Validation of Traditional Meteorological Principles in Saurashtra, India

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Introduction;

Saurashtra, located in the western part of Gujarat state is predominantly a dry land farming area. Since the early seventies, it has been identified as a drought prone area. The occurrence of drought has become a regular phenomena of the region and other adjacent parts of the state. Monsoon (from June to September) is characterized by irregular, erratic and uneven showers.

The farmers of this region give a lot of weightage to prediction of the onset of monsoon since the choice of cropping pattern depends on that. Early showers would enable a farmer to go for long duration crops such as ground-nut (spreading type), cotton and sesamum. On the other hand delayed monsoon could mean restricting the choice to pulses, pearl millet, castor and bunch type of ground-nut.

Although Indian satellite technology has made considerable progress since independence, the monsoon predictions made by the Department of Meteorology are not very helpful to farmers in making choices related to cropping pattern. This is because the department makes long-range predictions only for the nation as a whole. In the case of specific regions, the predictions are of short ranged in nature i.e. for a period of three days only. As a result farmers in Saurashtra (as in many other dry land regions of India) rely mainly on indigenous meteorological beliefs and knowledge to make predictions regarding monsoon. They base their crop-mix decisions on predictions made by local experts.

The farmers' beliefs in traditional meteorological beliefs are quite strong. The local experts use methods and principles evolved by eminent Astronomers and Astrologers such as Varahmihir (700-800 A.D.), Poet Ghagh (1200-1300 A. D.), Unnad Joshi (1350-1400 A. D.) and Bhadli (1000-1200 A. D.). Many of the principles were embedded in cultural and religious books or carried on from generation to generation by word of mouth.

The Junagadh Campus of Gujarat Agricultural University is located in the heart of Saurashtra region. The university has been contributing to the development of agriculture in the region since 1960. In this paper our experience of participatory meteorological assessment and prediction with farmers of Saurashtra, based on traditional beliefs and principles of the region is presented. The process initiated in 1990 has taken the form of an informal network of local experts and formal scientists which provides voluntary service to the people of Saurashtra by making predictions on the basis of collective assessment.

(1) Structure of the Paper:

Methodology

The paper is divided into four sections. After providing a brief review of the traditional meteorological knowledge and principles of the area (section one), the description of the beliefs those were chosen for validation and systematic assessment is depicted(section two). Then the detail of the process by which local experts got involved in the systematic scaling up and refinement of their techniques (section three),and finally the concluding section(four) is presented.

Traditional principles: A brief review of literature

Bhadli (circa 12th century) described ten "chieftains" (variables) responsible for the development of "ethereal embryo" of rain. these are: wind clouds, lightning, colours of the sky, rumbling, thunder, dew snow, rainbow and occurrence of orb around the moon and the sun. Bhadli considered the interactions of these variables with inter-planetary, stellar systems during each of the 12 lunar months to characterize rainfall patterns through out the year.(**Constellations in Appendix 1**)

Raman (1960) identified general atmospheric situations as indicators of a healthy conceptions of the "ethereal embryo". some of these are listed below:

1. Gentle and agreeable wind from the north, northeast and east.
2. Clear sky.
3. Soft, white deep halo around the moon or the sun.
4. Dark coloured sky – as dark ass crow's egg.
5. Sky overcast with huge, bright dense clouds.
6. Needle shaped or sword shaped clouds.
7. Blood red clouds
8. Rainbow in the morning or in the evening.
9. low rumblings of thunder.
10. Lightning
11. Appearance of a "mock sun".
12. Planets and stars shining in full form and with soft light.

Similarly, **Golakia** (1992) collected local beliefs regarding occurrence of drought based on meteorological observations:

1. If the sky acquires a faint yellow colour, there is less hope of rain.
2. If crow coloured clouds are observed throughout the day while and night sky remains clear, a drought is indicated.
3. If the velocity of wind is not high during *Mrighirsh* constellation[1] and high heat is not experienced during *Rohini* constellations a drought can be expected to follow.
4. If it does not rain in *Adra* and no winds occurs in *Mrighirsh* then a drought would occur.
5. If the wind blows from east during the month of *Shrawan* and from southwest during the month of *Bhadrapad*, a severe drought could be expected.
6. Occurrence of wind with velocity on the fifth day of the first fortnight of *Shrawan* month is indicative of severe drought.
7. Occurrence of rain in the presence of sunshine is an indicator of poor rainfall in the near future.

Biological indicators of monsoon have also been well documented and are extensively used by local experts.

Kanani *et. al.*(1995) documented various tree species those have been used as indicators of monsoon by the local communities (see Table 1).

