a project entitled “Climate Prediction for Mitigation of Global Change Impacts on Agroecosystems in Sudano-Sahelian West Africa”.

(d) Climate Forecasting for Agricultural Resources (CFAR) is a joint project of the University of Georgia and Tufts University (both in the United States) that targets smallholder farmers in Burkina Faso.

(e) CLIMAG–Asia. The initial project, entitled “Management Responses to Seasonal Climate Forecasts in Cropping Systems of South Asia’s Semi-arid Tropics”, was carried out in India and Pakistan with participants from Australia and the United States. The next phase, “Applying Climate Information to Enhance the Resilience of Farming Systems Exposed to Climatic Risk in South and Southeast Asia”, extended this project to Indonesia.

(f) The Advanced Training Institute on Climate Variability and Food Security, implemented by the International Research Institute for Climate and Society (IRI) and co-sponsored by the Global Change System for Analysis, Research, and Training (START), was designed to equip young agricultural and food security professionals in developing countries to apply advances in seasonal climate forecasting to the ongoing efforts of their home institutions. Participants in 14 countries are now managing projects that involve exploration or application of seasonal forecasting.

(g) The Agrometeorological Information Center (CIIAGRO)–Brazil. In 1998 CIIAGRO was
created in the state of São Paulo, Brazil, as a joint initiative by the Office of Agriculture and Supply and the Office for Science and Technology. A key activity is the operational use of agrometeorological models for estimation of water needs of main crops and related productivity, as well as estimation of the potential frequency of pests and crop diseases (Fontana and Camargo, 2002).

(h) Regional Climate Outlook Forums (COFs). COFs are international frameworks in which climate analysis, assessment and data are synthesized by various regional forecasting groups to arrive at consensus regional forecasts for a particular upcoming rainfall season. Policymakers and decision-makers are active participants in this effort. The Office of Global Programs under the National Oceanic and Atmospheric Administration (NOAA) in the United States initiated this process (Buizer et al., 2000).

Many countries highlight the need for extension training (using rural training centres, for example) to include the use of tailored forecasts. For example, Lesotho instituted awareness-raising campaigns aimed at farmers (and the larger community) regarding the importance of climate information and its distribution, and user education programmes to raise consciousness about the usefulness of forecasts in communal areas. Lesotho also organized an annual workshop aimed at extension training in various agricultural risk management directorates. In South Africa, this training included recommendations for the interpretation of the South African Weather Service's training manual specifically for the agricultural sector. Lessons from these workshops and similar projects funded by NOAA and other agencies are summarized in Table 17.1.

17.3 EXPERIENCE FROM EXTENSION SERVICES: KEY LESSONS

Quantitative, computer-based analytical tools can be combined effectively with participatory approaches to facilitate farmer discussion and foster mutual learning.

Climate information is likely to have the greatest value if it is communicated through advisors whom farmers already know and trust. Any initiative must either work through existing institutions and advisory networks or invest considerable time and effort to establish trust and credibility.

Different factors determine farmers’ ability to change decisions in response to forecasts. Many apparent barriers can be overcome by taking a holistic approach and engaging all relevant stakeholders in the process. As has been shown, such activities entail considerable personnel (and personal) effort and resources applied over long periods. As agricultural applications of seasonal climate prediction move increasingly beyond exploratory efforts of the climate

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Table 17.1. Key lessons from international experience with agricultural application of seasonal forecasts (Konneh, 2006)

- Climate information is likely to have value if it is communicated through extension agents or contacts whom farmers already know and trust. Seasonal forecast communication, therefore, needs to flow through existing trusted institutions (Hansen, 2003; Jones, 2003; Walker et al., 2003).
- Communicating the right information to farmers at the right time is one of the greatest challenges in the application of seasonal climate information in farmer decision-making. This study suggests that current information needs to include additional details, such as technological options that can be applied given the forecast. For instance, if the forecast changes during the season, how can users respond?
- The availability of the right type of seasonal climate information does not guarantee that it will be used. The method of presenting the information and understanding the decision contexts of different user groups, such as the seed growers, livestock managers and seed suppliers, are equally critical to effectively communicating seasonal climate forecast for the benefit of users (Kirshen et al., 2003).
- Future resource allocations and policy priorities should focus on both technology transfer and programmes, such as microcredit financing, that would create an enabling environment for the application of technology, especially in developing regions, such as Africa, Latin America and South-East Asia.
- Decision-makers continue to resort to crisis management in climate-related disasters largely owing to the low confidence they have in the current seasonal climate forecasts (Baethgen, 2003). The low level of use of current seasonal forecasts is due in particular to their minimal ability to accurately inform decision-makers about upcoming climatic conditions.
- User perception of climate vulnerability (for example, exposure to recent extreme events) and understanding user decision contexts are critical factors that can influence forecast use (Yarnal et al., 2003).
- The value of ENSO forecasts depends to a great extent on the identification of flexible mitigation options and the desire and ability of agricultural stakeholders to adopt alternative farm management practices.
community into mainstream agricultural research, credible demonstration of farmer use and benefit becomes increasingly important (Ziervogel, 2004).

