LOCAL FORECAST COMMUNICATION IN THE ALTIPLANO

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According to data from two Altiplano communities, Andean farmers do not use the forecasts broadcast by national weather services . . . so what forecast information do they use?

Agricultural production systems are extremely sensitive to climate variability. This is especially true for small farmer production systems in developing countries where there are few resources to cushion the impacts of climatic shocks. Seasonal and monthly forecasts hold the promise of reducing the impacts of these shocks by allowing farmers to take actions that will either minimize the impacts of adverse weather conditions or take advantage of good growing conditions. To do this requires that small farmers receive forecasts in the form and time needed to help them make decisions. In the last 10 years, there has been a growing realization that farmers have not used forecasts to the degree that ▶

Local farmers Evaluating potato crops in the Altiplano.

the forecast community had hoped. As a result, considerable effort has been devoted to understanding why this has not taken place. This paper describes the networks used to transmit forecast information in the Altiplano of Bolivia and Peru with special reference to three indigenous communities. The implications of these findings for improved forecast utilization are then discussed.

LINKING FORECASTERS AND END USERS. It has long been believed that seasonal climate forecasts and forecasts of the onset of annual rains would greatly improve the livelihoods of farmers in developing countries. During the 1990s, improvements in climate forecasting, especially in areas influenced by the ENSO phenomenon, seemed to offer the potential of making this dream a reality. The El Niño of 1997/98 was the first opportunity to see how climate forecasts could actually contribute to the solution of real world problems (Buizer et al. 2000). News of this event was widely publicized and 11 Regional Climate Outlook Fora were organized. These fora were to develop and communicate consensus seasonal outlooks, to encourage cross-national cooperation, and to create a dialogue between the producers and users of forecasts.

The events following the release of seasonal forecasts around the 1997/98 El Niño showed both the potential value of seasonal forecasts as well as the challenges that had to be met before the potential of these forecasts could be realized. The value of anticipating and mitigating the negative impacts of El Niño through increased preparedness was demonstrated, but so were the limitations of the forecast technology and the institutions that were to use the forecasts. The probabilistic forecasts were often misinterpreted by the media and by policy makers (Manning 2003; Webster 2003). These groups tended to overestimate the skill levels of the forecasts and viewed probabilistic forecasts as certainties. Low skill levels limited the utility of the forecasts, especially for individuals and institutions working at the local level (Greenfield and Fisher 2003). In other cases, the forecasts were not in a form that was useable for decision makers either because of their timing or because it was difficult to translate regional predictions to the local level (Lemos et al. 2002; Orlove et al. 2002).

Even though climate forecasts were publicized via mass media and the Internet, many groups did not use the forecasts. Many relied on traditional forecast methods and traditional risk-reduction strategies. Others, particularly the poor who are most vulnerable to climate shocks, did not have access to forecasts (Archer 2003; Broad et al. 2002).

One of the most important conclusions drawn from the 1997/98 El Niño experience was the need to improve linkages between forecasters and end users (Greenfield and Fisher 2003). Failed forecast communications and misunderstood forecasts can only be reduced by developing a meaning system that can be mutually understood by forecasters and users. In addition, improved interactions between users and forecasters were needed to develop more useful and trusted forecast products.

Network analysis provides a useful framework for helping us understand how forecasts are communicated and used. Its utilization can improve the efficiency of forecast communication and the quality of forecast products. Network analysis has long been one of the tools for understanding the diffusion of information about innovations (see Valente 1996 for an overview). However, in the case of climate forecasting, its application goes beyond the analysis of the efficiency of communication. Studying the flow of information is also one of the simplest ways to identify stakeholders in the system who produce, transmit, transform, and/or receive forecast information. Ziervogel and Downing (2004) have demonstrated the utility of this approach in southern Africa.

