Linking traditional and scientific knowledge systems on climate prediction and utilization

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Abstract

Traditionally, farmers have used traditional knowledge to understand weather and climate patterns in order to make decisions about crop and irrigation cycles. This knowledge has been gained through many decades of experience, and has been passed on from previous generations. The knowledge is adapted to local conditions and needs. However, increasing variability in climate has reduced farmers' 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 paper discusses a project initiated by the M.S.Swaminathan Research Foundation that focuses on integrating scientific and local knowledge on climate by developing localized climate and weather systems at the village level. The project strives to bridge two different knowledge systems by following a multi-stakeholder participatory approach. The project includes information sharing and training programs designed to build the capacities of women and men farmers in the use of forecast information. The selected villages have computer-based `Village Knowledge Centers,' in which a central 'hub' receives the more general scientific information and adds value to it by converting it to locale specific information. The local farmers manage the Village Knowledge Centers; access is ensured to all irrespective of caste, class, gender and age. The paper shows how linkages were made between the farming communities and government agencies, and chronicles the needs, constraints and opportunities of this type of approach to bridging different forms of knowledge across scales.

Introduction

Degradation of soil, decreasing water resources and changes in the climate are the three main obstacles in sustainable agricultural development. Climate including weather is an important abiotic variable influences the crop production especially in semiarid regions. The most effective way to deal with increased vulnerabilities due to climatic variability is by integrating climate concerns in development process. The current generic forecast information doesn't help the farmers to take alternate decisions at the farm level. However, recent developments in climate research indicate that prediction skill for Indian monsoon is better and reliable. Development of Global Circulation Models (GCM) using sea surface temperature as a predictor enables researchers to predict seasonal rainfall (Blench, 1999). Similarly the capacity to generate and supply site-specific medium range weather forecast also enhanced in recent times. But access to get location specific rainfall forecast to take proper decision at the farm level is very limited.

Traditionally farmers have been using their own knowledge on rainfall prediction, which is evolved through observation and experience over a period of time. They use a set of indicators and developed a reliability factor for each of them. Consequently they evolved several coping strategies in rainfed systems across the world. Many international development agencies, government sectors, universities and research institutions have started focusing on indigenous knowledge and they have incorporated it in development perspectives.

The dichotomous model of indigenous knowledge and modern scientific knowledge is seen as a cause for underdevelopment and hence efforts are being made to develop a continuum between these two systems. Participatory research, farmer-back-to farmer model (Amanor *et al.,* 1993) are some of the attempts towards establishing such a continuum. Subjects such as ethnobiology have tried to understand the indigenous knowledge and establish a relationship with modern science. However, the challenge is how to bring together traditional knowledge and modern science with out substituting each other, respecting these two sets of values and builds on their respective strengths.

M.S. Swaminathan Research Foundation (MSSRF), Chennai, India is a non-profit, non-governmental organization working on sustainable agriculture and rural development. The basic scientific mandate of MSSRF is to impart a pro-nature, pro-poor and pro- women orientation to a job-led economic growth strategy in rural areas.

Recently MSSRF has initiated a project on '*Establishing decentralized climate forecasting system at the village level* during October 2002 to create an access and enhance farmer's capacity to use locale-specific seasonal climate and weather forecasting in collaboration with RSGA. The main objectives are to understand the traditional knowledge associated with the climate and weather forecast and its reliability and institutionalize the scientific forecast system at the village level. Also, it strives to bridge two different knowledge systems with the participation of local men and women following multi stakeholder participatory approach.

Study area

Reddiarchatram block a semiarid region located in Dindigul district of Tamil Nadu state, has 24 village panchayats. More than 80 percent of the households depend on agriculture. Important planting seasons are June-July and Oct-Nov for both the irrigated and rainfed crops, in addition to the summer irrigated crop. The mean annual rainfall is 845.6 mm. The area benefits more from northeast monsoon. The maximum rainfall is between October - December. January and February are the months, which receive minimum (49.6mm) rainfall. The total area under cultivation is 24,624 ha which includes both dry and irrigated lands and households involved in agriculture are 29,568. Among the total more than 50% of the households are small and marginal farmers.

MSSRF has been working in this region since 1996 to develop models for operationalising sustainable rural development in the villages. Participatory research, capacity building and grassroot building are its three major dimensions. It strives to develop biovillages, which address the twin problems of natural resource management and livelihood security leading to an integrated use of resources. The grass root level institutions helps to reduce the environmental and social transaction cost in the development process. Reddiyarchatram Seed Growers Association (RSGA) is one of the grassroot institution evolved in this region to promote sustainable agriculture and rural development. Small and marginal farmers constitute the majority, and one third of them are women farmers in the association. They are organizing need based capacity building programmes with the support of Commonwealth Of Learning (COL), Canada.

