CHAPTER 12

Harmonizing Traditional and Scientific Knowledge Systems in Rainfall Prediction and Utilization

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Historically, and still today in India, farmers have used traditional knowledge to understand weather and climate patterns in order to make decisions about crop and irrigation cycles. This knowledge is adapted to local conditions and needs and has been gained through many decades of experience passed on from previous generations. However, in recent years, farmers have perceived that the variation in rainfall is becoming increasingly erratic and difficult to predict. This has reduced their confidence in traditional knowledge and has led them to seek out scientific weather forecasts. These scientific forecasts are formulated at a much larger scale, diverging with local needs.

This chapter describes a project initiated by the M. S. Swaminathan Research Foundation (MSSRF) focused on harmonizing scientific and local knowledge of rainfall prediction for better use at the grassroots level in a few selected villages. The project activities are implemented through already-established computer-based "Village Knowledge Centers" (managed by a local farmer association), in which a central "hub" receives the scientific information and disseminates it to farmers in their local parlance. At the same time, the project has sought to link the traditional knowledge system on rainfall prediction with this scientific information through a multistakeholder participatory approach.

Degradation of soil, decreasing water resources, and changes in the climate are the three main obstacles to sustainable agricultural development in India.

Climate, including weather, is an important abiotic variable influencing crop production, especially in semiarid regions. The most effective way to deal with increased vulnerabilities caused by climatic variability is to integrate climate and weather concerns in agricultural planning and implementation processes. Scientific weather forecasts in India have until recently provided information on seasonal rainfall and weather only at a regional scale, which is generally too coarse to help decision making at the farm level. However, recent developments in weather and seasonal rain forecasting have increased the accuracy and reliability of the prediction of the Indian monsoon. General circulation models (GCMs) using sea surface temperature as boundary/initial conditions now enable researchers to predict seasonal rainfall (Blench 1999). Similarly, the capacity to generate and supply site-specific, medium-range weather forecasts has been enhanced in recent years. Despite these advances, access to the location-specific rainfall forecasts needed for proper decision making at the farm level is very limited.

Traditionally, farmers in India have made their own rainfall predictions, based on knowledge that has evolved through observation and experience over a considerable period of time. They base their predictions on a set of indicators, each of which has a different level of reliability. In response to the variability of the climate and weather as well as the uncertainty in their forecasts, they have evolved several coping strategies and mechanisms in rain-fed systems across the country.

Many international development agencies, government sectors, universities, and research institutions have begun to emphasize more strongly the value of indigenous knowledge in development. The dichotomy between indigenous knowledge and modern scientific knowledge is increasingly seen as a cause for underdevelopment; hence, work is now under way to bridge these two systems. Participatory research and farmer-back-to-farmer models of technology transfer (Amanor et al. 1993) are examples of attempts toward establishing such a bridge. Similarly, disciplines such as ethnobiology have sought to build bridges between indigenous knowledge and modern science. However, the challenge is how to bring together traditional knowledge and modern science without substituting one for the other and while respecting these two sets of values and building on their respective strengths.

In October 2002, the MSSRF, based in Chennai, India, initiated a project called "Establishing Decentralized Climate Forecasting System at the

Village Level" to enhance farmers' capacity to use locale-specific seasonal rainfall and weather forecasting. The project was undertaken in collaboration with Reddiyarchatram Seed Growers Association (RSGA), a farmers' association in Kannivadi in the Dindigul district of Tamil Nadu state, India. The main objectives of the project are to document the traditional knowledge on climate and weather forecasting, to examine the reliability of that knowledge, and to create a mechanism to provide access to scientific forecasting information that can supplement the traditional system. The project strives to link the two different knowledge systems through a multistakeholder participatory approach.

MSSRF has been working in this region since 1996 to develop biovillage models that address the twin problems of natural resource management and livelihood security for sustainable rural development. Participatory research, capacity building, and grassroots institution building are the three major dimensions of this work. Grassroots institutions help reduce the environmental and social transaction cost in development process. RSGA is one of the grassroots institutions developed in this region to promote sustainable agriculture and rural development. Small and marginal farmers constitute the majority of RSGA members, and one-third of the members are women. RSGA has organized need-based capacity-building programs with the support of Commonwealth of Learning, Canada. RSGA also manages a meteorological station as well as a Web page providing information on commodity prices and other economic market information, and it serves as the hub of Internet-based village knowledge centers (VKCs). The hub connects with four VKCs located in four different villages through a wireless local area network. This helps to serve the local villagers in four villages, especially those deprived of access to information important to their day-to-day life.