The basic components of networks are channels and nodes. In this case, channels are the means and acts of communication. Nodes are those individuals and institutions that connect two or more channels; an individual who has access to one channel is not a node. Nodes can be of two kinds. There are nodes that simply pass on information received from other nodes, such as a newspaper that prints forecasts that it obtains from a meteorological service. Other nodes may transform information received through one or more channels and then pass it on to others. Extension workers and communications specialists are professional nodes while local opinion leaders

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The abstract for this article can be found in this issue, following the table of contents.
DOI:10.1175/2008BAMS2183.1

In final form 19 July 2008

are crucial nodes for the adoption of new technology (Valente 1996).

The present study looks at the networks used for the communication of climate forecasts in the Altiplano of Peru and Bolivia starting at the farm level. The case of the Altiplano of Peru and Bolivia is very interesting in this regard. High elevations and frequent droughts and floods make farmers in the region very vulnerable to climatic risk. Altiplano populations are very poor and hence very vulnerable to climate shocks. In addition, weather considerations are an important part of traditional farm decision making. Farmers vary the time of planting, the place of planting, and the crops planted according to their expectations about growing conditions. The Bolivian and Peruvian Altiplano are ethnically and ecologically similar, but the two nations are quite different when it comes to the production and utilization of forecasts. Peru has well-developed forecast institutions that have several decades of experience. During the 1997/98 El Niño, the climate forecasts were widely publicized and the government used climate forecasts to guide disaster mitigation and prevention efforts. Bolivia's forecast institutions are young and fragile. Efforts linking food security and climate forecasting began in the late 1990s financed by the European Union. At the time that the field research presented here was conducted, the system was not fully operational.

Fig. 1. Location of study communities.

THE RESEARCH SITES. Field research was undertaken in three Aymara-speaking communities in Bolivia and Peru—San Jose Llanga in Bolivia's Armoa Province and Ancacca and Santa Maria in Peru's Department of Puno (see Fig. 1). Household surveys were supplemented with interviews of meteorologists and forecast professionals in La Paz and Lima. Although the forecast communities differ in Bolivia in terms of size, experience, and efficiency, the systems in both countries have similar structures. Peru is unique in that it has two forecasting institutions, but the basic flow of information is similar in the two countries. Data from satellites, foreign sources, and field stations are developed into forecasts. These forecasts are then disseminated to radio and television stations and to government agencies. To reach farmers, government extension services and local governments are the target audiences for forecasts of information. Forecasting agencies in both countries assume that farmers will receive forecast information from radio and television or from government agents.

Communities have legal standing and usually are made up of more than one area of settlement (referred to as sectors in this paper). San Jose Llanga has five sectors, Santa Maria four, and Ancacca three. Potatoes are the primary food crop in all three communities. Sheep and cattle are also raised. The communities differ in terms of the relative importance of crops and livestock and in terms of access to nonfarm income sources. Livestock production is very important in San Jose Llanga and Ancacca. Dairy and sheep production are important activities in San Jose Llanga, and sheep and beef production in Ancacca. Livestock play a lesser role in Santa Maria where handicraft production and off-farm employment are more important (Table 1).

All three communities suffer from periodic droughts and floods. In addition, the high altitude and low nighttime temperatures make frost a constant concern. In group meetings in 2006, producers indicated that the greatest threat to their well-being were weather-related risks. As a consequence, producer planting decisions are made with these risks in mind. Farmers have a keen interest in seasonal forecasts, because their planting decisions are based on the kind of weather that they anticipate. They have a number of options available to them that can either reduce the risks of drought, floods, and frosts or take advantage of favorable growing conditions. For example, they can alter planting dates or they

Table 1. Community characteristics.

	San Jose Llanga	Santa Maria	Ancacca
Location	112 km from La Paz, Aroma Province	4 km from city of Llave, Puno Department	37 km from Puno, Puno Department
Altitude	3,876 m	3,835 m	Approx 3,950 m
Precipitation	402 mm	597 mm	439 mm
Area	7,200 ha	340 ha	1,090 ha
Families	101	77	66

can plant varieties of potatoes that are more resistant to frost and drought. Planting resistant varieties involves a trade-off because these varieties do not have a larger market demand or have lower yields in normal or good years. Farmers in these communities also possess fallow fields in low areas and on slopes, so they can also alter where they plant. Low areas are more subject to frost and flooding but can produce more in dry years. Slopes are more productive in wetter years or in years when frost is a problem.