Table 1: Flowering & foliage of tree species as indicators of rain

Name of Species	Indicator	Expected Outcome
Mahuda, *Madhuca latifolia*	Good foliage	Good monsoon
Bamboo spcs.	Good foliage	Drought, rat attack
Ber, *Zyzyphus mauritiana*	Heavy flush of fruit	Average monsoon
Darbha grass *Eragrostis cynosuroides*	Appearance of good foliage	Good monsoon
Billi, *Aegle marmelos*	Good foliage	Subnormal monsoon
Pipal, *Ficus religiosa*	Good foliage	Adequate rain
Khejro, *Prosopis cineraria*	Heavy foliage	Drought
Kothi, *Limonia acidissima*	Good growth	Stromy rain
Neem, *Azadirachta indica*	Heavy flush	Drought

Observations on the behaviour of specific birds and animals have also been used as indicators of rain, as reported by Savalia *et. al.* (1991) and Golakia (1992) (See Table 2).

Table 2: Behaviour of Birds and Animals as Predictors of Rain

Indicator	Expected outcome
Sparrow bathing in dust	good rain
Kachinda (Chameleon) climbs the tree and assumes black-white-red colours	Immediate rain
Frogs start singing in the initial days of the *Jayestha* (May)	Early rain
Batairs (a bird) sing in pairs	Certainty of rain
Peacocks cry frequently	Rain within a day or two
Crows cry during the night and foxes during the day	Severe drought
Titodi or Lapwing bird lay eggs during the night, especially on river-bands	Heavy rains
Klheu/Bapaiya (a bird) sings songs early in the morning	Rains within a day or two
Snake climbs up on trees	Drought
Camel keeps facing north-east direction, goat does not browse, crow scratches its nest	Immediate rains
Birds take bath in the dust on the full moon day of *Jayestha* (May)	Plenty of rain

Pisharoty(1993) reported that the tree *Amaltas* or Golden Shower tree (*Cassia fistula*) is a unique indicator of rain. It bears bunches of golden yellow flowers in abundance about 45 days before the onset of monsoon. This is also mentioned in *Brahad Samhita* written by Varahmihar (circa 8th century**).** The results of the same was given below.

Detail observation /prediction of monsoon based on the flowering of the *Amaltas* or Golden Shower tree (*Cassia fistula*)

Sr. No.	Assessment Year	Date of flowering in *Amaltas*	After 45 Days(As per text)	Actual date of onset of monsoon	Difference of days
1	1996	29th April	13th June	14th June	+1
2	1997	20th April	4th June	1st June	-3
3	1998	22ndApril	6th June	9th June	+3
4.	1999	30th April	14th June	17th June	+3
5	2000	26th April	10th June	8th June	-2
6	2001	29th April	13th June	14th June	+1
7	2002	23rd April	7th June	16th June	+9
8	2003	25th April	9th June	16th June	+7

The details showing observed and expected frequencies of Golden Shower Tree

Class	**Observed frequencies**	**Expected frequencies**	**Proportion observed**	**Proportion expected**
1	**46**	**45**	**.7188**	**.7031**
2	**42**	**45**	**.6563**	**. 7031**
3	**48**	**45**	**7500**	**.7031**
4	**48**	**45**	**.7500**	**.7031**
5	**43**	**45**	**.6719**	**.7031**
6	**46**	**45**	**.7188**	**.7031**
7	**54**	**45**	**.8438**	**.7031**
8	**52**	**45**	**.8125**	**.7031**
Total	**379**	**360**	**5.9219**	**5.6250**

Chi-Squre= 3.622 Prob= .7276

X^2 is found non –significant. It indicated that there is no real difference between expected frequencies and observed frequencies. This means that whether dates were expected on the basis of flowering in Amaltas(*Casia fistula*) for on set of monsoon was in agreement with the observed on set of monsoon since 1996 under the study.

Participatory Validation, Assesment & Prediction

Trigger In 1990, the Department of Meteorology had predicted normal monsoon for the nation as a whole. Although monsoon was normal in the rest of the country, it eluded the region of Saurashtra till the month of July. The farmers of the region were anxious, since the time for sowing the long duration crops and already passed by. It was during this time that I had occasions to meet two local meteorological experts.

