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Short Communication

Biotic indicators as weather predictors in Wayanad district of Kerala

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Weather is certainly the most important factor determining the success or failure of agriculture. It forms the only factor over which farmers have no control. It directly influences the growth, development and yield of crops (Verma, 1998). Before the advent of modern methods of weather forecasting the rural communities used ITKs for weather prediction. The correct predictions are dependent upon the correct interpretation of indicators which is based on experience, skills and in sights of people and were applied to minimizing the risks rather than maximizing profits. Weather forecast describes the anticipated meteorological conditions for a specified place (or area) and period of time. Farmers are very astute weather watchers and they use different kinds of indigenous knowledge to predict weather. This knowledge is generally passed down from generation to generation by experimental learning and by word of mouth and is, for the most part, undocumented in written form. These local indicators and local knowledge systems cannot be replaced with scientific knowledge, as they are holistic and specific to local situations. They provide farmers with the ability to make decisions and plan in advance mostly making use of the local resources.

The study was conducted in Padinharethara, Vellamunda, Nenmeni and Mullankolly panchayats of Wayanad district of Kerala. Random sampling was followed to select 25 farmers from each of the four selected panchayats to make a total sample of 100 farmers. In addition, 20 key informants were selected purposively from the Department of Agriculture Development and Farmers Welfare, Non-Governmental Organizations working in the area viz. Wayanad district Adivasi Youvajana Samithy, Wayanad Social Service Society, M. S. Swaminathan Research Foundation, Malanad Charitable Society and Sulthanbathery Mannam Social Service Society, and Farmer Interest Organization viz. *Karshagasangams/samathy* working with traditional farmers/ indigenous/ tribal groups. Exhaustive sampling was followed to include all the four blocks (Mananthavady, Kalpetta, Sulthanbathery and Panamaram) of the district for the study. Based on area under cultivation and crop damage reported under natural calamity during the past three years (2015, 2016, 2017), one panchayat each was selected from all the four blocks.

The survey of the study area was conducted in the month of December 2017- February, 2018 using standardized measurement instruments developed for the purpose. Identification and documentation of indigenous weather forecasting practices was done with the help of key informants from different parts of Wayanad. Personnel interview method using open-ended schedules were used to collect the data. In order to ensure the collection of meaningful information, participatory tools like Focus Group Discussions (FGD) were also used involving expert farmers/ key informants, and irrelevant and irrational practices were screened off. A list of 35 biotic weather forecasting practices were identified and documented for the study (Table 1,2,3).

Validation was operationalized as the process of checking the quality of recorded ITKs in terms of its logical and factual exactness. The ITKs were validated through farmer participatory process using Use validity score (UVS) developed for the purpose and also authentication using published research findings/ theories where ever possible. Use validity of a particular ITK was measured on three dimensions viz. purpose of use (PU), extent of use (EU) and perceived reliability (PR). Raw use validity score was calculated for each of the dimensions with the maximum possible score 12 and minimum possible score 3 (Fig.1). A score sheet was prepared using the above scoring pattern for each individual farmer. The use validity score (UVS) was developed as sum of product of each component score (PUscore, EUscore, PRscore) and their respective weightage (Wpu, Weu, Wpr).

$$UVS = (Wpu * PU\ score) + (Weu * EU\ score) + (Wpr * PR\ score) \quad \ldots\ldots\ldots (1)$$