The VKCs are community-managed, demand-driven centers, each with three computers and an Internet connection. They dynamically supply information to meet different needs of the community, such as the product price in several nearby market centers, employment information, and government entitlements. The hub at RSGA receives the generic information and adds value by converting it to locale-specific information. Each VKC employs two women from the respective villages with secondary school education, who are trained in handling the computers to manage the unit. Access is ensured to all members of the community, irrespective of caste, class, gender, or age.

Methodology

The project has been undertaken in Reddiarchatram block, a semiarid region located in Dindigul district of Tamil Nadu state that contains twenty-four villages (administrative). More than 80 percent of the households depend on agriculture. Important planting seasons are June to July and October to November for both the irrigated and rainfed crops, in addition to the summer irrigated crop. The mean annual rainfall is 845.6 millimeters. Rainfall in the region varies greatly among seasons. Although the area benefits both from the northeast monsoon (October to December) and southwest monsoon (June to September), the maximum percentage (52.5 percent) of rainfall is received during the northeast monsoon, with only 25.8 percent of the annual rainfall received during the southwest monsoon. The area receives only 5.4 percent of the total annual rainfall during January and February, and nearly 16.3 percent during the summer seasons between March and May.

The total area under cultivation is 24,624 hectares, which includes both dry and irrigated lands. Approximately 29,600 households are involved in agriculture, and more than 50 percent of these are small and marginal farmers. Sorghum, small millets, grain legumes, cotton, and chickpea are the major annual crops cultivated under rain-fed conditions. Cotton, maize, flower crops, vegetables, gherkins, sugarcane, annual moringa, paddy, and onion are the most important annual crops grown in this region. The major source of irrigation is underground water through wells, followed by small tanks and reservoirs.

Four villages with functioning VKCs (one of which includes the hub center) were selected for the project. The four villages are located in the three distinct agroecosystems of the block: (1) Pudupatti and Kannivadi (with the hub center) villages, dominated by irrigated agriculture; (2) Samiyar patti village, which represents a subsistence cereal and legume production area with vast area under rain-fed cultivation of cotton and chickpea; and (3) Thonimalai, a hill zone where a coffee-based, multitier cropping system is being practiced.

The project was carried out between October 2002 and March 2004. In each village, the traditional knowledge concerning weather and climate forecasting was studied through the use of a conventional survey questionnaire; anthropological tools, such as participant observation; and participatory developmental tools, such as the Venn diagram and focus group discussions. Through questionnaires, the traditional weather and seasonal rainfall indicators and predictors were identified among 20 percent of the selected sample households in each of the villages. Anthropological tools (such as open-ended interviews) were used to study the metaphors, folklore, and proverbs that gave a better perspective on the traditional knowledge. A series of participatory rural appraisals was organized in representative villages in the block to obtain additional information on the social system, existing natural resources, agricultural practices and seasons, rainfall patterns, and the prevailing pattern and system of information flow. The needs, constraints, and coping strategies of farmers and agricultural laborers in response to variability of weather and climate were assessed through focus group discussions; this information was validated through triangulation with the information obtained through informal discussion with other knowledgeable men and women farmers.

MSSRF facilitated access for the VKC hub to scientific forecast information from the National Centre for Medium Range Weather Forecast (NCMRWF) for medium-range weather forecasts and Tamil Nadu Agricultural University (TNAU) for seasonal rainfall forecasts. The hub also manages a weather station, and the animators (staff) at the hub were trained in weather observatory management by TNAU. MSSRF also trained the animators to convert the generic information into farmer-friendly versions. The animators regularly recorded local weather parameters (maximum and minimum temperature, soil temperature at different depths, hours of sunlight, wind direction and velocity, evaporation rate, relative humidity) according to the norms of the Indian Meteorological Department and communicated that information to NCMRWF twice each week through electronic mail. In turn, NCMRWF provided weather forecasts of cloud cover, precipitation, temperature, wind direction, and wind velocity to the hub twice each week.