Three key areas of concern relating to communication can be distilled from these efforts (for instance, Ziervogel and Downing, 2004):

(a) Language/terminology: Challenges of language and terminology were specifically highlighted by 10 of the responding country teams. A range of responding countries called for the translation of forecast terms into a language understandable to the agricultural user. Zambia, for example, specifically stated that the language is too technical.

(b) Awareness and training for providers/users/stakeholders: User/stakeholder training and awareness are critical weaknesses. In addition, providers need to be educated about the needs and decision-making processes that the farmers employ. Strategies to improve user and stakeholder awareness of climate information and its potential applications are described below.

(c) Characteristics of climate forecasts: The spatial distribution of forecasts is of particular concern for several countries and locations. Agroecologically specific forecasts are of key importance (for instance, statements from Lesotho, southern Mozambique and Mauritius). Several country teams analysed forecasts currently provided for different timescales and raised the following criticisms:

(i) Seasonal: provides probability of rainfall amounts, but does not address distribution;
(ii) Monthly: provides probability of rainfall amounts, but is too general and probabilistic;
(iii) Dekadal: addresses rainfall distribution, but in general provides no daily rainfall amounts or relative humidity projections;
(iv) Daily: addresses rainfall distribution, but is generally deficient in providing rainfall amount and relative humidity parameters.

That forecasts can be too general (spatially and in other aspects) to be of use to the agricultural sector echoes findings of other assessments. Farmers and extension agents also point to the limited utility of the above-normal, normal and below-normal categories regularly presented in Climate Outlook Forums for decision-making. Thus, determining the level of acceptability of risk for particular negative outcomes is key.

Given the limited familiarity with concepts of climate across timescales (from extremes to change), efforts simply to provide awareness of the role of climate in the lives of farmers and agribusiness need to be developed and understood by information providers, including extension agents themselves (see 17.3.2 on training the trainers). One such effort is the “Climate Field School”. While the lessons from the field school concept are slowly emerging, it is worth outlining the approach for the purpose of supporting effective communication channels.

17.3.1 The Climate Field School concept: setting the context for effective communication

The concept of the Climate Field School is adopted from the Farmer Field School designed for Integrated Pest Management (see Gallagher, 1999; Birkhaeuser, 1991). The Climate Field School (CFS) is intended to increase farmers’ knowledge of climate and their ability to anticipate extreme climate events for particular farming activities; assist farmers in observing climatic parameters and facilitate their use in support of farming activities; and aid farmers in translating the climate (forecast) information to support farming activities, in particular in the areas of planting decisions and cropping strategy (see the Annex to this chapter for an illustrative case). The procedure for the dissemination of climate information to farmers should follow the process used to introduce new technology. Farmers should be convinced from their own experiences that the use of climate forecast information will be to their benefit and enhance the resilience of their systems to extreme climate events. The activities of the Climate Field School are conducted in the form of simulation processes and interactive discussion on climate between a field facilitator and farmers, and through group dynamics. Training materials in field schools should cover the following aspects:

(a) Basic concepts of climate prediction (probability concept, terminology used in climate prediction, and so on), climate forecast products, and explanation of seasonal forecasts on shifting probabilities for crop yields, marketing trends, likely pest outbreaks, and so forth;
(b) The use of historical agriculture data (such as drought/flood data, planting data, frost, harvesting data and agriculture production data) to assess the impact of climate
variability/extreme events on agriculture, and simple water balance analysis, technology for harvesting rain, and so on;

(c) The use of climate forecast information for setting up a cropping strategy (cropping patterns, crop rotation, intercropping, and so forth).