Where,

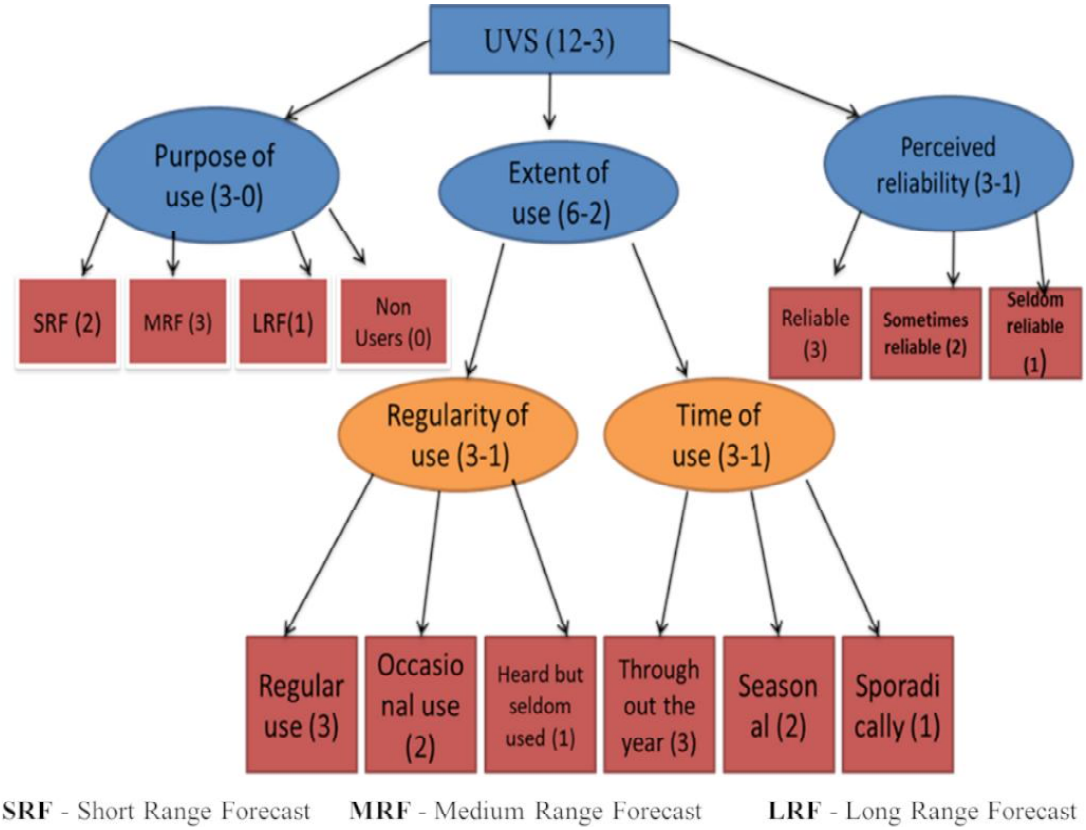

Fig.1: Flow diagram showing scores assigned to purpose of use (PU), extent of use (EU) and perceived reliability (PR) used to measure UVS

Table 1: List of plant indicators used in weather prediction and related predictions

Sl. No.	Indigenous Technical Knowledge	Weather prediction
Indicators related to plants		
1	Heavy flowering of South Indian Plum Njarapazham: *Syzygiumcaryophyllatum)*	Good rainfall
2	Fully developed three seeds in the fruits of Flame of Forest (Chamata: *Buteamonosperma)*	Good rainfall with uniform distribution throughout the season
3	Softening of stored flowers of Illipe butter tree (Aattuelippa: *Madhukanerifolia)*	Upcoming rain
4	Softening of stored tamarind (Puli: *Tamarindusindica)*	Upcoming rain
5	Heavy flowering of mango tree (*Mangifera sp.)*	Drought
6	Flowering of night blooming jasmine (Andhimulla: *Cestrum nocturnum)*	No rainfall / Dry season
7	Early flowering of Golden shower tree (Kannikonna: *Cassia fistula)*	Increasing temperature

Wpu– Weightage of PU; PUscore– Purpose of use score

Weu– Weightage of EU; EUscore – Extent of use score

Wpr– Weightage of PR; PRscore – Perceived reliability score

The above score was calculated for each farmer and the average of the scores for the sample was used as the UVS of a particular indicator. Ranking of ITKs was done based on Use Validity Score (ICAR, 2004). The weightage for each component was calculated based on the procedure developed

Table 2: List of invertebrate animal indicators used in weather prediction and related predictions.