After the hub received the scientific forecasts, the staff converted the generic information into locale-specific, farmer-friendly language. For example, a forecast of a wind direction of one hundred degrees might be communicated to a particular village as *"lessana kathu sanimolaiyilurunthu addikkum,"* which means "mild wind blow from northwestern direction." The forecasts were then disseminated to farmers and agricultural laborers through the VKCs, bulletin boards, and local newspapers. After they received the information, the four VKCs communicated the forecasts to fifteen additional nearby villages through bulletin boards.

Similarly, linkages were established for the VKC hub to receive the seasonal rainfall forecast from TNAU. For example, in 2004, TNAU forecast that the region had a 40 percent probability of normal rainfall, a 40 percent probability of above-normal rainfall, and a 20 percent probability of below-normal rainfall for the northeast monsoon season. A focus group discussion was carried out in each of the four villages to communicate the forecast. In each village, the initial focus group discussion involved an explanation of how the scientific forecasts were generated and a discussion of the forecasts' attributes. The probabilistic nature of the seasonal rain forecast was explained to the farmers, and small games were organized to clearly explain the concept of probability. Then, using the climatological data, a "probability of exceedance" graph was generated to explain the relationship between rainfall amount (forecast) and probability.

Attempts are being made to communicate only the forecast information to the people instead of giving agro advisories, since this allows the farmers to make their own decisions. Under varied cropping pattern and rain-fed situations, farmers make follow-up decisions based on the event of rainfall and follow dynamic strategies instead of single strategy as most of the forecasters recommend. The discussions also focus on the areas of agreement or disagreement between weather indicators established in the traditional knowledge system and the available information supplied by the scientific forecasting system. The entire process of providing the scientific forecasts and interacting with farmers in participatory discussions is institutionalized through the VKCs.

Traditional Climate Knowledge and Forecasting

The term *traditional knowledge* as used in this chapter is defined as the "knowledge of a people of a particular area based on their interactions and experiences within that area, their traditions, and their incorporation of knowledge emanating from elsewhere into their production and economic systems" (de Boef et al. 1993). It differs from Western or scientific knowledge in the way it explains and establishes knowledge claims (Millennium Ecosystem Assessment 2003). Traditional knowledge is a cultural tradition that is constantly being developed and adjusted, and transmitted from generation to generation. It continues to play a major, even if largely unrecognized, role in the modern world. For example, the pharmaceutical industry still uses knowledge of traditional medicines to develop modern drugs. And interest in the use of indigenous knowledge has surged in such areas as agriculture and the conservation of genetic resources.

Understanding people's perceptions and knowledge of weather and climate is critical for effectively communicating scientific forecasts. Likewise, traditional weather and climate knowledge can provide significant value alongside the scientific forecasts. Traditional knowledge is learned and identified by farmers within a cultural context, and the knowledge base reflects the specific language, beliefs, and cultural processes. The local weather and climate are assessed, predicted, and interpreted by locally observed variables and experiences using combinations of plant, animal, insect, and meteorological and astronomical indicators. The different weather and seasonal rainfall indicators used to predict the occurrence of the rainfall are given in table 12.1.

Farmers use different kinds of traditional knowledge to predict rainfall based on their observation of such phenomena as wind movement, lightning, animal behaviors, bird movement, halos or rings around the moon, and the shape and position of the moon on the third to fifth days from the new moon. These types of information provide a framework that farmers use to explain relationships between particular events and changes in the climate and weather. Farmers combine different predictors and indicators to inform critical farm decisions and to decide on adaptive measures. Shaped by local conditions and needs, the knowledge is dynamic and nurtured by observation and experiences of both the men and women farmers. Also, the farmers in the region have developed certain beliefs with regard to rainfall. For example, farmers consult a local calendar to see whether *sani* (the god Saturn) takes an upper position, in which case the rainfall will increase for the coming season. Farmers also listen to local fortune-tellers. If there is a long dry season, in one ritual the community collects food from each household and then eats together; after the meal the people cry and then plead with the god to bring rain.

Men and women have different kinds of knowledge and use it for different purposes. Similarly, elder persons are more knowledgeable and able to use more indicators with greater understanding of their individual reliability. The older men and women used more than twelve indicators for weather forecasting, whereas the middle-aged persons (twenty-five to thirty-five years old) used only three or four indicators. Farmers as well as agricultural laborers have their own indicators that are based on their own needs and experiences. Also, farmers can list more indicators than the agricultural laborers.

