

Indigenous Rain Forecasting in Andhra Pradesh

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V.R.K. Murthy and Y.S. Ramakrishna**



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Preface

Weather is the most important factor determining the success or the failure of agricultural enterprises. It is an accepted fact that food production is inextricably linked with climate and weather. Farmers' use different kinds of traditional knowledge to predict rain, based on their observation of phenomena such as formation of halo around the moon, wind and cloud movement, lightning, animal behaviour, bird movement etc. Farmers' schedule their farming activities well in advance based on almanacs. International organizations such as the World Bank, UNESCO and FAO explicitly acknowledge the contribution that indigenous knowledge can make to sustainable development and poverty alleviation. Of late, rainfall variability in terms of distribution both in time and space is being acknowledged both by scientists and farmers. Being an agro-meteorologist, I believe that traditional methods combined with scientific observations can prove to be better in forecasting weather than relying on any single method. Ultimately, knowledge base has to be strengthened with an objective of attaining precision in weather forecasts for improving agro-advisories.

With climate change and changing trends in monsoon patterns affecting agricultural production systems, this timely work on participatory weather forecasting is apt for solving contemporary weather related problems faced by farmers. I congratulate the efforts put by Dr. Ravi Shankar and his team of professors in analyzing all the available traditional methods on weather forecasting. Several ITKs for rain forecasting have been documented from the farmers and the possible scientific reasons have been explained. Also, the reliability of rain prediction by almanacs and astro-meteorological methods has been compared. This work can be considered as a vital input towards integrating the efforts of both traditional and scientific weather forecast methods for realizing the opportunities along with better understanding of the limitations in their application in farm management. An effective forecast will support farmers' decision-making that ultimately improves the long-term performance of the farming enterprise, both by increasing profits and by improving sustainability indicators such as erosion, soil organic matter indices or by reducing production risks.

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1. Introduction

Farmers are very astute weather watchers and are quick to recognize weather that is either favourable or unfavourable to their production systems (Mcfarland and Strand, 1994). Local forecasting combines empirical observations and spiritual insights that draw from a variety of religious traditions (Roncoli *et al.*, 2001). It is based on many natural, cultural and social phenomena, such as presence of visible spectrum around the sun and the moon, cloud, wind direction and weather prediction through behaviour of birds and other animals. Rain forecasting based on '*panchang*' (Hindu almanac) is a common practice among farmers. Predicting weather is an important cultural component for farmers, as it is common to discuss indicators on the street, markets and with family members (Hatch, 1983). The production and application of local forecasts are deeply localized, derived from an intimate interaction with a micro environment whose rhythms are intertwined with the cycles of family and community life (Roncoli *et al.*, 2001).

The vulnerability caused by vagaries of weather situation creates a knowledge base among farmers in the form of Indigenous Technical Knowledge (ITK) that helps to overcome the uncertainties and prepares for possible events. Local indicators and local knowledge systems cannot be replaced with scientific knowledge, because they are holistic, providing farmers with the ability to decide and prepare psychologically for the coming agricultural year (Bharara and Seeland, 1994).

Mechanisms for integrating both traditional and scientific weather forecast systems would improve understanding of uncertainties and limitations to application of farm management, as well as form a basis for fitting scientific forecasts into existing decision processes of farmers (Robinson Knuthia Ngugi, 2002).

The present study was undertaken with two main objectives. One is of identifying, analyzing and documenting the ITKs of farmers' regarding rain forecasting in Andhra Pradesh. The second is to know the impact of weather forecasting in terms of reliability as predicted in

panchangs i.e., comparison of predicted rainfall with actual rainfall data recorded by meteorological department. Further, rain forecasting experiences by different experts have been described towards the end. Ananthapur, Rangareddy and Visakhapatnam districts representing three different regions of the state were selected randomly. Of the 63, 37 and 43 mandals of Anantapur, Rangareddy and Visakhapatnam districts, respectively, three mandals from each district were selected. Two villages from each mandal making a total of eighteen villages were selected. A total of 180 farmers (10 from each village) were selected as respondents. The sampling procedure followed for selection of mandals, villages and farmers was random. An open-ended interview schedule was used for collecting data from farmers.