Sl. No.	Indigenous Technical Knowledge	Weather prediction
1.	**Indicators related to annelids**	
1	Earthworms (*Lumbricusterrestris)* come out of the ground in rainy season	Ensure good rain in the particular day
2.	**Indicators related to insects**	
1	Dragon fly (*Odonata sp.*) flying low in groups	Upcoming rain
2	Swarming of winged termites/ black rainfly (*Reticulitermes sp.*) in the evening	Upcoming rain
3	Ants (*Componotus sp.*) transport eggs to safer place	Upcoming rain
4	Cicada (*Cicadoidea sp.*) singing in groups	Upcoming rain
5	Biting nature of housefly (*Musca domestica*)	Upcoming rain
6	Honey bee (*Apiscerana indica*) hide their honey comb and reduced bee activity	Upcoming rain
7	Spider makes thicker vertical webs relative to earth	Upcoming rain / Onset of rainy season
8	Crabs makes sloppy holes in soil	Good rainfall
9	Appearance of large number of grasshoppers	Upcoming rain
10	Presence of Army worms (*Spodoptera sp.)* in large numbers in paddy	No Rainfall
11	Termites (*Globitermessulphureus*) developing new mounts	Rainfall
12	Butterflies (white colour) are seen in large numbers	No rainfall

by Rao (1987). The formulae used to calculate the weights for PU, EU and PR are given below.

$$Wpu = \frac{r\ pu.eu + r\ pu.pr}{2(pu.eu + pu.pr + pr.eu)}$$

$$Wpr = \frac{r\ pr.eu + r\ pu.pr}{2(pu.eu + pu.pr + pr.eu)}$$

$$Weu = \frac{r\ pu.eu + r\ eu.pr}{2(pu.eu + pu.pr + pr.eu)}$$

Where,

Wpu – Weightage of PU; *rpu. eu* – Inter correlation between pu and eu

Weu – Weightage of EU; *rpu. pr* – Inter correlation between pu and pr

Wpr – Weightage of PR; *rpr. eu* – Inter correlation between pr and eu

Thirty-five indigenous practices related to biotic indicators used for weather prediction were identified through interviews with the key informants. These indicators were based on the phenology of certain plants and behavior of certain animals in response to changes in atmospheric conditions. Accordingly, they were categorized as plant-based indicators and animal-based indicators. Results related to plant-based indicators used by farmers of the study area are presented in Table 1.For the farmers, phenology of plants is a reliable predictor of rainfall. Good rainfall, for example, is easily predicted by the heavy flowering of *Syzygium caryophyllatum* and fully developed three seeds in the fruits of *Butea monosperma.* Prediction of upcoming raincan be explored from plant biotic indicators such as softening of stored flowers of *Madhukaneri folia* and *Tamarindusindica*.Flower initiation of *Cestrum nocturmum* was used to predict the onset of dry season. Likewise, the occurance of adverse weather conditions such as drought and increasing temperature can be predicted by heavy flowering of *Mangifera sp.* and early flowering of *Cassia fistula* respectively.It revealed the presence of seven plant-basedweather prediction indicators of which majority (57%) were related to rainfall prediction and 43 per cent of the

Table 3: List of vertebrate animal indicators used in weather prediction and related predictions

Sl. No.	Indigenous Technical Knowledge	Weather prediction
1.	**Indicator related to fish**	
1	Emergence of fish swimming near the surface of pond	Upcoming rain
2.	**Indicator related to amphibians**	
1	Frogs (*Rana hexadactyla*) croaking near swampy areas in groups	Upcoming rain
3.	**Indicator related to reptiles**	
1	Large number of snake	Good rainfall
4.	**Indicator related to avians**	
1	Jungle owlet (*Glaucidiumradiatum*)make special sounds	Upcoming rain
2	Grey wagtail (Mazhakunni / Kunnikili flies/ Nilamkulukkipakshi: *Motacillacinerea*) fly down to the earth in groups	Upcoming rain
3	Eagle (Chembarundhu: *Haliasturindus*) make special sounds and flies low	Upcoming rain
4	Unusual chirping of Hill myna (*Gracularegiosa*) and aggressive behaviour	Upcoming rain
5	Greater Coucal (Uppan/ chamboth*: Centropussinensis*) making special sounds	Upcoming rain
6	Peacock (*Pavocristatus*) making special sounds and make rhythmic movements	Upcoming rain
7	Indian grey hornbill (*Ocycerosbirostris*) make noise	Upcoming rain
8	Chickens (*Gallus gallus*) staying under shade and bathing in dust	Upcoming rain
9	Crows (*Corvussplendens*) cry during the night	Drought
5.	**Indicator related to mammals**	
1	Jumping of cattle (*Bostaurus*)	Upcoming rain
2	Unusual barking and restlessness of street dogs (*Canisfamiliyaris*)	Rain
3	Malabar giant squirrel (Malayannan: *Ratufaindica*) seen in large numbers	No rainfall

indicators were associated with the prediction of dry periods. This reiterates the significance of rainfall related forecasts for farmers above all other factors that influence crop production.