Devji bhai Jamod, of Jetalsar village, an engine driver employed with *Indian Railways.* He was deeply interested in rainfall prediction as a hobby and used to record meteorological observations in his diary on a daily basis. Devji bhai was emphatic that there was no possibility of monsoon for that year fill the 15th of August. His assertion was based on the traditional belief that:

"If there is a rain, accompanied with lightning and "roaring of clouds" (mild thunder), on the second days of Jayestha, there will be no rain for the next seventy-two days". (Bhadli, circa 12th century)

Jadhavbhai Kathiria of Alidhra village,a farmer and school teacher, made precisely the same prediction based on the same observation.

We were intrigued by their observations and predictions and was curious to see the efficacy of this knowledge. To our surprise, their prediction came true. Exactly after seventy-two days, on the 15th August, Saurashtra experienced heavy showers, enabling farmers to plant late season crops.

So impressed were we by the successful predictions of these local experts that we decided to publicize it in the local press. Their success was reported by almost all the local dailies such as *Phoolchhab, Sandesh, Gujarat Samachar and Akila* . An appeal was also made to the readers to send information about other such local meteorological experts on Saurashtra. Many farmers wrote back, suggesting that the university should take up systematic research on the topic. This was the genesis of the project on systematic validation of traditional meteorological beliefs and principles

(2) Belief Chosen for Validation

In 1990, we initiated a research project at the Department of Extension, Junagadh campus, to take up selected meteorological beliefs for scientific validation. The following beliefs were shortlised on the basis of their popularity in the region. These have also been recorded by academicians in Gujarati, the vernacular language (Trivedi, 1986; Adhvaryu, 1974).

1. If there is rain at the beginning of *Rohini* constellation with lightning accompanied by "roaring of clouds" (light thunder) there will be no rain for the next 72 days.
2. If there is rain during *Adra* constellatins there will be rain during the next three constellations viz., *Punarvasu*, *Pushya*, and *Ashlesh*.
3. If there is rain during *Punarvashu* constellation, there will definitely be rain during *Pushya* constellation.
4. If the rain occurs on 2nd and 5th day of the first fortnight of *Ashadh*, there will definitely be more rain in 2nd fortnight of *Ashadh*, and 1st fortnight of *Shravan*.
5. If the 11th day of *Ashadh* month (known as Dev Podhi Ekadashi)falls on a Sunday, Saturday or Tuesday, then food grain will be costly and there will be 'rainy hazards" (losses on account of thunder storms and natural calamities).
6. If on the 12th day of *Kartika* month, the sky is clear at night bright moon (known as Pushpa bandh yog), the ethereal embryo will develop for the forthcoming monsoon.
7. Observations on the wind direction on *Holi* day, for a period starting about haf-hour before lighting of the *Holika* to about half-hour after its lighting, can be used to forecast the rainfall for the year (see figure 1 for the various wind directions and associated outcomes).
8. Observations on the wind direction on *Akshya Tritiya* during 3 am to 6 am can be used to predict the rainfall pattern and expected crop yield for the year (see Figure 2 for the various wind directions and associated outcomes).

The last two of these beliefs were based on Bhadli's couplets and were perceived as the most reliable indicators by majority of the local experts. These beliefs were based on the direction of the wind on two specific days viz., Akshya tritya and on the day of Holi festival. Predictions could be made not only about the ethereal embryo of monsoon. but also on secondary outcomes such as intensity of diseases and pests and expected crop yields.

Emergence of Knowledge Network

To enable farmers to record the observations on the last two beliefs, we developed diagrams (Figure 1 and 2) providing instructions of making systematic observations on the direction of the wind. These diagrams were developed after extensive consultation with local experts. In 1992, these were first published in the local dailies with an appeal to the farmers and local experts to send their observations to the GAU,. The editors of all the local dailies decided to publish these diagrams, free of charges. they felt it was an important experiment for the region and were only too happy to provide this service to the farming community, which constituted its main readership. They continued providing this support in subsequent years, in the same spirit and have published the charts every year.

In response to the initial appeal in 1992, we received more than two hundred letters form farmers all over Saurashtra. The responses were classified according to the districts and talukas from which they came. We needed collaborators form the entire region, and this classification would help in selecting potential collaborators. Two hundred collaborators were selected from the six districts of Saurashtra as follow: Junagadh (61), Amreli (45), Rajkot (37), Jamnagar (32), Bhavnagar (17) , Surendranagar (8).

(3) The Participative Research and Prediction Process

The collaborators were sent a questionnaire in which they were expected to record observations on various parameters such as velocity and direction of wind, humidity, occurrence of rainbow, occurrence of orb around moon and sun, occurrence of dew, etc. These observations were to be made for 195 days from the 1st day of *Kartika* to the 15th day of *Chaitra*. Collaborators were also expected to take observations on fixed days (for beliefs 7 and 8) as advised through the local press. The observations recorded by participating experts were tabulated each year and analyzed on the basis of criteria given by Bhadli.