2. ITKs of Farmers' Regarding Rain Forecasting

The ITKs are conceptualized in terms of bio indicators and non-bio indicators. Bio indicators are those living beings / biotic agents which change their behaviour with any change in the surrounding environment / weather. Non-bio indicators are those non-living phenomena / materials that change in response to the change in the surrounding environment. By watching those behavioural changes of the nature closely, people predict the present and future events like weather (Mishra, 1998). These forecasting techniques along with weather folklore and proverbs have been in vogue. These were identified and documented as follows:

The bio-indicators and non-bio indicators for rain forecasting are given in Table 1.

Table 1: Bio and non-bio indicators of Rain Forecasting

S. Indicator No.	Category	Type of Rain Forecasting	Visakhapatnam	Ranga Reddy	Anantapur	Explanation	Conformity	
1.	Movement of dragon flies	Bio Indicator	Short range	◆	◆	◆	When humidity reaches saturation, a couple of hours before, dragon flies move in swarms indicating rain.	Sivanasayana (1993)
2.	Flapping of ears by goats	-do-	Short range	◆			Increasing moisture causing uneasiness and sweating to goats, thereby flapping of ears.	Chhaganbhai (1992)
3.	Foxes howling in the morning and evening	-do-	Short range	◆			Steady increase in relative humidity with peaks at 8 AM & 5 PM. If saturation at these timings is sensed by foxes, they reflect the same through howling, indicating impending rain.	
4.	Jumping cattle	-do-	Short range	◆	◆	◆	Cattle anticipate rain few hours early by sensing cool breezes developed before rain for a short period. Therefore, they	

Table 1 contd....

S. No.	Indicator	Category	Type of Rain Forecasting	Visakhapatnam	Ranga Reddy	Anantapur	Explanation	Conformity
5.	Poultry inserting feathers in the soil	Bio Indicator	Short range	◆	◆	◆	jump joyfully. Poultry birds respond to the increased moisture content in the soil, by relishing some hotness while pushing their wings into the soil.	
6.	Flocking of Sheep and goats	-do-	Short range	◆	◆	◆	When low clouds are formed, enough energy is released from water vapour resulting in formation of excess heat, which cannot be tolerated, by sheep and goats. Hence they form flocks.	Seetharaman (2001)
7.	Biting nature of housefly	-do-	Short range		◆		Houseflies become active when atmospheric humidity reaches saturation, which brings rain.	
8.	Movement of	-do-	Short range		◆		If both atmospheric and soil surface humidity	

Table 1 contd....

S. No.	Indicator	Category	Type of Rain Forecasting	Visakha-patnam	Ranga Reddy	Anant-hapur	Explanation	Conformity
	termites in rows						are high, termites move in large numbers in rows. Since rain is expected when humidity is more, these termites are believed to indicate rain in a few hours.	
9.	Dogs barking continuously and sharply	Bio Indicator	Short range			◆	Due to release of heat from water vapour into the atmosphere, cloud formation takes place resulting in restlessness among dogs indicating ensuing rain.	
10.	Chirping of <i>Rishi pitta</i> (bird)	-do-	Short range	◆			When these birds move at heights above 0.5 kms, they sense the upper air winds and chirp. Usually rain bearing clouds occur at heights between 0.5 and 2.5 kms. Because	

Table 1 contd....

S. No.	Indicator	Category	Type of Rain Forecasting	Visakhapatnam	Ranga Reddy	Anantapur	Explanation	Conformity
							of the sensible response of these birds to the winds, farmers predict rain. It is also believed that if these birds fly in rows after the occurrence of rain, the possibility of further increase in rain is very high.	
11.	Parabolic flight of open stork bill (<i>Natagullalu</i>)	Bio indicator	Short range	◆			Response to change in winds at higher altitudes (around 0.6 km) brings about a change in behavioural pattern of these birds in the form of a parabola shaped flight. This indicates rain.	
12.	Movement of <i>Dinakollelu</i> bird	-do-	Short range		◆		Response to change in winds at higher altitudes (around 0.6 km) brings about sudden movement of	

Table 1 contd.....

