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RESEARCH PAPER

Weather prediction through indigenous knowledge and relevance in agriculture education : A review

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Abstract: Increased user friendly weather information determines the resilience of farmers to climate change. In India, provision of local specific, reliable, timely, modern weather information services that effectively addresses the needs of farmers. Indigenous technical knowledge (ITK) is the total of knowledge and practices based on people's accumulated experience in dealing with problems related to various aspects of climate vagaries. These are undocumented and passed on from generation to generation through experimental learning processes and word of mouth. The indigenous knowledge based weather forecasting practiced by humans for millennia helps to reduce uncertainty in agriculture. Before modern weather forecasting methods, rural communities used indigenous knowledge, mostly based on observations of atmospheric conditions, astronomic and birds and animal activities, to predict weather over short and long periods. This reviewed paper highlighted and documented indigenous weather forecasting knowledge of the farming community. It can be improvised and used effectively for disaster risk reduction in inaccessible areas.

Key words : Bio Indicators, Indigenous knowledge, Monsoon, Prediction, Weather

Introduction

Among the factors which control agricultural production, weather is the only factor has an overwhelming dominance over the success or failure of crop production. It is an accepted fact that food production is directly linked with climate and weather. Indian monsoon is a gamble with a food basket. They also reported that weather induced variability of food production can be as high as the normal production regarding smaller areas of rained crop production. In order to lower the risks of loss in food production because of the vagaries of weather, it should be one of the major inputs in agricultural planning (Banerjee *et al*., 2003). It may be reason weather forecast plays a vital role in agricultural production. It also helps to minimize crop losses to a considerable extent. Thus, development and improvement of the art of weather prediction has been essential since time immemorial. Presently, we have many improved technologies for weather forecasting as well as their dissemination to stake holders. Previously, when there was no such technology available, farmers used to predict weather phenomena based on their natural, cultural and social phenomena (Waiwai and Malsale, 2013).

Types and sources of climate information

Farmers across India access different weather information. These include onset of rainfall, duration of the cropping season, expected rainfall amount and distribution. Meteorological and astrological indigenous weather forecasting indicators include direction and strength of winds, star-moon alignment, apparent movement of stars, direction of the moon crescent, types of clouds, temperature conditions, lightning and thunder, color of the sky and rainbow to forecast the next rainy season.

Indigenous knowledge weather and climate forecasting

Farmers use a combination of plants, animals, and insects, meteorological and astrological indicators, to predict local weather (Egeru, 2012). It commonly practices indigenous knowledge of weather and seasonal climate forecasting in many regions of the world (Shoko, 2012; Risiro et al., 2012). In this paper, we grouped indigenous knowledge based indicators into biological, non biological and meteorological indicators.

Bio indicators

Farmers predict local weather by observing different activities or movement of birds and animals.

Table 1. Bio indicators for short range rain forecasting

Sl. No	Indicator	Explanation	Conformity
1	Movement of Dragon fly	Dragon fly starts movements in a swarm, just before when humidity attains saturation, indicating rain	Sivanarayana (1993)
2.	Flapping of ears by goats	Higher moisture causing uneasiness and sweating to goats, flapping of ears	Chhaganbhai (1992)
3	Fox howling in the morning and evening	Foxes sense the increase in relative humidity in the morning and evening and they reflect the same through howling, indicating impending rain.	
4	Jumping of cattle	Cattle expect rain and jump joyfully few hours before by sensing cool breezes developed before rain.	
5	Poultry inserting feathers in the soil	Poultry birds respond to the increased moisture content, by relishing some hotness while pushing their wings into the soil.	