The variations in indigenous knowledge in a community are based on age, gender, kinship affiliation, ideology, and literacy. Thus, social stratification influences the evolution and management of knowledge. Socialization and social heredity (the process of learning) take place within a particular

Table 12.1

Indicators/beliefs, reliability, related decisions, and user groups

Indicators	Decisions	Reliability (low, medium, high)	Users
Weather Indicators (twenty-four-hour forecast information)			
If lightning occurs from the east, west, and south, expect rain immediately	Indirectly helps to mobilize labor for weeding, day-to-day activities like shifting the cattle and other livestock and poultry to the shed, drying and collecting the dried products from the drying yard, and organizing fuels under shade; very rarely used for pesticide application	High, commonly used	Farmers and other people in the community
If lightning comes in an opposite direction (east to west), expect rain in one hour	Indirectly helps to mobilize labor for weeding, day-to-day activities like shifting the cattle and other livestock and poultry to the shed, drying and collecting the dried products from the drying yard, and organizing fuels under shade; very rarely used for pesticide application	Very high, commonly used	Many farmers
If lightning happens in the southeast and northwest directions, expect rain in the night	Used to make decisions on picking fruits and flowers that would generally occur the following morning	High	Commonly used by all farmers
Rings around sun	Used to decide irrigation, labor arrangement, and fertilizer application	High	Commonly used by all farmers
Increased number of mosquito bites	Supportive indicator	Low	Used by a few women agricultural laborers
Weather Indicators (two- to ten-day forecast information)			
In April and May, if the shade appears in the nearby hilltop (*thonimalai*), expect rain in another two to five days (*konamalai* for Kannivadi region; *gopinathan malai/palani malali* for Pudupatti village)	Used to initiate activities like arranging the dry fodder heap, land preparation (e.g., summer plowing and organizing/booking for country plough and tractor), and sowing of some vegetables under irrigated conditions	High	Majority of farmers

Table 12.1, continued

Indicators	Decisions	Reliability	Users
If there are small streaks in the clouds, expect rain in another two days; called "mazhai sarai"	Not used directly to make decisions, but farmers believe this indicator strengthens the reliability of other indicators	Low	Farmers and other people in the community
If circles are found around the moon, expect less rainfall; if small circles appear, expect less rainfall within two days	Land preparation: making arrangements for plowing, labor allocation, irrigation decisions, harvest decisions, and arrangements for post-harvest processing	High	Farmers
Northwesterly wind blows: expect rain in another two days; popularly called "mula kattru" (brings rain-bearing clouds)	Fodder and fuel arrangement; weeding, harvesting, sowing, irrigation, and postharvest decisions	High	Farmers and other people in the community
Northeast wind brings rain, and northwest wind (*sanimuzhai*) prevents the rain; south or northeast wind (female wind) helps to mobilize the clouds, and southwest wind (male wind) condenses clouds	Generally, people are more confident	Common and reliable	Both farmers and agricultural laborers
If frog in the well makes continuous sound	Arrangements for raising the motor in the well, making bookings for starting bore wells; decisions on irrigation and weeding	High	Farmers and other people in the community
If crab makes a bigger hole in the channel	Making arrangements for weeding and harvesting, organizing threshing floor and accessories, making bookings for implements like a plough, and arranging seeds for sowing	High	Farmers
During evening if the lower cloud appears red followed by a black cloud at the top, expect rain in another two days; if, during that time, the wind comes from the southeast (Saturn side), rain is unlikely	Decisions on irrigation, plowing, sowing, harvesting, and threshing	High	Farmers

Table 12.1, continued

Indicators	Decisions	Reliability	Users
If dragonflies and black sparrows fly in a group at three to four meters above ground level, expect rain the same day	Decisions on threshing floor, making arrangements for fuel and fodder; keeping the livestock under protection	High	Farmers
Black clouds with no stars bring rain; white clouds do not bring rain	Decisions on irrigation, postharvest operation, vegetable and flower plucking, drying of fodder and fuel	Medium	Farmers
Increase in body sweating	No decision is made based on this indicator, but it is used to support other indicators	High, nowadays decreasing	Farmers and other people in the community
Expect rain if dog jumps irregularly on the road at midday, poultry sit in a place for a long time, and sheep move in a group; popularly called "requesting a favor from god" (*mazhai varam ketkirathu*)	Used as a supportive indicator	Medium	Women and herders
In the cyclone period, if the clouds move in a group from east to west, expect rain in next two days	Irrigation, fertilizer application, harvesting, postharvest operations	High	Farmers
Seasonal Indicators (one- to three-month forecast information)			
South- and east-side winds indicate good rain during summer months; locally known as "thennal"	Plowing, sowing, and making arrangements for seeds and decisions on crops and cropping system	High	Farmers
Westerly wind brings heat and southwesterly wind bring coolness and clouds—rains during monsoon season	Sowing, planting, weeding, and threshing	High	Farmers
If there is more wind during July and August, expect good rain in October and November	Decision on cropping pattern and farm investment	High	Farmers