RSGA is managing a hub of the internet based Village Knowledge Centers (VKC) operating through a wireless Local Area Network (LAN) to serve the local villagers especially those who are deprived of access to information which are important to their day to day life. The `hub' is the nodal point, which receives the generic information and adds value by converting it to local specific information. The hub works on a 'hub and spoke model' and connected to four of the VKC located in four different villages through a self install radio network with spread spectrum modulation works in 2.4 GHz. Access is ensured to all irrespective of caste, class, gender and age. From hub to other knowledge centers messages are sent through fax protocol- the messages are stored in the temporary information folders. Each knowledge center has two medium level educated women volunteers to manage the unit, trained in handling the computers.

Methodology

The study used multiple tools for studying the traditional knowledge on weather and climate prediction. The conventional survey method, anthropological tools such as participant observation, participatory developmental tools such as Focus Group Discussion (FGD) have been utilized in the study. The conventional survey was used to study the traditional predictors by selected sample households in the villages. The anthropological tools such as open ended interview was used to study the metaphors, folklore and proverbs that gave better perspective on the traditional knowledge. A series of Participatory Rural Appraisal (PRA) exercises were organized in representative villages in the block. The exercises were focused on the social system, existing natural resources, agricultural seasons and rainfall patterns and also about the prevailing pattern and system of information flow. Through FGD the needs and constraints and coping strategies on weather and climate of farmers and agricultural laborers were assessed. Through a process of triangulation, the views expressed in the FGD were consolidated.

Three villages are selected in Kannivadi region for the study and a group of women and men farmers and laborers are the main decision maker's. The scientific forecast is made available to the farmers through networking with appropriate institutions. Information on seasonal climate predictions on precipitation and medium range weather forecast mainly on precipitation, temperature, wind velocity and other related elements are made available to the farmers.

RSGA, the farmer's organization is the central point which receives the scientific forecast data from NCMRWF and TNAU and IRICP and disseminate to other knowledge centers after processing as information. The center collects the forecast and converts them into local language after value addition (generic to locale specific) using local measurements and specific forms. The information is communicated to other villages through fax mode and can be accessible through multimedia folders using internet. The messages are also communicated to nearby villages through bulletin boards where the dynamic information is updated in a daily basis.

Traditional climate knowledge and forecasting

The subject of traditional knowledge has acquired importance in recent times. Traditional knowledge is generally 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" (Boef *et al.*, 1993). Traditional knowledge is a cultural tradition preserved and transmitted from generation to generation. It is in "contrast with the knowledge generated within the international system of universities, research institutes and private firms" (Liebenstein and Marrewijk, 2000). Traditional knowledge is playing a major role in the modern world. Pharmaceutical industry has utilized the knowledge on traditional medicine to develop modern drugs. In areas such as biodiversity and agriculture, there has been a surging interest on the indigenous knowledge.

Understanding the local peoples perception on climate is critical for effective communication of scientific forecast. Since it is learned and identified by farmers within a cultural context and the knowledge base follows specific language, belief and process. The local weather and climate is assessed, predicted and interpreted by locally observed variables and experiences using combinations of plant, animal, insects, and metrological and astronomical indicators. The different weather and seasonal climate indicators used to predict the occurrence of the rainfall are given in Table 1.

Farmer's traditional knowledge is structured into three basic groups; first set follows certain universal principles and logics, second set is based on the correlation and the third set is based on the local experience without any scientific basis. The knowledge set gives framework to explain relationships between particular events in the climate and farming. Different predictors (environmental, biological and traditional belief) are common among farmers to take critical farm decisions and adaptive measures. This knowledge is evolved by locally defined conditions and needs. It is dynamic and nurtured by observation and experiences of the men and women farmers; incorporating their perspectives by slightly modifying and using to meet current needs and situations.

Men and women have different knowledge levels and use it for different purposes. Similarly elder persons are more knowledgeable and able to give more indicators with its reliability rate. Farmers as well as agricultural laborers have their own indicators that are based on their need and interaction. The variations in the indigenous knowledge in a community are based on age, gender, kinship affiliation, ideology and literacy. The social stratification influences the evolution and management of knowledge. Socialization and social heredity (the process of learning) take place within a particular socio-cultural realm, which is determined by class and caste (or caste in class). Gender is another important dimension in the social stratification. Knowledge is passed through older generations on causal conversation and observation mostly during the practice in the field.