METHODOLOGY. This study is based on surveys and key informant interviews in the three communities and on interviews conducted with forecast professionals in La Paz, Bolivia, and Lima, Peru. In Bolivia the surveys were carried out in 1999 and 2000 and those in Peru were carried out in 2000 and 2001. In addition to the surveys, a series of unstructured interviews were carried out in the Bolivian community in 2001. These were followed up with community meetings in the summer of 2006. The purpose of the 2006 meetings were to evaluate changes since the original surveys. In Bolivia, a representative sample of 45% of the families in the community took part in the survey and 70% were included in the unstructured interviews. In Peru, a representative sample of 77% of households in the two communities participated in the surveys. Care was taken to have samples that represented all of the sectors in a community.

The surveys and interviews gathered information on sources of forecast information, demographic information, production information, and income. The information on forecasts was used to map the networks that communicated and processed climate information for each of the communities. A matrix was formed with every member of each community listed as both potential sources (horizontal axis) and recipients of information (vertical axis). In this matter we could identify those persons/nodes that were crucial for the communication of forecasts. Communication was coded as one way or two way. One-way communication was defined as the case where an individual sought information from another by either asking a knowledgeable person or by observing their behavior. Two-way communication involved information exchange and discussion. One-way communication dominated in our study communities. Very few persons exchanged information; instead, information was sought from a few individuals. The relationship that persons had with other persons in their networks was also noted—the relationship based on kinship, neighborhood residence, membership in an organization, or participation in community activities.

FINDINGS. *Sources of forecast information.* Scientific forecasts were not an important element in farmer decision making. While television ownership was not common, nearly all the producers listened regularly to radio programs that included forecasts. In Peru where the forecasting system is more developed and where the government has made concerted efforts to publicize forecasts, 22% of the farmers in one community and 10% in the other accessed scientific forecasts broadcast by this medium. In Bolivia, which has a less developed forecast system, only 4% did. In all communities, farmers were aware of the existence of extra-local forecasts but did not use them. Radio forecasts were viewed with interest, but the prevailing view is that they were not relevant to local conditions (Table 2).

Forecasts made in the community where one lives are seen to have the most value. For example, even though most farmers in San Jose Llanga listen to an Aymara-language radio program on Radio San Gabriel, where traditional weather experts from two nearby communities discuss their observations of forecast indicators and make forecasts, the prevailing view is that the forecasts are only valid for the location where the indicators were observed. This is true for scientific forecasts. Even people who have some confidence in western science believe that if a forecast comes out of the capital city, it is seen as at best valid for that city and invalid for indigenous communities. Instead people relied on traditional forecast methods and local experts.

Traditional forecasting was based on two types of indicators—abiotic indicators and biotic indicators. The abiotic indicators included the appearance of the constellation Pleiades and the direction of winds around days that had astrological significance, such as the winter solstice and the midpoint between the solstice and the equinox and certain saint's days. Orlove et al. (2000, 2002) have demonstrated that there is a correlation between the appearance of the Pleiades and precipitation in the Altiplano. There may also be some connection between future climate events and winds.

The biotic indicators include the flowering patterns of certain perennial plants, the nesting behavior of a number of bird species, and the behavior of foxes and some insects. Plant indicators are used primarily to determine planting times and may be more related to soil moisture and temperature than to future weather. The animal indicators are used to determine whether a year will be wet or dry and are used to help decide where to plant. The empirical link between these indicators and climate is less clear.

In Peru, the most common source for forecast information from outside of the community was the *Bristol Almanac,* a publication resembling the *Farmer's Almanac* in the United States. Like the *Farmer's Almanac,* the *Bristol Almanac* contains seasonal forecasts. However, relatively few people expressed confidence in its predictions themselves. Instead they used the almanac as a reference to identify days of astrological importance (phases of the sun and the moon) and saint's days. These are the days when most traditional forecast indicators are interpreted.