sociocultural realm, which is determined by class and caste (or caste in class). Gender is another important dimension of the social stratification. Knowledge is transferred to younger generations by the older ones through causal conversation, observations in the field, folk songs, metaphors, and so forth. In the ritual of "ceremonial plowing," all of the farmers in a village come together and initiate the first plowing. This traditional practice or ritual communicates to the entire community about the onset of rain. The elders use the same occasion to informally educate the younger generation about the traditional rain classification and appropriate cropping practices.

The indicators listed in table 12.1 reveal the qualitative nature of the indigenous knowledge concerning seasonal rainfall and weather. Weather predictions are used to make short-term decisions in both the irrigated and rain-fed systems. These predictions help the small and marginal farmers to plan various agronomic practices more effectively, especially at the time of sowing, weeding, spraying of chemicals, and harvesting and postharvest operations. Farmers also use seasonal rainfall predictions to prepare themselves for anomalies related to rainfall. For example, the predictions help determine the appropriate cropping pattern for the season. If the rainfall is normal, farmers plant high-value crops with high-yielding varieties (such as maize); however, if the rainfall is forecast to be below normal, they are more likely to plant short-duration, drought-resistant pulses and small millets. Farmers have been using different strategies to adapt and cope with uncertain weather and climate based on their experience and acquired knowledge from previous generations (box 12.1).

In the focus group discussions, farmers indicated that recent increases in the variability in rainfall have reduced their confidence in their own predictors, leading them to rely more on scientific forecasts. They indicated that variability has increased in terms of more water deficit years, late onset of rain and premature end of rains, and irregular distribution of rainfall in time and space. A climatological analysis of the interannual variability using twenty years of annual rainfall in this region indicated a coefficient of variation of about 36 percent; across the season, the variability in terms of coefficient of variation is high during the southwest monsoon season (71.6 percent) followed by the northeast monsoon season (52.2). Hence, the challenge and necessity are to provide reliable forecasting through appropriate methods based on the farmers' needs.

Box 12.1

Examples of Traditional Weather Prediction

Farmers use several meteorological indicators for seasonal rainfall prediction. For example:

- Westerly wind during *Adi* (June and July) brings rain in *iyappsi* (October and November).
- If there is no rain in the summer and there is wind in *Adi* (June and July), farmers prefer short-duration crops (such as cowpea), they reduce their farm investment, and some will invest in livestock, especially goats.

Farmers have evolved contingency cropping systems as a risk-averse strategy to reduce the potential for crop failure associated with climate fluctuations, especially for the rain-fed systems. It is common for farmers to start planting at the onset of rains. The following example shows how their crop selection changes according to the variation under a rain-fed agroecosystem.

- If rain sets in during June and July: lablab, sorghum, redgram, groundnut, vegetable cowpea
- If it is late by fifteen days: cowpea, fodder sorghum
- If it is late by another fifteen days: green gram and blackgram
- If it delays by yet another fifteen days: minor millets/short-duration sorghum

Other decisions involve mobilizing seed, fertilizer, and application; decisions on sowing (early or late); land and bed preparations; and midseason corrections, such as reducing population or providing irrigation.

Bridging Knowledge Systems

Scientific forecasts differ from traditional prediction in scale and, to some extent, in the type of factors used to predict weather patterns. Some of the weather predictors (e.g., wind speed and direction, temperature changes) used by farmers are similar to those used in the scientific forecast. However, while farmers have been using a combination of various biological, meteorological, and astronomical indicators to predict the rainfall, the scientific forecasts rely primarily on meteorological indicators, such as wind and sea surface temperatures. Traditional forecasts are highly locale specific, mostly at the village level within a radius of one to two square kilometers, and are derived from an intimate interaction with a microenvironment observed over a period of time. In contrast, the scientific forecasts encompass much larger geographic scales of fifty to three hundred square kilometers and depend on global meteorological parameters and their dynamics. Also, farmers perceive a high-rainfall year or season based on the time of onset and distribution instead of the total amount of rain received in a year.