Different biotic indicators related weather predictions based on animals were grouped into invertebrates and vertebrates' category. The results from the tables showed 13 indicators reported from invertebrate categories (Tabel 2) and 15 from the vertebrate group (Table 3). Insects dominated in the invertebrate category and within the vertebrate category the dominant group was the avians. In the invertebrate category 69.2 per cent of the indicators were related to rainfall prediction and 30.8 per cent of the indicators were related to prediction of dry season. Same trend was seen in vertebrates, 73.3 per cent of the indicators were related to rainfall prediction and only 26.7 per cent of the indicators were related to prediction of dry seasons/ drought. This again conforms the significance of rainfall related forecasts for farmers above all other factors that influence crop production. Out of the thirty-five biotic indicators majority (42.9 %) indicators were associated with vertebrates including fishes, amphibians, reptilians, avians and mammals, 37.1 per cent indicators were related to invertebrates these included the insects and annelids. Only 20 per cent of the indicators were related to the flowering and fruiting penology of plants.

Indigenous biotic indicators with high UVS (>2.56) based on farmers' perception is given in Table 4. The results

Table 4: Indigenous biotic indicators with high use validity (>2.56) based on farmers' perception N=100

Sl. No.	Indicator	RawUVS	Weighted UVS	Rank
1	Swarming of winged termites in the evening indicate rainfall	8.94	3.03	Rank 1
2	Frogs croaking near swampy areas in groups indicate rainfall	8.87	3.00	Rank 2
3	Grey wagtail flying down to the earth in groups indicate rainfall	8.30	2.92	Rank 3
4	Dragon fly flying low in groups indicated rainfall	8.29	2.71	Rank 4
5	Indian grey hornbill make noise indicate rainfall	8.12	2.69	Rank 5
6	Early flowering of golden shower tree indicates increasing temperature	8.02	2.67	Rank 6
7	Peacock making special sounds indicate rainfall	7.76	2.62	Rank 7
8	Chickens staying under shade and bathing in dust indicate rainfall	7.68	2.57	Rank 8

from the table showed that out of the 35 biotic indicators documented, eight indicators had UVS > 2.56. They were swarming of winged termites, frogs croaking near swampy areas, grey wagtail flying down to the earth, dragon fly flying low in groups, Indian grey hornbill making noise, peacock making special sounds and chickens staying under shade and bathing in dust. All of these indicated rainfall and had the respective UVS scores between 2.57 and 3.03. Early flowering of golden shower tree was the only indicator with high UVS of 2.67 that was used to predict dry weather. It indicated increase in temperature. Twenty-one indicators had medium UVS scores that ranged between 1.43 and 2.56 and six indicators that had low UVS (< 1.43) scores.

It can be inferred from the results that most of the indicators had medium (21 no.) or high use validity (8 no.) among farmers. Indicators with high UVS were mostly based on observations of biological processes related to plants and animals. As the difficulty of observation increased in terms of requirement of specific details and skills the popularity of indicator showed a decreasing trend towards medium to low levels. Among biotic indicators, all the three top ranked indicators were used for the prediction of rains and were associated with swarming of winged termites in the evening, frogs croaking near swampy areas in groups and grey wagtail fly down to the earth in groups with UVS 3.03, 3.00, 2.92 respectively.

Based on UVS eight biotic indicators were grouped under high UVS category (> 2.56). All the three top ranked indicators were used for the prediction of rains. As the difficulty of observation increased in terms of requirement of specific details, the popularity of indicators showed a decreasing trend towards medium to low levels.

In conclusion, ITK indicators have for years been and still continue to be widely used by farmers across the district, this study therefore was timely, coming at a time when the users of ITK who are predominant agriculturalist require proper documentation of its effective use.

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