6	Flocking of goats and sheep	Poultry birds respond to the increased moisture content in the soil, by relishing some hotness while pushing their wings into the soil.	Seetharaman (2001)
7	Biting nature of housefly	Houseflies become active when atmospheric humidity reaches saturation, which brings rain.	
8	Movement of termites in rows	Whenever atmospheric and soil surface humidity are increasing, termites move in large numbers in rows. Since we expect rain when humidity is more, we believe these termites to indicate rain in a few hours.	
9	Dogs barking frequently	Due to release of heat from water vapour into the atmosphere, convective cloud formation takes place, resulting in restlessness among dogs, indicating ensuing rain	
10	Appearance of insects in large numbers during rainy season	Abrupt increase in the moisture causing saturation and rain.	
11	Peacock making sound early in the morning, late in the evening	Sometimes a cool breeze along with nearly saturated atmospheric humidity co-exist. Hence, peacocks play and exhibit rhythmic movements, which shows the occurrence of rain.	
12	Activity of Red hairy caterpillar	The adults of red hairy caterpillar become restless as the humidity increases beyond 90%. Consider their active movement as an indicator of rain.	
13	Frogs croaking underneath stones	Because of lack of oxygen, frogs come out of holes for want of air. Hence they croak.	Lishk (1983)
14	Movements of ants in a row	Ant's hair lengthens because of the increase in the humidity, triggering carrying the eggs to a safer place. This process is observed with thousands of ants moving in a stream, there by indicating rain.	Selvanayagum (1991)

Table 2. Bio indicators for long range forecasting

Sl. No	Indicator	Explanation	Conformity
1	Termites make hills at corner bunds (medium range)	Because of soil moisture differences in soil surface to that inside the soil, termites come to the hills, showing ensuing rain.	
2	Positioning of nest by weaver bird	Whenever weaver birds built a nest at the lower side of the well, it indicates well is not reached because of deficit rain. However, if the nest is built at the upper side of the well, it indicates good rainy season. Also, the possibility that this bird observes the clouds, sky condition and weaves its nest slightly above the water level in the well, expecting possible good rain.	
3	Full bloom of neem tree in summer	When temperatures exceed 40 oC for a week, low pressure is created. Clouds move into the low pressure after onset of monsoon triggering heavy rains.	Chhaganbhai (1992)

Table 3. Non Bio indicators for rain forecasting

Sl. No	Indicator	Explanation	Conformity
1	Dampness of jaggery, indicator tamarind and salt	Increasing humidity results in an increase in water vapour content in the atmosphere. On saturation, water vapour gives rise to clouds bearing rains. Since relative humidity and absolute humidity are considered as factors that determine the response of these materials, a sign of the occurrence of rain.	
2	Smell of dried fish	When dried fish absorb moisture, some smell emanates. Over 80% of relative humidity has the capability to give such a smell that shows nearby rain. In tropical conditions, 80% of relative humidity coupled with air currents and gentle winds gives enough rain.	
3	More moisture in the *Tambaku* (tobacco) bag of farmers	In villages, elderly farmers usually carry a small bag for "*Tambaku*" (Tobacco) for Hukka (Smoking device). When this bag shows more moisture in the *Tambakku* then farmers predict rainfall within one or two days.	

Meteorological indicators

Farmers are using different indigenous local knowledge of atmospheric conditions for predicting rainfall.

Astrological indicators

Astrological indicators were more pronounced among the range of indicators used for weather forecasting, interpreting