The indicators clearly show that this indigenous knowledge on seasonal climate and weather are qualitative in nature. Weather predictions are used to take short-term decisions both in the irrigated and rainfed systems. However, seasonal climate predictions are mostly used to prepare themselves for the anomalies. Farmers have been using different strategies to adapt and cope up with uncertain weather and climate based on their experience and acquired knowledge from previous generation.

In seasonal climate prediction farmers use metrological indicators: westerly wind during *Adi* (June - July) bring rain in *iyappsi* (Oct- Nov) and if there is no rain in the summer and wind in *Adi* (June - July) they prefer short duration crops like cowpea and they reduce their farm investment and some will invest on livestock's especially goat. Farmers have evolved contingency cropping system as a risk aversive strategy from the climate fluctuations especially for the rainfed systems. The following example shows their crop selection skills according to the variation under rainfed agro-ecosystem.

If rain set during

June-July - lablab, sorghum, redgram, groundnut, vegetable cowpea
If it is late by 15 days – cowpea, fodder sorghum
If it is late further by 15 days - green gram and blackgram
If it delays further by 15 day – Minormillets/short duration sorghum.

Other decisions are mobilizing seed, fertilizer and application, decisions on sowing (early or late), land and bed preparations, mid season corrections such as reducing population / providing irrigation

The increasing variability in climate reduced the farmer's confidence on his or her own predictors and increasingly looking for scientific forecast. However, the challenge is to provide reliable forecast through appropriate methods based on the needs of the farmers.

Scientific climate forecasting

Institutional linkages were established with National Center for Medium Range Weather Forecast (NCMRWF), New Delhi and Tamil Nadu Agricultural University (TNAU), Coimbatore and International Research Institute for Climate Prediction (IRICP), New York to get seasonal climate predictions. The institutional linkage with National Center for Medium Range Weather Forecast (NCMRWF), New Delhi for site-specific (at 20-30 sq.km) radius medium range weather forecast. A 'B' type observatory was established with the technical support of TNAU. An agreement was made with RSGA with regard to monitoring and managing the observatory. The members were trained in the management of the observatory and recording the parameters as per the IMD norms. The local parameters are recorded and being send to the NCMRWF biweekly by RSGA. The forecast is based on T80 global circulation model and two days in a week they receive forecast on rainfall, wind direction, temperature and humidity. Similarly, seasonal climate forecast information is made available to farmers during the Northeast monsoon season (winter monsoon) of 2003 with the technical guidance of IRICP and TNAU. The seasonal forecast is developed based on the regional specific predictors using the numerical statistical tools.

Decentralized forecasting system and management

The Training and capacity building programs were organized for the farmers as well as VKC volunteers. The volunteers in the hub as well as other knowledge centers were trained in weather station management, data retrieval and converting the generic data in to locale specific information. Farmer's organization is receiving the scientific forecast directly from the provider especially the medium range weather forecast from NCMRWF, New Delhi. Regarding the seasonal climate forecast till now MSSRF is helping to acquire the data. The volunteers in the hub developed multimedia folder on weather and climate and constantly it is being updated and available to other centers immediately. A general preamble on weather and seasonal climate and existing scientific forecasting skills and the related institutions were given to them as well as farmers in the selected villages. The climatology of the area by analyzing the 15-25 years daily rainfall data from the nearest sites was discussed with the farmers to start the process after studying their traditional knowledge on rainfall forecast. An analysis of conditional probability, onset, withdrawal, length of the growing season and coefficient of variability were carried out and discussed with the farmers. Attempts are being made only to communicate the forecast only to the people instead of giving follow-up advisories based on the forecast. It allows the farmer to take decisions on their own. Because under rainfed situations farmers take decisions based on the event and they have been following dynamic strategies instead of single strategy as forecasters recommend. The entire process is institutionalized through these *'village knowledge centers'*.

Bridging the knowledge systems

The scientific forecast diverges from traditional farmers prediction in scale and to some extent on predictors. Some of the principles of the predictors like wind flow, temperature changes et., of farmers converge with the scientific forecast. Farmers have been using combination of various biological, meteorological and astronomical indicators to predict the rainfall. While the scientific forecast are developed using the predictors such as wind, sea surface temperatures etc., which are primarily a meteorological indicators. The traditional forecast is highly local specific, mostly at the village level within a radius of 1-2 sq.km derived from an intimate interaction with a microenvironment observed over a period of time. But the scientific forecast are generated at much larger geographic scale i.e., 60- 300 sq.km that depends on the global metrological parameters and their dynamics. Also, farmers perceive high rainfall years/season based on locality, onset and distribution instead of the total amount of rain received in that season/year. Though the reliability of the traditional indicators is not definite, it helps the farmer to prepare for the timing and distribution, while a scientific forecast helps them to prepare for the amount.