The scientific forecast provides a probability distribution for the amount of seasonal rainfall as well as specific quantitative forecasts for medium-range rainfall amounts. The seasonal rainfall forecast does not provide information on the likely onset of rainfall and its distribution. The amount of rainfall and the timing of onset are the two most significant variables farmers use to make decisions on their initial agricultural activities.

On the other hand, traditional forecast knowledge is able to help the farmers in terms of the possible onset of rainfall using such indicators as direction and intensity of the wind during summer season, position of the moon on the third day, and traditional calendars (including other supportive indicators). Although the reliability of the traditional indicators varies, they do help farmers prepare for the timing and distribution of rain, while a scientific forecast may help them prepare for the amount. The different strengths of the two systems, when combined, provide farmers with more valuable information than either system can provide in isolation. The benefits of the two systems were elaborated during the group discussions with the farmers concerning seasonal rainfall forecasts. In this way, it was possible to establish a continuum between scientific and traditional forecast, which combines the scale and period of the onset of rainfall.

During the 2003 winter monsoon, the quantity of rainfall was predicted and communicated to the farmers in probabilistic mode two months in advance. The forecast indicated a 40 percent probability of normal rainfall (approximately 375 millimeters) between October and December and only a 20 percent probability of below-normal rainfall. At the same time, farmers also used traditional knowledge and observed wind pattern during the 2003 summer months (May through July) as a predictor. During May through June, the wind flow from west to east was very weak, but it increased during the subsequent month of August. According to the farmers, this delayed wind movement indicated that there would be a delayed onset of rain of about two to three weeks beyond the normal onset (i.e., the onset was expected to shift from the fourth week of September to the third week of October). The farmers also predicted a slightly below normal rainfall.

During that season, 230 millimeters of rainfall was received, which is 39 percent lower than the average rainfall; thus, the traditional forecast was more accurate than the scientific forecast. The onset of rainfall was delayed by more than three weeks. The farmers prepared themselves and practiced mixed crop-based, drought-tolerant, short-duration crops, such as sorghum and cowpea. Based on this experience, farmers indicated that they needed time to observe the effectiveness of scientific forecasts over seasons and years. It is unlikely that farmers will rely heavily on scientific forecasts until the forecasts prove their reliability.

Regarding the medium-range weather forecasts, the scientific forecast provides an expected quantity of rainfall, while farmers predict the possible period of rain using such meteorological indicators as lightning, cloud density, and wind movement. They also use supportive indicators derived from changes in the behavior of animals and insects. Thus, for medium-range forecasts, both the traditional and scientific knowledge systems help prepare the farmers for amount and timing of rainfall. This experience demonstrates the possibility that exists to harmonize the two knowledge systems in the context of the farmers' cognitive landscape, which is tuned to incorporate multiple sources of information.

Conclusion

This chapter documents the vast traditional knowledge that farmers hold concerning rainfall prediction and the level of their sophistication in understanding the reliability of these predictions. The traditional weather forecasting system in these communities provides information not available in the scientific forecasts. But scientific forecasts also have their benefits, and it is necessary to understand local peoples' perception of rainfall prediction in order to communicate scientific forecasts effectively, since weather-related information is learned and identified by farmers within a cultural context and their knowledge base follows specific language, beliefs, and social processes. Acknowledging the importance of the traditional knowledge base also aids social interaction and acceptance of scientific forecasts among the farmers. Thus, the two different knowledge systems need to be bridged.

Intensive dialogue between the scientific knowledge providers and user groups helps to define the strategies for bridging these two knowledge systems. The project described in this chapter shows that farmers were able to bridge the two different knowledge systems, which is not surprising since the farmers are used to operating in multiple cognitive frameworks. Participatory approaches were critical in developing a decentralized forecasting system at the village level that could effectively bridge the traditional and scientific knowledge base. On the other hand, access, availability of infrastructure, skill, and expertise are crucial to developing reliable region-specific scientific forecasts to serve the farming societies.

It is too early to judge what the final balance will be in the use of traditional and scientific knowledge in decision making by farmers in this region. But a system and process now exist within which farmers' understanding and confidence in scientific forecasts can be developed without undermining the benefits provided by traditional systems. There is a vast scope to link two different knowledge systems with the participation of local people.

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