On June 16, 1997, the First Seminar on Ancient Methods for Studying Rain Phenomena was organized at Junagadh in which about 60 traditional meteorologists participated. The Gujarat Agricultural University sponsored the seminar and each local expert was allowed to present his/her findings and make predictions. The predictions were documented in the proceedings and carried to the people by the local press.

The seminar was a great success and resulted in the formation of Ancient Rain Prediction Network. The seminar became an annual feature. The participation from local experts has been increasing each year. Participants come from all over Saurashtra at their own cost. Only network members are invited to present their predictions for the forthcoming monsoon. In subsequent years, local experts get a chance to review their previous predictions and make suitable improvements in their techniques. Their peers held experts who had made accurate predictions over the years in high esteem.

In term of gender, the participation of women was weak with only four women participating in the seminar. These women came from near-by villages. They had earlier attended a training programme at the farmers' Training Center, run by the Agricultural University. When they came to know about the seminar, they decided to attend.

However, this does not mean that women are less interested in the subject. One of the women participants brought to the seminar a Gujarati publication on *Bhadli's Vakya* and made it accessible to other members of the network.

In the seminar held on the 6th July 1999, a resolution was passed to establish a professional body called the "Ancient Rain Phenomena Association".The names of executives of this association is given in Appendix 1. The procedure for registration of the Association has been initiated. An executive body with seventeen members representing different parts of Saurashtra has been established. The rules and norms are now being evolved. The annual membership fee is Rs. 75/- only while life membership fee has been fixed at Rs. 525/-.

(4) Validation of Traditional Beliefs: Summary of Findings

Testing of the eight beliefs (treated as hypotheses) has been carried out since 1990. Each year the results were presented to the Agricultural Research Committee at the GAU, in order to get feedback from researchers and extension workers.

The observations taken over a period of eight years, from 1990 to 2003 indicated that seven out of the eight hypotheses have not been proved untrue so far (see Table 4). The results indicate that many of these beliefs are likely to provide reliable indicators of monsoon.

Table 4: Validation of Traditional Meteorological Beliefs in Saurashtra: Summary of Findings.

Table 4.1: Hypothesis **: If there is rain in the beginning of *Rohini* constellation with lightning accompanied with "roaring of clouds" (light thunder) there will be no rain for next 72 days.**

Inference: The belief was found true since 1990.

Year	Occurrence of Condition Specified	Rainfall (in mm. where specified)
1990	Condition observed on 25/5/90	Rainfall recorded exactly after 72 days i.e. on 16th August 1990.
1991	Condition specified did not occur	Monsoon was regular
1992	Condition specified did not occur	Monsoon was regular
1993	Condition specified did not occur	Monsoon was regular
1994	Condition specified did not occur	Rain was recorded during 72 day period
1995	Condition specified did not occur	356 mm rain recorded during 72 days period
1996	Condition specified did not occur	642 mm rainfall recorded during 72 day period
1997	Condition specified did not occur	514 mm rainfall recorded during 72 day period
1998	Condition specified did not occur	681 mm rainfall recorded during 72 day period
1999	Condition specified did not occur	312.4 mm rainfall recorded during 72 day period
2000	Condition specified did not occur	341.8 mm rainfall recorded during 72 day period
2001	Condition specified did not occur	529.7 mm rainfall recorded during 72 day period
2002	Condition specified did not occur	537 mm rainfall was recorded with 23 rainy days..
2003	Condition specified did not occur	1280 mm rainfall was recorded with 43 rainy days.

Table 4.2 : Hypothesis : If there is rain during *Adra* constellation there will be rain in the next three constellations viz., *Punarvasu, Pushya* , and *Ashlesha.*

Inference : This was found false in 1995 and hence it can be considered a reliable indicator of rain.