As discussed by Feder et al. (2003), there is merit in continually reviewing the curriculum and focusing training on topics with the highest priority, while simplifying the presentation of the information. The simplification of the programme’s content will make it more effective, as this will improve the performance of graduates and increase the likelihood and speed of diffusion of new knowledge among other farmers. Diffusion can also be enhanced (and made more cost-effective) by employing mass media and other dissemination approaches for key aspects of the knowledge (for example, safety rules regarding the use of pesticides). This would require additional efforts to ensure that the media (print, television) are familiar with concepts such as ENSO and the associated forecast uncertainties. They may themselves be seen as recipients of extension services. The narrowing and prioritizing of the curriculum will also shorten the length of the training and reduce programme costs. Increasing the extent of simple decision rules in the training will make the programme less dependent on trainer quality and more amenable to scaling up.

17.3.2 The necessity of training the trainers

Information providers should themselves be clear as to the nature and limitations of the information being provided. Extension agents can themselves benefit from Climate Field Schools, which would build additional trust among users. In addition to developing a critical acceptance, the key emphases should be identifying appropriate entry points and application of jointly produced information at those points of decision-making (Pulwarty et al., 2003). This requires a technically strong facilitator. A major problem is that the providers of climate information are communicating probability information in deterministic ways. Seasonal forecasts must be communicated and understood in probabilistic terms. It is, however, difficult to communicate that the climate forecasts are a spread of possible outcomes (with some probability of an outcome of “dry” conditions in a forecast that is wetter than normal) and not a single prediction. The expectation of a deterministic forecast that will turn out to be either “correct” or “false” is especially damaging in situations when the decision-maker will experience post-decisional regret after believing that he or she acted on a “false” forecast.

Overconfidence due to miscommunication or distortion of uncertainty can negate the value of forecast use, leading farmers to make decisions that are inconsistent with their risk tolerance. Better understanding of the outcome variables that matter to farmers provides guidelines on whether and how best to “translate” climate forecasts. If, for example, crop yields or the costs of production input require particular attention, it becomes necessary to “translate” a climate forecast into the agronomic yield, income and/or cost implications that it holds.

Various researchers have found that communicating the nature of seasonal forecasts is critical for changing user behaviour with regard to utilizing seasonal forecasts. The researchers agree that agricultural extension agents are among the best vehicles to communicate forecast information to users in the agricultural sector. Many extension agents, however, lack basic climate education to enable them to “package” the probabilistic climate information into flexible and operational formats for users (Hansen, 2002; Jones, 2003; Walker et al., 2003.) As discussed, workshops and participatory discussions, which actively engage decision-makers, are effective for communicating seasonal forecast information (Kirshen et al., 2003; Patt and Gwata, 2002; Orlove and Tosteson, 1999). This conclusion is especially true for rural communities in developing regions of Africa, Latin America and the Caribbean, and South-East Asia, where opportunities for Internet access are low and the use of print media is minimal due to low literacy levels. As noted above, however, even in more technologically advanced areas, there is still the need for face-to-face, multidirectional communication and training.

There are many other issues that undermine the effectiveness of agricultural extension agents, especially in developing regions such as Africa. Extension services in many countries (for example, Burkina Faso) are being severely impaired by cuts in government spending, so that agents do not even have the means of transport to reach farmers; low pay and poor work conditions result in a lack of motivation and absenteeism. In other cases (such as Uganda), “modernization” policies support the hiring of university graduates as agricultural
extension agents, but the latter have no experience with farming, can often show too little respect for farmers and rarely visit the areas they are supposed to cover (Roncoli, 2006). Against this backdrop, WMO should collaborate with Radio and Internet for the Communication of Hydro-meteorological Information for Rural Development (RANET), the NOAA climate education programme, IRI, the NOAA Regional Integrated Sciences and Assessments (RISA) through the Southeast Climate Consortium (SECC), and regional institutions in Africa, Latin America and the Caribbean, South-East Asia and the South Pacific, to develop a training and reporting scheme that would enable the extension agents, regional journalists and users to understand the basics of seasonal forecasting, and how climate affects the agricultural sector. The instruction should focus on how the trainees use the knowledge to optimize production and minimize climate-related losses in the agricultural sector (Konneh, 2006).

17.3.3 Off-farm planning and decision-making

Climate variability is also associated with other sources of production risks such as pest and disease incidence; for their part, market plans require analyses of supply and demand projections throughout the cropping season and post-season storage and transportation. In addition to on-farm users (farmers), a broader typology of agricultural “users” or “stakeholders” would include:

(a) Information providers;
(b) Owners and suppliers of inputs (seeds, fertilizers);
(c) Buyers and market intermediaries;
(d) Sources and developers of technology;
(e) Financers of technology transfer;
(f) Local, regional and national governments.