The scientific forecast provides the quantitative rainfall in probabilistic mode for seasonal climate and determined amount for medium range weather; it does not support farmer's need interms of onset of rainfall and the distribution. It is one of the significant variable necessary for the farmers to make decisions on the initial agricultural activities. On the other hand, traditional forecast knowledge able to help the farmers interms of its possible onset using indicators such as direction and intensity of the wind during summer season, position of the moon on the 3rd day and traditional calendars (including other supportive indicators). It gives an opportunity to blend both the system of the knowledge, which was evolved during the group discussion with the farmers on seasonal climate forecast. The scientific forecast prepare the farmers in terms of its quantity while the traditional prediction helps them to know the possible onset of the rainfall. In this way it is possible to establish a continuum between scientific and traditional forecast, which combines the scale, and time of the onset of rainfall.

During 2003 winter monsoon was predicted and communicated to the farmers in two months advance in a probabilistic mode. There is a possibility of getting on average of nearly 375 mm between October to December. The probabilistic occurrence of this amount is as follows

40 % above normal
25 % normal
35 % below normal

Similarly, farmers used traditional knowledge and applied/observed wind pattern during the summer months of 2003 as a predictor. During that period the wind movement was almost nil during those months instead it happened during the subsequent month of August instead of getting more wind during June – July, that is the normal situation. According to them it indicates the delayed onset of rain about 2-3 weeks against normal. Subsequently they used the distribution of rainfall within the season using indicators such as easterly winds and moon position. During that season they received only 230mm of the rainfall, which is 39 percent lower than the normal rainfall. The experience shows that there is a possibility to bridge the two different knowledge systems and the above experience indicates the farmers' cognitive landscape, which is tuned to incorporate plurality of knowledge frameworks.

With regard to the medium range weather, the scientific forecast provides the determined quantity, and farmers predict the possible period using the metrological indicators such as lightening, cloud density and wind movement. In addition they are using other supportive indicators derived from the changes in animal/insect behaviour in the system. Thus both the knowledge system helps them to prepare the farmers for amount and possibility of occurrence.

Summary

The study clearly brought out the vast traditional knowledge of the farmers on rainfall prediction and their understanding on its reliability through their observation, experience and practice in the field. Understanding the local peoples perception on rainfall prediction is necessary to communicate the scientific forecast, since it is learned and identified by farmers within a cultural context and the knowledge base follows specific language, belief and process. Perceiving such a knowledge base facilitates social interaction and acceptance among the farmers. Without valuing the traditional knowledge it is very difficult to communicate the scientific forecast among the farmers. Thus it is necessary to bridge two different knowledge systems.

The process indicates that intensive dialogue between the scientific knowledge providers and user groups helps to define the strategies for bridging the knowledge systems. The study shows that farmers could able to bridge the two different knowledge systems since they are used to operate in multiple cognitive frameworks. The project helped us to understand that, to develop a decentralized system of forecasting system at the village level by bridging the traditional and scientific knowledge needs a participatory approach to mobilize the farmers around the technology. On the other hand, access, availability of infrastructure, skill and expertise are crucial to develop reliable region-specific scientific forecast to serve the farming societies.

At this phase due to the limited experience and observation it is difficult to derive any conclusion. It helps us to set the system and in the process slowly farmer's understanding and confidence will be built on scientific forecast and there is a vast scope to link two different knowledge systems with the participation of local people.

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Table 1. Indicators, reliability and related decisions