Year	Occurrence of Condition Specified	Rainfall (in mm)
1990	35.50 mm rainfall recorded during *Adra* constellation	*Punarvasu*-30.2, *Pushya* -18.4 *Ashlesha* -21.3
1991	13.00 mm rainfall recorded during *Adra* constellation	Punarvasu-241.05, *Pushya* -148 *Ashlesha* -43.08
1992	35.6 mm rainfall recorded during *Adra* constellation	*Punarvasu*-15.4, *Pushya* -351.6 *Ashlesha* 103.7
1993	34.4 mm rainfall recorded during *Adra* constellation	*Punarvasu*-95.8, *Pushya* -2.8 *Ashlesha* -10.9
1994	258 mm rainfall recorded during *Adra* constellation	*Punarvasu*-434, *Pushya* -117 *Ashlesha* -55
1995	No rains observed during *Adra* constellation	*Punarvasu*-361.9, *Pushya*-258.7 *Ashlesha* -22.1
1996	18 mm rainfall recorded during *Adra* constellation	*Punarvasu*-33.2, *Pushya* -285.3 *Ashlesha* -30.7
1997	152.8 mm rainfall recorded during *Adra* constellation	*Punarvasu*-117.9, *Pushya*-163.4 *Ashlesha* -23.9
1998	362.9 mm rainfall recorded during *Adra* constellation	*Punarvasu*-83.4, *Pushya* -93.2 *Ashlesha* -94
1999	67.30 mm rainfall recorded during Adra constellation	*Punarvasu200.2, pushya18.48 Ashlesha 21.50*
2000	156.30 mm rainfall recorded during Adra constellation	*Punarvasu152.60, Pushya0.60 Ashlesha 94.30*
2001	30.60 mm rainfall recorded during Adra constellation	*Punarvasu114.30, Pushya84.20 Ashlesha 153.40*
2002	277.20 mm rainfall recorded during Adra constellation	*Punarvasu12.90, Pushya32.90 Ashlesha 24.10*
2003	58.00 mm rainfall recorded during Adra constellation	*Punarvasu422.30, Pushya78.30 Ashlesha 396.40*

Table 4.3: Hypothesis : If there is rain in *Punarvasu* Constellation, there will definitely be rain in *Pushyai* Constellation.

Inference: This was found true except 2000 since 1990.

Year	Occurrence of Condition Specified	Rainfall (in mm)
1991	*Punarvasu* – 30.28	*Pushya* – 18.42
1992	*Punarvasu* – 241.05	*Pushya* – 148
1993	*Punarvasu* – 95.8	*Pushya* – 2.8
1994	*Punarvasu* – 434	*Pushya* – 117
1995	*Punarvasu* – 361.9	*Pushya* – 258.7
1996	*Punarvasu* – 33.2	*Pushya* – 285.3
1997	*Punarvasu* – 117.9	*Pushya* – 163.4
1998	*Punarvasu* – 83.4	*Pushya* – 93.2
1999	Punarvasu 200.2	Pushya 18.48
2000	Punarvasu 152.6	Pushya 0.60
2001	Punarvasu 114.3	Pushya 84.20
2002	Punarvasu 12.90	Pushya 32.90
2003	Punarvasu 58.00	Pushya 422.30

Table 4.4 : Hypothesis: If the rain occurs on 2nd and 5th day of *Ashadh* month, there will definitely be more rain during the 2nd fortnight of *Ashadh* and 1st fortnight of *Shravan* month respectively.

Inference : Except for 1995& 2001the hypothesis was found to hold

Year	Occurrence of Condition Specified	Rainfall (in mm)
1990	Rainfall observed as follows: 2nd day of Ashadh- 5mm 5th day of Ashadh- 22.34 mm	2nd fortnight of Ashadh- 37.5 1st fortnight of Shravan-59.7
1991	2nd day – 118 mm 5th day – 53.7 mm	2nd fortnight of Ashadh- 117 1st fortnight of Shravan-50.20
1992	2nd day – 10 mm 5th day – 6 mm	2nd fortnight of Ashadh-246.50 1st fortnight of Shravan-219.40
1993	2nd day – 25 mm 5th day – No rain	2nd fortnight of Ashadh- 127 1st fortnight of Shravan-1.0
1994	2nd day – 21 mm 5th day – 80 mm	2nd fortnight of Ashadh- 45 1st fortnight of Shravan-60
1995	2nd day – 10 mm 5th day – no rain	2nd fortnight of Ashadh-443.7 1st fortnight of Shravan-155
1996	2nd day – 1.9 mm 5th day – 1.2 mm	2nd fortnight of Ashadh-36 1st fortnight of Shravan-39.9
1997	2nd day – 6.3 mm 5th day – 0.2 mm	2nd fortnight of Ashadh-164.10 1st fortnight of Shravan-25.9
1998	2nd day – 20.80 mm 5th day – 63.8 mm	2nd fortnight of Ashadh-117.40 1st fortnight of *Shravan*-139.40
1999	2nd day 100.5 mm 5th day 00.00 mm	2nd fortnight of Ashadh- 21.3 1st fortnight of *Shravan*-4.80
2000	2nd day 13.00 mm 5th day 97.00 mm	2nd fortnight of Ashadh- 1.1 1st fortnight of *Shravan*-85.7
2001	2nd day 00.00 mm 5th day 00.00 mm	2nd fortnight of Ashadh-141.7 mm 1st fortnight of *Shravan*-56.8 mm

Table 4.5 : Hypothesis : If the 11th day of first fortnight of *Ashadh* (Dev Podhi Ekadashi-DPE) falls on Sunday, Saturday on Tuesday, natural hazards due to excess rainfall may occur causing food grain prices to shoot up.