Table 4. Meteorological indicators for short range rain forecasting

Sl. No	Indicator	Explanation	Conformity
1	A sky dominantly covered with light cloud	Indicates drought	Anon (2017)
2	Easterly winds	Rain occurs through active Bay of Bengal branch of S-W monsoon wind	
3	Halo circle around the moon	Halo circle around the moon is formed because of high moisture content in the atmosphere. Halo is effectively seen as night progresses.	Verma (1998)
4	Less thunder sequence	High clouds travelling at a far away distance	
5	Northern winds with rain bearing clouds	Rain due to N-E Monsoon	Selvanayagum (1991)
6	Roaring sea	Salts released because of interaction of sea surface with atmosphere act as condensation nuclei, resulting in rains. The more the roaring, the greater is the possibility of rain occurrence.	
7	Wind direction closer to 90^0	Carrying of water vapour and heat by wind. These components form the basis for rain occurrence when wind shifts its direction.	
10	Dull / dark sky	Higher moisture in the atmosphere and formation of low clouds results in a moderate to heavy rain depending on the wind speed.	
9	Rainbow in Sunny weather	This is because of high relative humidity. Water vapour becomes saturated, resulting in rains. When rain is occurring, rainbow also appears because, within its vicinity, clouds are absent. This indicates no possibility of further rain.	
10	Westerly winds during June to September	Rain occurs due to S-W monsoon, if these seasonal winds persist for 2-3 days.	
11	Lightning in the east	Clouds at a long distance, which results in onset of rains after a gap of 7- 8 hours.	
12	Dark clouds moving towards East	Movement of low clouds associated with precipitation in the lower atmosphere	Verma (1998)
13	Clouds in N-W - direction (S-W monsoon)	Slow-moving clouds are characteristic of SW monsoon that gives rain.	Gupta (1993)
14	Lightning in S-E during N-E monsoon	Lightning points that N-E monsoon is active and shows rain.	
15	Cool breeze	Cool winds with moisture in the atmosphere triggers saturation with existing clouds, resulting in rains.	
16	Low clouds	Stratocumulus, stratus and nimbostratus are rain bearing low clouds	
17	Overlapping clouds	Presence of stratocumulus clouds gives rain.	
18	Lightning in N-E before onset of S-W monsoon	Because of active Bay of Bengal branch of S-W monsoon, lightning occurs in N-E, giving indication of good rains	
19	High humidity and temperature	With an increase in temperature, thermo humid situation prevails leading to sweating, showing nearby rain.	
Medium range forecast			
1	Red clouds at sunrise and sunset	Clouds reflect long wave radiation (Red colour and above) when they are dark and water bearing. Hence the occurrence of rain.	Selvanayagum (1991)

2	Presence of water vapour and warm clouds	Water vapour acts as condensation nuclei for warm clouds, giving rain.
3	Westerly winds during Indicator N-E monsoon	Winds carry both water vapour and heat essential for cloud formation, rains in November
4	Seasonal reversal of wind direction	Wind is the carrier of moisture, and rain occurs from the clouds when enough moisture is available. Both wind and clouds move in the same direction, resulting in rain
5	Hot and desiccating winds from west	Hot winds blowing for nearly two months are a better indicator for ensuring good monsoon.
6	Rohini constellation ideal for onset condition of S-W monsoon.	Low pressure formation when temperatures range between 38-42oC, hot winds blowing for 15- 20 days. This results in onset of the monsoon.
7	If the first 10-15th of the May-June is hot	We predict good rainfall during the coming monsoon season because of favorable condition

alignment of the moon and stars, size and appearance of the star, and appearance and form of cloud cover. Based on star-moon alignment, traditional astrologists can forecast the timing, duration, and amount of rainfall or drought up to 6 months or years in advance. Traditional astrologists use the panchanga to choose when to observe the star-moon alignment. Climate forecast based on star-moon alignment is considered the more effective and reliable indicator to forecast and plan livestock mobility and sharing among relatives to minimize the losses due to weather adversity.

Level of Acceptance

Different indigenous weather forecasting indicators have varying levels of acceptance depending on their precision. For instance, star-moon alignment is the most dependable weather information (Anon., 2017). The challenges facing indigenous knowledge weather forecasting include insufficient documentation of the knowledge and a poor knowledge transfer system, lack of coordinated research to investigate its accuracy and reliability, death of forecast experts, and influence of religion and modern education. It plays a major role in local livelihoods and is crucial to supporting local efforts to forecast and make sense of seasonal climate situation at the local level. However, progressive loss of indigenous knowledge threatens the ability of farmers to cope with and adapt to climate change. The challenge ahead is finding ways of integrating indigenous weather forecasting with the scientific weather forecasting systems.

Summary

The study clearly brought out the farmers' vast indigenous knowledge of weather prediction and their understanding of its reliability through their observation, experience and practice in the field. Understanding the farmers' perception of weather prediction is necessary to communicate the scientific forecast, since farmers learned and identified it within a cultural context and the knowledge base. 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 shows 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 operating in multiple cognitive frameworks. Access, availability of infrastructure, skill and expertise are crucial to develop reliable region-specific scientific forecast to serve the farming societies. At this phase, because of the limited experience and observation, it is difficult to derive any conclusion. It helps us to set the system and, slowly farmer understands and it will build confidence 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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