While studies have identified barriers related to resource availability, few have attempted to involve relevant actors sufficiently, such as suppliers of agricultural inputs or credit, to address the barriers (Hansen, 2002). Few attempts at forecast interventions have allowed sufficient time for farmer learning, often due to the constraints of project funding cycles. There are not many clear, well-documented examples of forecast use, particularly by resource-poor farmers in less-developed countries (see Archer, 2003). Marketers now examine seasonal forecasts in developing marketing and shipping plans, and harvest operators and farmers have identified different harvesting strategies that can be employed for different climate outlooks. In addition, they have identified how seasonal climatic forecasts can be used to assist with herbicide and fertilizer management. The ex post analysis of forecast use and utility should facilitate an ongoing process of social learning.

17.3.4 Linking the decision-making calendar to the agroclimatic calendar: seasonality of climate, practices and decision-making inputs

Decision-makers in numerous domains, including research, have been shown to have limited insight into their own decision processes and goals and objectives. Employing simple elicitations such as “What do you need and when do you need it?” might be in fact misleading since a high degree of prior knowledge is presumed. Successful information development and use is a learning process. Many researchers and mediators have argued for consensus in judgemental forecasts, for example, combining regional-scale dynamic forecasts with local insight. Without consensus validity, scientific consistency and generalizability may be lost (Arkes, 2001). Such processes can also lead to “groupthink”, with domination by particular individuals. A more careful structuring of feedback within partnerships developed between providers and users (or representatives of users) needs to be established.

The concept of the decision calendar was introduced in Pulwarty and Melis (2001) as a means of obtaining and cooperatively mapping decision-making characteristics, perceptions and information inputs as they co-evolve with the hydroclimatic, or in the present context, the agroclimatic calendar. This simple tool, employed as a joint product among farmers, resource providers (for instance, of seeds, fertilizer, and so forth) and information providers, is a means of co-producing knowledge about the key timing of inputs to generate particular outcomes. In addition to the benefits of the “annual round”, it can also indicate potential off-farm interactions (for example, at the ENSO level, in the market, or relating to the globalization of farm inputs) as they affect on-farm activities. Table 17.2 (Walker et al., 2003) shows one example of an agroclimate decision calendar. Added to this could be information on how ENSO affects the seasonality of precipitation during key activity periods and what climate information would be needed at which critical points in time to be included in decision-making, as shown in Table 17.3 (Pulwarty et al., 2001). It helps an information provider structure his or her interaction while allowing for stakeholder inputs for planning, resource gathering, implementation, harvest,
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storage, processing and transportation as forecasts change or verify. It also offers a means of facilitating knowledge development among providers at different scales (such as on-farm, regional forecast providers) and farmers (or managers).

Table 17.3 provides a sequential list of questions that may be cooperatively answered by providers and stakeholders over the period of interest (for instance, planting through harvesting), linking the key inputs (for instance, how an ENSO event modifies the climatological averages and exceedance probabilities, and how this in turn affects practice).

17.4 CONCLUSIONS

Few studies that have taken a holistic approach have been designed explicitly to evaluate information adoption, impact and refinement. Podesta et al. (2002) and other authors outline the following key supporting activities in the effective communication of climate information for agricultural decisions:

(a) There is need to develop procedures to convert raw climate information and forecasts into likely outcomes of alternative decisions in climate-sensitive sectors of society. Mapping practical pathways to different outcomes can be carried out as a co-production strategy among research, extension and farmer communities.

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Table 17.3. Key issues in linking the decision-making calendar to the agroclimatic calendar for assessing and responding to potential ENSO impacts (Pulwarty et al., 2001)

- What are the sources of climate variability and controls on yields and operations?
- What are the critical months that influence the crop quality in the following harvest?
- How do rainfall and temperature (solar radiation, and so forth) affect these critical months?
- What is the critical period (which seasons) for ENSO impacts on yield predictability?
- How do different “warm” (El Niño) and “cold” (La Niña) events and their evolution phase affect yield?
- What is the present degree and evolving use of climate information?
- Where are the entry points for climate information into the annual cycle of operation decisions and into longer-term planning?
- What types of information (forecast characteristics) are identified as important and when, where and how should this information be provided?
- What other factors determine vulnerability? What practices and policies give rise to failures and to successes in the use of scientific information? What changes in the physical and management environments have affected sugar production on an annual basis (pest outbreaks, worker strikes and factory breakdowns)?
- What management actions can be taken with given probabilities and lead times? What capacity-building measures are needed within the industry?