Inference : Found true, except in 1995 , when it was found only partially true

Year	Occurrence of Condition Specified	Rainfall pattern and natural calamities
1990	DPE was on Tuesday (3/7/90)	Heavy rainfall recorded in Kutch, and Banaskantha resulting in floods. Food grain prices were unusually high
1991	DPE was on Thursday(22/7/91)	No natural calamities
1992	DPE was on Friday (10/7/92)	No natural calamities
1993	DPE was on Wednesday (30/7/93)	No natural calamities
1994	DPE was on Tuesday (11/7/94)	Heavy rainfall was recorded all over Gujarat Plague occurred in South Gujarat. Food grain price were high
1995	DPE was on Sunday (9/7/95)	No natural calamities, however, food grains prices were observed to be high.
1996	DPE was on Saturday (27/7/96)	Cyclone occurred with heavy rain causing extensive damage to standing crops and trees. Food grain prices were high.
1997	DPE was on Wednesday (16/7/97)	Heavy rains in North-Gujarat; prices of food grain were stable
1998	DPE was on Sunday (5/7/98)	Severe cyclone in coastal area of Saurashtra on June 8, 1998; floods in Surat city, due to heavy rainfall. Prices of food grains, potatoes and onions were very high.
1999	DPE was on Saturday(24/7/1999)	Rain observed localized and food grains price high
2000	DPE was on Wednesday(12/7/2000)	Rain observed irregular but the food grains price stable
2001	DPE was on Monday(1/7/2001)	Rain observed satisfactorily
2002	DPE was on Thursday (10/7/2002)	Rain observed satisfactorily
2003	DPE was on Saturday (20/7/2003)	1280 mm rainfall was recorded with 43 rainy days, natural hazards occurred

Table 4.6: Hypothesis : If on the 12th day of *Kartika* month, the sky is clear at night with brigaht moon (known as *Pushpa bandh yog*), the ethereal embryo is believed to have developed for the forthcoming monsoon.
Inference: Found true since 1990.

Year	Occurrence of Condition Specified	Rainfall pattern
1990	Clear sky on the specified day	Monsoon was satisfactory
1991	Cloudy sky	Monsoon was erratic an uneven
1992	Very clear sky	Normal monsoon, evenly distributed
1993	Cloudy sky	Erratic rainfall
1994	Clear sky	Regular and adequate monsoon
1995	Cloudy sky	Erratic rainfall
1996	Clear sky	Regular monsoon
1997	Clear sky and Bright Moon	Regular and adequate monsoon
1998	Clear sky and Bright Moon	Regular and adequate monsoon
1999	Cloudy sky and dull moon	Monsoon was irregular in nature
2000	Cloudy sky and dull moon	Monsoon was irregular in nature
2001	Very clear sky	Regular monsoon
2002	Cloudy sky and dull monsoon	Rain was irregular and uneven
2003	Clear sky	Monsoon was regular

Table 4.7 Hypothesis : The direction of the wind approximately half-an-hour before and after the lighting of the *Holika* on the day of *Holi* festival can be used to forecast the rainfall for the year. A set of eight hypotheses has been proposed on the basis of eight wind directions as shown **Figure 1.**

Note : This belief was pre-tested between 1990-1993 and gave positive indications. During this time the diagram shown in Figure 1 was developed, to facilitate systematic recording of wind direction by the farmers. Since 1994, recording has been made with the help of this diagram.

Inference: Found true since 1993. This belief was found to be a reliable indicator of rainfall.