Indicators	**Decisions**	**Reliability (1 -3) less, medium and high**
<u>**Weather indicators : 24hrs indicators**</u> If lightening occurs from east, west and south expect rain immediately	Indirectly helps to mobilize labor for weeding, day to day activities like shifting the cattle's, other livestock and poultry birds to the shed, organizing the fuels under shade, very rarely used for pesticide application Drying and collecting the dried products from the drying yard	High, still date it is commonly used, both men and women are using
If lightening comes in a opposite direction (East to west) expect rain in another one hour	- do - Mostly used to take decisions related to the above activities	Very high, common and used by large number of farmers, both are using,
If it happens in south east and north west directions - expect rain in the night	Used to take decision on picking up fruits/flowers which are supposed to done in the next day morning	High, commonly used by all the farmers
Rings around sun	Used to decide irrigation, labor arrangement, ferilitser application and irrigation	High commonly used by all farmers
Belief is if there is a more mosquito bite	Supportive indicator	rare
<u>**2- 10 days indicators**</u> In April - May if the shade appears in the near by hill top (*thonimalai*) expect rain in another 2-5 days (*Konamalai* for Kannivadi region, *gopinathan malai* /*palani malali* for *pudupatti* village)	Activities like arranging the dry fodder heap Land preparation like summer ploughing and organizing/booking for country plough and mechanized means (tractor) Sowing of some vegetables under irrigated conditions	High, still date it is commonly used by majority of the farmers, both men and women use it
If there are small streaks in the cloud expect rain in another 2 days locally called as '*mazhai sarai*' and thorough out the year it is used irrespective of the season.	It is not used to make any decisions, but farmers used to observe this indicator to strength the other indicators	Less, used by both
If circles found around the moon if it appear as bigger size circles - expect less rainfall, if it appears small circles - expect less rainfall with in another 2 days	Land preparation – making arrangements for ploughing, labor allocation, irrigation decision, harvest decisions, and arrangements for post harvest process of the already harvested produces	High, used by both and it is also a common indicator irrespective of the moons position
North Westerly wind blows expect rain in another 2 days	Fodder and fuel arrangement Weeding, harvesting, sowing, irrigation and post harvest decisions	High reliability , commonly used, observed by both
If frog in the well makes continuous sound	Arrangements for uplifting the motor in the wells Making bookings for starting bore wells Decision on irrigation	High

	Decision on weeding	
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 plough and arranging seeds for sowing	High
During evening if the lower cloud appears red followed by black cloud at the top expect rain in another 2 days and if wind comes from south east (Saturn side) it would not helpful for rain	Decision on irrigation, plowing, sowing, harvesting and threshing	High
If dragonfly's and black sparrow flies in a group at 3-4 m height from the ground level	Decisions on threshing floor, making arrangements for fuel and fodder Keeping the livestock under protection	High
Black cloud with no stars bring rain and not the white clouds	Decision on irrigation, post harvest operation, vegetable and flower plucking, drying of fodder and fuel	Good
If body sweating is more - used as a supportive indicator	no decision is taken based on this	High, nowadays decreasing
In dec- Jan if the clouds appear black third day it will rain	Decision on harvesting, threshing, vegetable and flower plucking	High
expect rain if dog jumps irregularly on the road on the mid day Poultry birds sit in a place for a long time Sheep's move in a group (Popularly called as requesting a favour from god. (*mazhai varam ketkirathu*)	Used as a supportive indicator	Medium
If wind appears from west side expect equal amount of rainfall popularly called as *'mula kattru'* which is believed that it brings rain bearing clouds	Sowing, plowing, weeding, irrigation, harvesting and drying operations	High
Use indicators along with the rising moon from the no moon day towards full moon day	No moon day brings rainfall due to the fluctuations in the temperature. Used to make sowing, planting and plowing decisions	High
In the cyclone period if the cloud moves in a group from east to west expect rain in next two days	Irrigation, fertilizer application, harvesting, post harvest operations	High
Northeast wind brings rain and northwest (*sanimuzhai*) wipe out the rain: south or north east wind (female wind) helps to mobilize the cloud and south west wind (male wind) condense it	Gives confidence and prepare themselves for the rain	Common and reliable
If the cloud is line and clustered (sarai saraiyaga)	Decision on labor arrangement, irrigation and post harvest operations	Common and used frequently
If jet plane flies (pogaikappal)	Supportive indicator	Rare,based on personal experience

Seasonal indicators South and east side winds indicates good rain during summer months locally known as *'thennal'*	Ploughing, sowing and making arrangements for seeds and decides crops and cropping system	High
Westerly wind brings heat and south westerly bring coolness and clouds - rains during monsoon season	Sowing, planting, weeding and threshing	high
If there is more wind during (July - Aug) expect good rain at October - November	Decision on cropping pattern and farm investment	Less
In annual *panchangam* (traditional calendar) if Saturn takes upper hand brings more rain during the main rainy season	Supportive indicator used to decide community functions/festivals	Less
3 to 5th day moon if it slides on north side expects more rain during that month and sliding rain on south side indicates no rainfall.	Sowing, plowing and harvesting	Medium
Summer wind (heavy and intensity) indicates good rain during monsoon season	Used to take decisions on crop and varietal selection Manure arrangements (FYM)	High
If more number of eagles and birds flies on the top from west to east	Supportive indicator for the good rains during monsoon season	Less

Some of the beliefs related to prediction are

- *Pozhukkal minnal minninal* – If lightening occurs in evening or morning
- If the rainbow occurs
- Hot sunny day followed by cloud formation brings rain
- If beetle gives continuous sound
- Halo rings occur around the sun
- Expect rain during No moon day
- If moon starts from north side there will be rain in that month and if it is from south there is no rain in that rain.