S. No.	Indicator	Category	Type of Rain Forecasting	Visakhapatnam	Ranga Reddy	Anantapur	Explanation	Conformity
13.	Appearance of <i>Chakali purugu</i> (insect) in large numbers at onset of monsoon	Bio Indicator	Short range		◆		these birds in the atmosphere, indicating rains. Abrupt increase in the moisture causing saturation, thereby rain.	
14.	Peacock making sound early in the morning, late in the evening	-do-	Short range		◆		Sometimes cool breeze along with nearly saturated atmospheric humidity co-exist. Hence, peacocks play and exhibit rhythmic movements, which indicates possible occurrence of rain.	
15.	Movement of <i>Jangamaiyyalu</i> (Red hairy caterpillar)	-do-	Short range		◆		The adults of red hairy caterpillar become restless as the humidity increases beyond 90%. Their quick movement is considered as an indicator of rain.	

Table 1 contd.....

S. No.	Indicator	Category	Type of Rain Forecasting	Visakhapatnam	Ranga Reddy	Anantapur	Explanation	Conformity
16.	Frogs croaking underneath stones, leaping of small frogs	Bio Indicator	Short range	◆	◆		Frogs under stones become restless because of deficient oxygen and come out of holes for want of air. Hence they croak.	Lishk (1983)
17.	Squeaking of owls	-do-	Short range		◆		Owls are blind to light but sensitive to humid conditions. The fear of increasing humidity and heat released by clouds instigates restlessness among owls. The peculiar squeaking sound of owls has been attributed to be an indicator of rain.	
18.	Migration of <i>parakeets</i> in N-S direction	-do-	Short range			◆	Presence of moisture and possible occurrence of rain.	
19.	Singing of black cuckoo	-do-	Short range	◆	◆	◆	Change in wave motion of air due to change in water vapour content	Shukla(1989)

Table 1 contd....

S. No.	Indicator	Category	Type of Rain Forecasting	Visakhapatnam	Ranga Reddy	Anant-hapur	Explanation	Conformity
							on a large area is sensed by cuckoo and is induced to sing. These melodious sounds are often taken as indicators of rain on any given day during that season.	
20.	Movement of black ants in a row	Bio Indicator	Short range	◆	◆		Hair of ants lengthens due to increase in the humidity triggering the process of carrying the eggs to a safer place. This process is observed with thousands of ants moving in a stream, thereby indicating rain.	Selvanayagum (1991)
21.	Number of seeds in the fruits of <i>Butea monosperma</i>	-do-	Short range		◆		Petiole of <i>Butea monosperma</i> is sensitive to changes in the humidity. So length of the fruit it bears also changes. Usually each	Sivanarayana (1993)

Table 1 contd....

S. Indicator No.	Category	Type of Rain Forecasting	Visakha-patnam	Ranga Reddy	Anant-hapur	Explanation	Conformity
						<p>fruit bears three seeds. Farmers believe if seed base of the fruit develops into full size, rains occur early in the season. If middle seed develops, rains occur heavily in the middle of the season. When seed is at the top of the fruit, rains occur at the end of the season. If all the three seeds develop fully, then good rainfall is predicted with uniform distribution throughout the season. So, when the monsoon winds start blowing, the seed near the petiole (first seed) develops fully in a short time. If the winds are further strong, middle seed develops. Similar</p>	

Table 1 contd....

S. Indicator No.	Category	Type of Rain Forecasting	Visakhapatnam	Ranga Reddy	Anant-hapur	Explanation	Conformity
22.	Termites developing living Indicator hills at corner bunds	Bio	Medium range	◆		is the case with third seed development. It can be concluded that seed development in fruits of this tree is directly related to the monsoon winds blowing.	
23.	Positioning of -do- nest by weaver bird	-do-	Long range	◆		Because of soil moisture differences above soil surface to that inside the soil, termites come to the hills indicating ensuing rain. If the nest is built near the bottom of the well, it acts as an indicator of poor recharge in the well due to poor monsoon. Contrast to this, if the nest is built at the top of the well, it indicates	

Table 1 contd....