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<table>
<thead>
<tr>
<th>Agroclimate zone</th>
<th>Crops</th>
<th>Order of choice</th>
<th>Date of sowing</th>
<th>Variety preference</th>
<th>Land preparation</th>
<th>Labour preparation</th>
<th>Harvest date</th>
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<tbody>
<tr>
<td>S3 Single growing period low rainfall areas: Melkassa and Miesso</td>
<td>Maize</td>
<td>Maize</td>
<td>Early April to early May</td>
<td>Medium duration</td>
<td>3 times</td>
<td>Medium</td>
<td>Starts in early Oct.</td>
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<td></td>
<td>Beans</td>
<td>1</td>
<td></td>
<td></td>
<td>2 times</td>
<td>Least</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sorghum</td>
<td>4</td>
<td></td>
<td></td>
<td>3 times</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Beans</td>
<td>Teff</td>
<td>Late June to early July</td>
<td>Short duration</td>
<td>4 times</td>
<td>Greatest</td>
<td>Late Oct to Nov.</td>
</tr>
<tr>
<td></td>
<td>Teff</td>
<td>2</td>
<td></td>
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<tr>
<td></td>
<td>Teff</td>
<td>Late July</td>
<td>No choice</td>
<td>4 times</td>
<td></td>
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<tr>
<td>D3 Double growing period, adequate rainfall: Awassa and Arsi Negelle</td>
<td>Wheat</td>
<td>Wheat</td>
<td>Early to late April</td>
<td>No choice, long duration</td>
<td>3 times</td>
<td>Medium</td>
<td>Nov. \&amp; Dec. for long duration</td>
</tr>
<tr>
<td></td>
<td>Maize</td>
<td>Barley</td>
<td></td>
<td></td>
<td>Medium</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Barley</td>
<td>Teff</td>
<td></td>
<td>Medium</td>
<td>4 times</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sorghum</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Potatoes</td>
<td>Onion</td>
<td>June, July &amp; August</td>
<td>Replanting if failure</td>
<td></td>
<td>High</td>
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<tr>
<td></td>
<td>Tomato</td>
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<td>High</td>
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</table>
(b) Efforts to foster effective use of climate information and forecasts must be grounded in a firm understanding of the goals, objectives and constraints of farmers and agribusinesses in the target system.

(c) Existing stakeholders’ networks and organizations may provide effective ways to disseminate and assess climate information and forecasts.

(d) Research, teaching and outreach on the environmental and societal implications of climate variability and change require a broad spectrum of talents and participants. Yet our understanding of factors leading to the development and sustained operation of successful interdisciplinary research and outreach teams is still quite limited.

Wherever resources allow, a holistic approach that attempts to put the necessary conditions in place and concerted efforts to demonstrate and quantify use and benefits will serve the cause of seasonal forecast applications and the farmers. The following framework for researchers and practitioners cooperatively engaging in the use of climate information, including forecasts, in the agricultural sector can be proposed:

(a) Integrate an understanding of local contexts and contending perspectives with an understanding of how new information becomes framed and socialized into farming practice;

(b) Assess impediments to and opportunities for the flow of information, including issues of credibility, legitimacy, compatibility (appropriate scale, content, match with existing practice) and acceptability.

Baseline work with farmers and other agricultural stakeholders includes the following steps:

(a) Describe the agroclimatic decision calendar/annual cycle of decisions of different processes (planning, information gathering, forecasting, decision-making, implementation, evaluation, and so on) to identify entry points for relevant climatic information and competing pressures at different stages;

(b) Clearly document single past events of significance and evaluate the contexts within which decision-making occurred, including lessons learned and incorporated;

(c) Refine Climate Field School material in the context of other field schools. Key emphasis should be on analyses of the role of antecedent events and decisions in constraining or enabling alternatives recommended during rapidly developing events;

(d) Evaluate decisions and outcome scenarios within the context of longer-term climate variations such as decadal-scale wetter and drier periods. This includes evaluating the cumulative impacts of shorter multi-year variations (such as extended dry periods) and antecedent physical conditions (such as high precipitation during key germination periods or high temperatures during flowering).

From the perspective of forecasting, the tasks outlined below involve actions to clarify both the acceptability of information and the context in which this information is going to be used (Fischoff, 2001; Pulwarty and Melis, 2001).