Local forecast networks and the importance of nodes. Even though almost everyone in the communities studied—young and old knew the traditional forecast indicators and how they were to be interpreted—farmers leave forecasting to a few local experts. These local experts or nodes in network parlance are the key to the distribution of forecast knowledge within each community. Each sector/neighborhood of a community would have one or more local experts who were in turn linked to other experts within and on rare occasions outside of the community. The experts who the neighborhood experts referred to are the primary nodes in the communication of forecasts. There were three primary nodes in San Jose Llanga, two in Santa Maria, and one in Ancacca.

The findings concerning networks are best understood using a network diagram. Figure 2 is a diagram summarizing the information networks in Ancacca. Each box represents a sector of the community and contains the names of the experts in each neighborhood. Arrows indicate information-seeking behavior, with the direction of each arrow indicating where a person seeks information. For example, Nicanor R in sector III seeks information from Jesus V in sector II who in turn gets information from Juan de Dios Y. When information is exchanged, the arrows point in both directions. In sector I, Juan de Dios Y and Emilio X exchange information. The diagram also shows that Juan de Dios Y is the primary node in the community. Almost all the other experts are connected to him through networks of communication and depend on him for forecast information.

The primary nodes are persons over 60 yr of age who devote themselves totally to agricultural activities. While most families are involved in other income-generating activities besides farming, the primary nodes are not. In addition, the local experts dedicate themselves more to potato production than many of their neighbors. In fact, they are recognized as the most knowledgeable potato producers of their communities. Their expertise in potato production is what validates their expertise in weather forecasting. Interviews with the six primary nodes revealed that none used scientific forecasts in their production decisions and only one, a retired extension worker, used information coming from the Ministry of Agriculture.

CONCLUSIONS AND RECOMMENDATIONS. The most startling finding is the lack of connection between producers in the Altiplano and the scientific forecast community in spite of the latter's efforts to disseminate their forecasts. Forecasters are devoting significant time and resources to improve

Table 2. Sources of seasonal forecast information in three communities.

Sources of Information used*	San Jose Llanga	Santa Maria	Ancacca
Radio/TV	4%	22%	10%
Neighbors	16%	18%	33%
Extension	0%	7%	13%
*Bristol Almanac***	4%	44%	33%
Traditional abiotic indicators	98%	84%	92%
Traditional biotic indicators	98%	100%	100%

* Respondents could indicate more than one source.

** In all three cases, less than 10% use the predictions contained in the almanac. The almanac is used to identify the saint's days and the phases of the moon when traditional forecasts are made using local observations.