S. No.	Indicator	Category	Type of Rain Forecasting	Visakhapatnam	Ranga Reddy	Anantapur	Explanation	Conformity
24.	Full bloom of neem tree in summer	Bio Indicator	Long range			◆	good monsoon. Also, the possibility that this bird observes the clouds, sky condition and weaves its nest slightly above the water level in the well anticipating possible good rain.	Chhaganbhai (1992)
25.	Wind blowing from East	Non-bio indicator	Short range	◆			Rain occurs through active Bay of Bengal branch of S-W monsoon wind.	
26.	Halo around the moon	-do-	Short range	◆	◆	◆	Halo around the moon is formed due to high moisture content in	Verma (1998)

Table 1 contd....

S. No.	Indicator	Category	Type of Rain Forecasting	Visakhapatnam	Ranga Reddy	Anantapur	Explanation	Conformity
27.	Less thunder sequence	Non-bio Indicator	Short range	◆			the atmosphere. Halo is effectively seen as night progresses. High clouds travelling at a far away distance become nimbostratus clouds giving rain	
28.	Northern winds with rain bearing clouds	-do-	Short range	◆			Rains due to N-E monsoon	Selvanayagum (1991)
29.	Eastward winds bring cyclones	-do-	Short range	◆			Depression in N-E monsoon period during November – December thereby cyclone formation	
30.	Roaring sea	-do-	Short range	◆			Salts released due to 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.	

Table 1 contd....

S. No.	Indicator	Category	Type of Rain Forecasting	Visakhapatnam	Ranga Reddy	Anantapur	Explanation	Conformity
31.	Wind direction closer to 90°	Non-bio Indicator	Short range	◆			Carrying of water vapour and heat by wind. These components form basis for rain occurrence when wind shifts its direction.	
32.	Pink coloured sky in the evening	-do-	Short range	◆			Mie scattering along with high relative humidity (more than 90) and low temperatures in the evening results in short duration high intensity rains.	
33.	Dark rolling clouds	-do-	Short range	◆			Stratocumulus clouds (dark colour) form into stratus and nimbostratus in East direction in a short span of time resulting in rain.	Sivanarayana (1993)
34.	Dull / dark sky	-do-	Short range	◆			Increase in moisture and formation of low	

Table 1 contd....

S. Indicator No.	Category	Type of Rain Forecasting	Visakha-patnam	Ranga Reddy	Anant-hapur	Explanation	Conformity
35.	Rainbow in sunny weather indicator	Short range	◆	◆	◆	clouds for more than 1-day results in a moderate drizzle to heavy rain depending on the wind speed. This is due to high relative humidity. Water vapour becomes saturated because of copious amounts of water vapour entering into that area, resulting in rains. When rain is occurring rainbow also appears because, within its vicinity clouds are absent. This indicates no possibility of further rain.	
36.	Westerly winds -do- of S-W monsoon	Short range	◆			Rain occurs due to Arabian sea branch of S-W monsoon, if	Gupta(1993)

Table 1 contd.....

S. No.	Indicator	Category	Type of Rain Forecasting	Visakha-patnam	Ranga Reddy	Anant-hapur	Explanation	Conformity
37.	Lightning in the East	Non-bio Indicator	Short range		◆		these seasonal winds persist for 2-3 days. Clouds at a long distance, which results in onset of rains after a gap of 7-8 hours.	
38.	Dark clouds moving East (S-W monsoon)	-do-	Short range		◆		Movement of low clouds associated with precipitation in the lower atmosphere.	Verma(1998)
39.	Clouds in N-W direction (S-W monsoon)	-do-	Short range		◆		Slow moving clouds are characteristic of S-W monsoon that give rain.	Gupta(1993)
40.	Lightning in S-E during N-E monsoon	-do-	Short range		◆		Lightning points that N-E monsoon is active and is indicative of rain.	
41.	Clear sky	-do-	Short range		◆		There is a strong relationship between pressure and weather. High pressure	

Table 1 contd....