Before making forecasts:

(a) Meet with recipients or representatives to determine which measures they would find most useful;

(b) Independently analyse the problems that stakeholders face in order to obtain a complementary perspective;

(c) Empirically test formats for communication in order to ensure that stakeholders understand the information as intended;

(d) Seek users’ explicit agreement on appropriate formats;

(e) Develop decision calendars cooperatively with stakeholders to determine key entry points for different kinds of information.

While making forecasts:

(a) Make the nature of links to decision calendars and the forecast as explicit as possible, including alternate possible outcomes;

(b) Document the assumptions underlying forecasts, including how changes in seasonal development would change the forecast (how the forecast is verifying).

When evaluating the use of forecasts:

(a) Do post-season farmer workshops;

(b) Review what was predicted and what assumptions were made;

(c) Construct explanations not only for what actually happened, but what could have happened as a way of retrieving uncertainties at the time of predictions;

(d) Evaluate what new information was learned about the process producing the event predicted as well as the event itself.

For climate information and forecasts to be used to their considerable potential, four general requirements are identified: (1) stakeholders (or intermediaries) must be able to obtain information
(from forecasts or existing information) on factors or variables of direct interest to them and at lead times that allow for planning; (2) paths to decisions, using this information, must be clear and practical; (3) stakeholders must be able to critically question the provided information to assess appropriateness; (4) stakeholders must be convinced that such information, when used effectively, will indeed make them better off than before.

Through mechanisms such as the Climate Field School (even an abbreviated version) and the co-production of agroclimate decision calendars, information providers should treat the development, communication and use of climate (and other scientific) information as a process in which symmetrical learning takes place among providers of scientific information and farmers and agricultural stakeholders over time. Researchers, through ongoing dialogue and joint studies, should engage practitioners as full partners in uncovering issues of mutual significance, and explicitly address uncertainties and known barriers to information. The goals are to have better matches among what is needed, what is provided and what actions may be undertaken that increase flexibility in decision-making. The recommendations above are made from years of empirical studies that show what has worked based on experience. The approaches require considerable transaction costs in terms of human resources and time. Realizing the potential of climate information, including forecasts, requires support for personnel to maintain sustained communication pathways as outlined above.
# ANNEX

**Key modules being developed in the first phase of the Climate Field School programme**  
(adapted from Boer et al., 2003)

<table>
<thead>
<tr>
<th>1. Knowledge about elements of weather and climate</th>
<th>Introduce element of weather and climate</th>
<th>Build ability to differentiate between weather and climate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Process of rain formation</td>
<td>Study the process of rainfall formation</td>
<td>Develop better understanding of the importance of forest in retaining water</td>
</tr>
<tr>
<td>3. Developing understanding of terminologies and indices used in seasonal climate forecast</td>
<td>Develop capacity to understand the meaning of averages and deviations from average</td>
<td>Develop capacity to translate the seasonal climate forecast used by the Bureau of Meteorology and Geophysics (BMG) to local conditions (on their farms) considering the trend in rainfall data measured by the farmers</td>
</tr>
</tbody>
</table>
| 4. Developing understanding of probability concept (forecast error history) | Develop better understanding of probability concept and skill of forecast in climate forecasting and its relation to decision-making | Impacts on previous years and seasonality  
Also for non-ENSO-related precipitation impacts |
| Types of seasonal variability: ENSO-related and non-ENSO-related: Effects of ENSO-precipitation relationship in critical periods | | |
| 5. Introduction to measuring tools for weather/climate, weather measurement equipment and ways of calibrating data | Introduce instruments used for measuring weather/climate elements | Learn factors affecting the accuracy of data measured by non-standard instruments |
| | | Learn how to calibrate data that are not measured using standard method |
| 6. Learning about water balance concept and its use to assess irrigation water requirement and flood risk | Develop better understanding of the meaning of rainfall deficit from evapotranspiration | Develop better capacity for estimating irrigation water requirement based on simple water balance |
| | | Assess risk of flood from water balance analysis |
| 7. Using climate forecast information for setting up field management and planting strategies | Develop better understanding of how extreme climate events will affect the crop (e.g., effect of cropping rotation and planting time on level of damage)  
– Site selection  
– Pest control and fertilizer applications | Develop better capacity for using seasonal climate forecast in setting up cropping strategies (to avoid or minimize effect of floods and drought)  
Vegetation conditions for livestock. |
| | | |
| 8. Assessing the economic value of climate forecast information | Develop better capacity to quantify the economic benefit of using climate forecast information | Market impacts |
REFERENCES


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