Year	Occurrence of Condition Specified	Rainfall pattern
1994	**Holi was observed on 26/3/94**. Reported wind direction was from North and North-West; Normal rainfall was predicted with strong **possibility of Locust attack.**	Normal monsoon, **Locust attack caused** extensive damage to crops.
1995	**Holi was observed on 16/3/95** The wind direction was East to West indicating localized rainfall	Localized rainfall in South Saurashtra zone.
1996	**Holi was observed on 14/3/96** 153 observations from farmers were received; reported wind direction was from East to West indicating localized rainfall.	Localized rainfall
1997	**Holi was observed on 24/3/97** 143 observations were received. The wind direction in 52.5% of the cases was from Northwest and West. Good rainfall predicted.	Good rainfall
1998	**Holi was observed on 12/3/98** 111 observations were received. 55.5% indicated wind direction from Northwest and West. Good rainfall was predicted.	Good rainfall
1999	Since 1999 The observations could not be taken since 1999,	

Table 4.8: Hypothesis : Observations on the wind direction on *Akshya Tritiya* (third day of *Vaishaka* month) during 3 to 6 a.m. can be used to predict the rainfall pattern and expected crop yield for the year. a set of eight hypotheses based on eight wind directions is proposed as shown in **figure 2.**

Inference: Found true since 1990. This belief was found to be a reliable indicator of rainfall.

Year	Occurrence of Condition Specified	Rainfall (in mm)
1994	**Akshya Tritiya observed on 13/5/94.** Responses received from 504 farmers; 63% indicated wind direction form the West while 35% indicated Northwesterly direction. Heavy rain was predicted with 75% crop yield.	Prediction was completely true.
1995	**Akshya Tritiya observed on 3/5/95.** Observations received from 51 farmers; 40% indicated wind direction from the West while 30.5% showed Northwesterly wind direction. Sufficient rain resulting in about 65% yield was predicted.	The prediction came true.
1996	**Akshya Tritiya observed on 20/5/96.** Responses were received from 386 farmers. The wind direction was as follows: Northwest (30%), West (24.5%) and North (13.2%). Sufficient rain with about 65% crop yield was predicted	This was found true.
1997	**Akshya Tritiya observed on 9/5/97.** Responses were received from 243 farmers. The wind direction was as follows: West(52%), indicating good rainfall for all crops and Southwest (46%) indicating erratic rainfall. Moderate rainfall with 50% crop yield was predicted.	This was found true.
1998	**Akshya Tritiya observed on 29/5/98.** Responses received from 288 farmers. Wind direction: West and Northwest (79%), indicating good rainfall for all crops. South-West (13%), indicating erratic rainfall 75% crop yield predicted.	Rains were sufficient in all areas except Northern Saurashtra, which experienced erratic rainfall.
1999	Akshya Tritiya observations could not be taken	Rain was only 431.30mm with 30 rainy days
2000	**Akshya Tritiya observed on 6/5/2000.** Responses received from 567 farmers. Wind direction: West and Northwest (51%), indicating good rainfall for all crops. South-West (33%), indicating drought, erratic rainfall 50% crop yield predicted.	Rain was insufficient (594.80mm) with 30 rainy days. Whole region experienced erratic and uneven rainfall.
2001	**Akshya Tritiya observed on26/4/2001**. Responses received from 418 farmers. Wind direction: West and Northwest (71%), indicating good rainfall for all crops. While North-East and South-East (20%), indicating irregular rainfall. 75% crop yield predicted.	Rain was 848.60mm with 51 rainy days. It is interesting to note that it found true

2002	**Akshya Tritiya observed on 15/5/2002.** Responses received from 122 farmers. Wind direction: West and Northwest (70%), indicating good rainfall for all crops. While ES and SW (23%), indicating drought. 60 -65 % crop yield predicted.	Rain was 537.8mm with 23 rainy days.
2003	**Akshya Tritiya observed on 4/5/2003** Responses received from 149 farmers. Wind direction: West and Northwest (69%), indicating good rainfall for all crops. While South(6%)and North East(4%), indicating natural hazards. 85% crop yield predicted.	Rain was 1280.8 mm with 43 rainy days.

The data collected for the wind direction on Akshya tritya for the year 1994 to 2003 (Bearing the year 1999) were utilized to obtain prediction equation for future forecasting to plan the cropping pattern

The response of the respondents recorded from seven districts of Saurashtra region. For various variables viz; X_1, X_2, X_3 and X_4 the cropping yield potential was determined in each year.

The attempt has been made to obtain prediction for cropping potential $\acute{Y}$ for future, all four variables (X_1 to X_4) were regressed on $\acute{Y}$ and the constant generated are given in equation -1. This equation provided the considerable predictability i.e. 95 per cent.

Table : Details of dependent and predictor variables.