S. No.	Indicator	Category	Type of Rain Forecasting	Visakhapatnam	Ranga Reddy	Anantapur	Explanation	Conformity
42.	Rainbow in the West during S-W monsoon	Non bio indicator	Short range		◆		followed by low-pressure gives rise to monsoon clouds. They give heavy rains. Because of more depth and heavy coverage of sky, rainbow appears in west. This is an indication of onset of S-W monsoon.	
43.	Cloud movement at right angles to each other	-do-	Short range		◆		Vertically moving water bearing clouds join horizontally moving clouds, giving enough possibility of heavy rains in short duration.	
44.	Cool breezes with moisture	-do-	Short range		◆		Cool winds with moisture trigger saturation with already existing clouds resulting in heavy rains.	

Table 1 contd....

S. No.	Indicator	Category	Type of Rain Forecasting	Visakhapatnam	Ranga Reddy	Anantapur	Explanation	Conformity
45.	Dark gigantic clouds in the west (S-W monsoon)	Non-bio Indicator	Short range		◆		Formation of cumulonimbus clouds in West direction preceding the arrival of S-W monsoon.	
46.	Dark gigantic clouds in South (N-E monsoon)	-do-	Short range		◆		Formation of cumulonimbus clouds in South direction preceding the onset of N-E monsoon.	
47.	Low clouds	-do-	Short range		◆		Stratocumulus, stratus and nimbostratus are rain bearing low clouds. Any one or all of these three types give rains.	
48.	Stationary clouds during transition phase from S-W to N-E monsoon.	-do-	Short range		◆		Advance of N-E monsoon into areas where S-W monsoon is receding. This gives rise to localized rains up to few hundred square km because of	

Table 1 contd.....

S. No.	Indicator	Category	Type of Rain Forecasting	Visakha-patnam	Ranga Reddy	Anant-hapur	Explanation	Conformity
49.	Pre dawn fully covered sky	Non-bio indicator	Short range		◆		these stationary clouds. In the absence of solar energy, accumulated moisture in the atmosphere tries to form into clouds in addition to the already existing clouds. This results in rain.	
50.	Overlapping clouds	-do-	Short range		◆		Presence of stratocumulus clouds gives rain.	
51.	Lightning in N-E before onset of S-W monsoon	-do-	Short range			◆	Because of active Bay of Bengal branch of S-W monsoon, lightnings occur in N-E giving indication of good rains.	
52.	Lightning	-do-	Short range			◆	Rolling of stratocumulus clouds in the sky gives rise to light to moderate	

Table 1 contd....

S. No.	Indicator	Category	Type of Rain Forecasting	Visakha-patnam	Ranga Reddy	Anant-hapur	Explanation	Conformity
	straight over head						lightnings. Hence rain is possible through the nimbus clouds formed out of stratocumulus clouds within a day.	
53.	High humidity and temperature	Non-bio Indicator	Short range			◆	With increase in temperature, thermo-humid situation prevails leading to sweating indicating nearby rain.	
54.	Low clouds moving in opposite direction	-do-	Short range			◆	Bundles of stratocumulus clouds moving in opposite direction give rain.	
55.	Winds (short duration) in criss cross direction after the commencement of rain	-do-	Short range			◆	Stratocumulus clouds become nimbostratus clouds and give continuous heavy rain.	

Table 1 contd.....

S. No.	Indicator	Category	Type of Rain Forecasting	Visakhapatnam	Ranga Reddy	Anant-hapur	Explanation	Conformity
56.	Dampness of jaggery, tamarind and salt	Non-bio indicator	Short range	◆			Increasing humidity results in increase in water vapour content in the atmosphere. On saturation, water vapour gives rise to clouds bearing water, thereby rains. Since relative humidity and absolute humidity are considered as factors that determine the response of these materials, an indication about the possible occurrence of rain.	
57.	Smell of dried fish	-do-	Short range	◆			When dried fish absorb moisture, some smell emanates. More than 80% of relative humidity has capability to give such smell that indicates nearby rain. In tropical conditions, 80% of	

Table 1 contd....