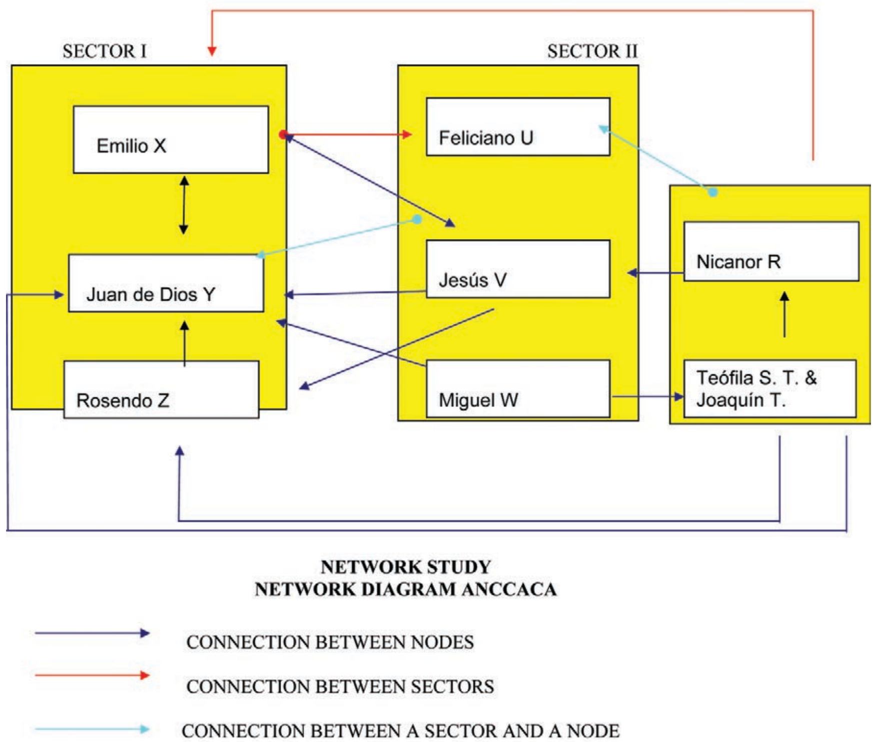

Fig. 2. Network study network diagram Ancacca.

the efficiency and quality of forecast communication with mass media, extension agents, and local governments, but none of these agencies is used as information sources by local decision makers. In other words, the current strategies for forecast communication are based on the faulty assumption that mass media, extension agents, and local government officials are part of the communication networks that farmers use. This connection does not exist.

Until there is a connection between forecasters and producers, there is no realistic way to evaluate the effectiveness of forecast products and the efficiency of their communication. When links exist, it is possible to use methods such as those outlined by Ziervogel and Downing (2003) to improve the quality of forecasts. At this point it is difficult to ascertain why there are not any contacts between local opinion leaders and the outlets that are targeted by forecasters. It is not for lack of interest on the part of producers. Forecasts play an important part in cropping decisions, so it would seem that farmers would seek out all possible sources of information.

A number of conclusions can be drawn from this study. First, to date, scientific forecasts are not being used by Andean producers. This suggests either that the nature of the forecasts is inappropriate or that the message is not reaching the appropriate people. These people would be the local experts. Because these experts are excellent potato producers, they are the people who are relied on to convert climate forecast information into production decisions. The fact that only a few experts used fertilizers or improved varieties but that all obtained significantly higher yields than their neighbors suggests that they have a high degree of skill in addressing the risks posed by climate and weather variations. These are people who do not currently have much contact with government agencies or extension agents.

Second, traditional forecast knowledge is widely dispersed and understood. It is not secret or disappearing knowledge held by a few aging experts as has been observed elsewhere (Taddei 2005). Virtually all farmers understand the traditional forecast indicators, but they depend on the observations of experts and on their interpretations of conflicting indicators. Producers and experts today have less confidence in these indicators than they did in the past. For that reason there is a strong demand for additional forecast information—a demand that is not being filled by scientific forecasts to date. However, there is an opportunity for collaboration between local experts and meteorologists in the development of better forecast communication.

Finally, it is likely that the notion that forecasts are only valid for the place where the forecaster is living is a principal reason for ignoring forecasts broadcast through mass media or official channels. This means that a forecast emitted on a radio station located in La Paz can, at best, only have validity for La Paz. This notion may have some empirical basis in a variety of microclimates that exist in the Andes, but at the same time, the Altiplano is relatively homogenous in terms of topography and rainfall. Work on downscaling in collaboration with local experts changes this as could educational programs aimed at local experts. These educational programs can be developed through collaborative workshops involving meteorologists and local experts.

ACKNOWLEDGMENTS. Funding for this research was provided by the National Oceanic and Atmospheric Administration Office of Global Programs through Grant NA96GP0239, and by the U.S. Agency for International Development's SANREM CRSP program through Grant EEP-A-00-0400013-00 CFDA98.001 #19228-42632. We would like to thank the Forecast Communication Networks in the Andean Altiplano. We would especially like to thank Rigoberto Espejo, who helped in the data collection and network analysis, and Lloyd Weber, who produced our map. We would also like to acknowledge the collaboration of Christian Jette of the United Nations Development Program, Roberto Quiroz of the International Potato Center, the staffs of Fundacion PROINPA and CIRNMA, and also the personnel of SEHNAMI in Peru and Bolivia for their collaboration and assistance.

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