Year	Forecasted crop yield (Y)	Wind direction observed by the largest No. of respondents (X1)	% response received for wind direction for X1 (X2)	Wind direction observed by the second largest No. of respondents (X3)	% response received for wind direction for X3 (X4)	Total no. of respondents
1994	75	1.0	63	2	35	504
1995	65	1.0	40	2	31	51
1996	65	2.0	30	1	24.50	386
1997	50	1.0	52	8	46	243
1998	75	2.0	79	8	13	288
2000	50	2.0	51	8	33	567
2001	75	2.0	71	6	20	418
2002	60	1.0	70	8	23	122
2003	72	1.0	69	4	21	149

Prediction of rain based on the direction of Akshya tritya

$\acute{Y} = 44.0119 + 4.6658\ X_1 + 0.6054\ X_2 - 3.3965\ X_3 - 0.1116\ X_4\ (R^2 = 0.9541)$

Where,

$\acute{Y}$ = is the crop yield predicted value

X_1 = is the direction of wind observed by the largest number of the respondents at the time of Akshya tritya

X_2 = is the percent respondents of variables X_1

X_3 = is the percent respondents of variables X_2

X_4 = is the percent respondents of variables X_3

Conclusion :

Apart from validating these beliefs across the whole of the Saurashtra, the study has helped to restore the confidence of the people in their traditional knowledge and skill. The resulting knowledge network has brought together the expertise of region, cutting across formal and informal systems. Such a network helps individual experts to pool their knowledge and learn from each other. It has predicted the drought, rat attack for the farming community, a valuable service. In the past, the farmers were often faced with conflicting judgments and predictions made by local experts. Now, the wide-scale dissemination of the collective judgment of experts makes it easier for farmers to make their decisions.

The group has already acquired a high degree of credibility because of successful prediction made during the past nine years. In 1994, we got more than 500 observations on the wind directions on *Akshya Tritya* and *Holi* days. As a result, we were able to make very accurate predictions. We even predicted the likelihood of a locust attack. This prediction came true and added to our credibility.The golden shower tree found as the best indicator of the onset of monsoon since 1996.

It is this service and the resulting support and appreciation of the farming community which keep on the network going. The network emerged spontaneously and has experienced an organic growth. It exists because of the need that it helps to meet. The experimentation and prediction are likely to continue without the help of external support. In the process, valuable meteorological data will be generated and additional beliefs will be tested. We believe that such a network can serve as a model for other dry land areas, which rely on traditional experts for prediction of monsoon.

Appendix 1: NAMES AND DATES OF CONSTELLATIONS

Serial No.	Name	Approximate dates
1	*Kritika*	10-11 May
2	*Rohini*	24-25 May
3	*Mrigshirsh*	7-8 June
4	*Adra*	21-22 June
5	*Punarvasu*	5-6 July
6	*Pushya*	19-20 July
7	*Ashlesha*	2-3 August
8	*Magha*	16-17 August
9	*Purba Falguni*	30-31 August
10.	*Uttra Falguni*	12-13 September
11.	*Hasta*	26-27 September
12.	*Chitra*	10-11 October
13.	*Swati*	23-24 October
14.	*Vishakha*	5-6 November
15.	*Anuradha*	18-19 November
16.	*Jayeshtha*	2-3 December
17.	*Mool*	15-16 December
18.	*Purvashadha*	28-29 December
19.	*Uttarashadha*	10-11 January
20.	*Shrawan*	23-24 January
21.	*Dharishtha*	5-6 February
22.	*Satatitha*	18-19 February
23.	*Purva Bhadrapad*	4-5 March
24.	*Uttara Bhadrapad*	17-18 March
25.	*Revati*	30-31 March
26.	*Aswini*	13-14 April
27.	*Bharani*	26-27 April

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VARSHA VIGYAN MANDAL,
EXECUTIVE COMMITTEE, JUNAGADH

Sr. No	Name	Designation
1	Dr. D.D.Malavia	President
2	Shri.Dhansukh bhai Shah (Pune)	Vice-President
3	Shri Jeram bhai Timbadiya	Vice-President
4	Dr.M.A.Munshi	Secretary
5	Dr.A.O.Kher	Addi. Secretary
6	Dr.P.R.Kanani	Tresurer
7	Shri.R.M.Chandra	Member (Jamnagar)
8	Shri.Sajanbha Sumania	Member (Jamnagar)
9	Shri Mavajibhai Kesarabhai Patel	Member Kutch
10	Shri Ramnikbhai Vamja	Member Junagadh
11	Shri.Dipakbhai Malani	Member Amreli
12	Shri Hasmukhbhai Nimavat	Member Junagadh
13	Shri Jasmatbhai Surani	Member Bhavnagar
14	Shri Pravinbhai Vora	Member Rajkot
15	Shri Jayantibhai Patel	Member Rajkot
16	Shri Kantibhai Joshi	Member Porbandar