S. No.	Indicator	Category	Type of Rain Forecasting	Visakhapatnam	Ranga Reddy	Anantapur	Explanation	Conformity
58.	Sky with fish skin appearance	Non-bio Indicator	Medium range	◆			relative humidity coupled with air currents and gentle winds gives enough rain. Cyclone clouds (Alto cumulus and Altostratus clouds) that bear rain	
59.	Dull appearance of stars	-do-	Medium range	◆			High relative humidity in the atmosphere	
60.	Red clouds at sunrise, sunset	-do-	Medium range	◆	◆	◆	Clouds reflect long wave radiation (Red colour and above) when they are dark and water bearing. Hence the possible occurrence of rain.	Selvanayagum (1991)
61.	Presence of water	-do-	Medium range			◆	Water vapour acts as condensation nuclei	

Table 1 contd.....

S. No.	Indicator	Category	Type of Rain Forecasting	Visakha-patnam	Ranga Reddy	Anant-hapur	Explanation	Conformity
	vapour and warm clouds						for warm clouds, thereby giving rain.	
62.	Westerly winds during N-E monsoon	Non-bio Indicator	Medium range			◆	Winds carry both water vapour and heat essential for cloud formation, thereby rains in November.	
63.	Easterly winds during S-W monsoon	-do-	Medium range			◆	Arabian sea branch of S-W monsoon gives rise to easterly winds. Hence rain occurs during S-W monsoon because of these seasonal winds.	
64.	Seasonal reversal of wind direction	-do-	Long range			◆	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.	
65.	Hot and desiccating	-do-	Long range			◆	Hot winds blowing for nearly two months is a	

Table 1 contd....

S. No.	Indicator	Category	Type of Rain Forecasting	Visakhapatnam	Ranga Reddy	Anantapur	Explanation	Conformity
	winds from West						better indicator for ensuing good monsoon.	
66.	Rohini constellation ideal for onset of S-W monsoon.	Astro-nomical condition	Long range		◆		Low pressure formation when temperatures range between 38-42°C, hot winds blowing for 15-20 days. This results in onset of monsoon.	



Plate 1: Movement of Dragon flies



Plate 2 : Flapping of ears by goats



Plate 3 : Flocking of Sheep



Plate 4 : Movement of Termites in rows



Plate 5 : Movement of ants in rows



Plate 6 : Peacock singing



Plate 7 : Positioning of nest by weaver bird



Plate 8 : Squeaking of Owls



Plate 9 : *Butea monosperma* tree



Plate 10 : Halo around the Moon



Plate 11 : Halo around the Sun

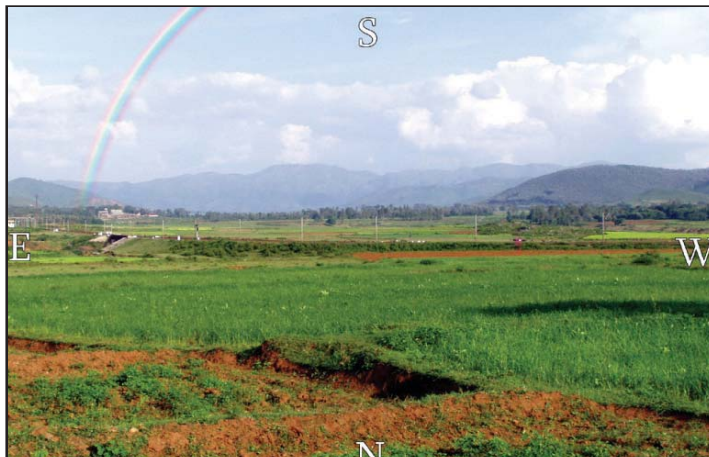


Plate 12 : Rainbow in sunny weather



Plate 13 : Rainbow in the West

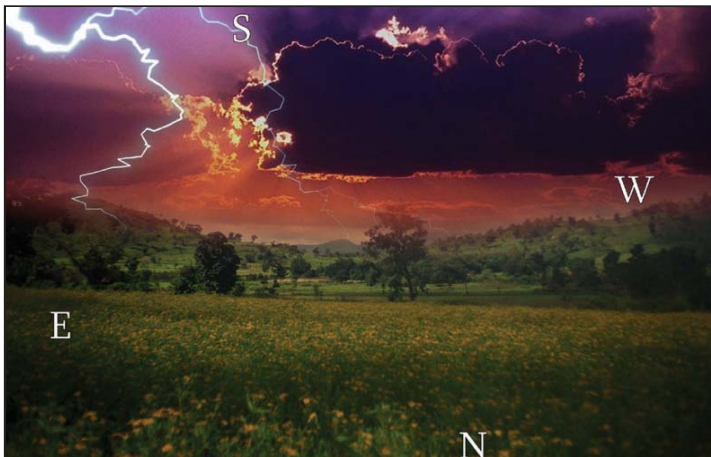


Plate 14 : Lightning in the East



Plate 15 : Lightning in North - East



Plate 16 : Lightning in South - East



Plate 17 : Lightning straight over the head



Plate 18 : Dull Sky



Plate19 : Sky with fish skin appearance



Plate 20 : Low clouds



Plate 21 : Dark rolling clouds

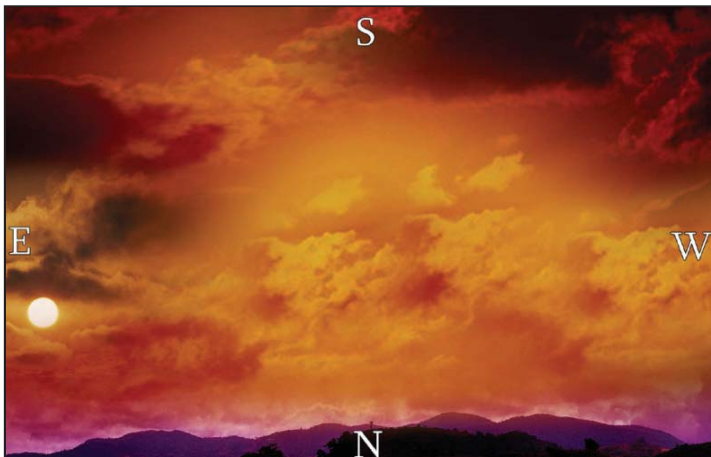


Plate 22 : Red clouds at sunrise



Plate 23 : Red clouds at sunset



Plate 24 : Dull appearance of stars

Indicators for rain prediction in the selected three districts were halo around the moon; formation of rainbow; red clouds at sunrise and sunset; movement of dragon flies; jumping cattle; poultry inserting feathers in the soil; flocking of sheep and goats; and singing of black cuckoo (Table 1). Also reliance on bio indicators was predominant. This may be due to the close association of farmers with the biological systems

in the ecosystem.

2.1. Classification of Bio indicators and Non-bio indicators of Rain forecasting by Farmers

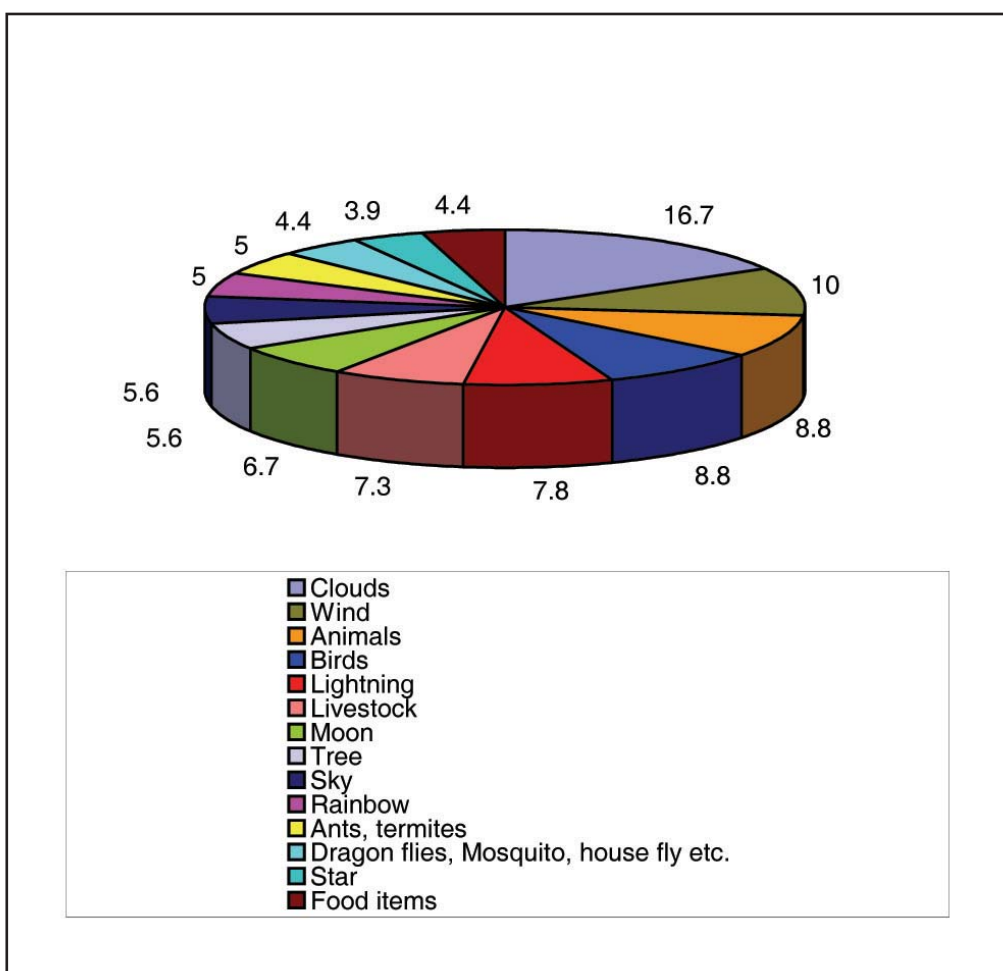
As indicated in Table 1, the respondents gave information on bio and non-bio indicators of rain forecasting. These were further classified broadly under different heads and presented in Table 2.

Table 2: Classification of Bio indicators and Non-bio indicators as expressed by Farmers

S. No.	Bio indicators and non-bio indicators	Frequency	Percentage	Rank
1.	Clouds	30	16.7	I
2.	Wind	18	10.0	II
3.	Animals	16	8.8	III
4.	Birds	16	8.8	III
5.	Lightning	14	7.8	IV
6.	Livestock	13	7.3	V
7.	Moon	12	6.7	VI
8.	Tree	10	5.6	VII
9.	Sky	10	5.6	VII
10.	Rainbow	9	5.0	VIII
11.	Ants, termites	9	5.0	VIII
12.	Dragon flies, mosquito, housefly etc.	8	4.4	IX
13.	Star	7	3.9	X
14.	Food items like Jaggery, tamarind etc.	8	4.4	IX

About 16.7 per cent of respondents used clouds as indicator for rain forecasting followed by wind (10%), animals and birds (8.8%), lightning (7.8%), livestock (7.3%), moon (6.7%), tree (5.6%), sky (5.6%), rainbow (5%), ants and termites (5%), dragon flies, mosquito and housefly (4.4%), food items (4.4%), and star (3.9%) in that order of magnitude.

Fig.1. Distribution of Farmers based on their classification of bio indicators and non-bio indicators of Rain Forecasting



Cloud as an indicator occupied first position since farmers are close observers of cloud movement and colour. Wind is a rain indicator for farmers because they watch changes in wind direction frequently. Animals and Birds are bio indicators and farmers trust their sounds and movement in predicting rain. Lightning as indicator is important because it usually accompanies rain. Livestock (like cattle, sheep and goats) are important rain predictors because of their behaviour and flocking nature. Moon is a rain indicator because of its position, halo formation. Trees are important predictors of rain with their flowering, fruiting pattern before onset of rains. Sky is an important source because of its changing colours in the morning and in the evening. Rainbow formation in the west is an important rain indicator to respondents. Ants and termites by their movement and position signify the coming rains. Housefly and mosquito by their biting behaviour indicate changes in weather. Food items like jaggery and tamarind turn damp and are used as indicators for rain occurrence. Stars either with their luster or dullness

signify rain occurrence.

It was observed by the authors that *nakshatra* based farming is predominant in Rangareddy district compared to Visakhapatnam district. Plant indicators (like certain trees with their flowering and fruiting pattern) for weather prediction are less relied upon in Ananthapur district.

2.2. Weather Folklore

Folklore comprises of the beliefs of the people based on their social and cultural conditions. These beliefs evolved over a long period of time and transmitted from one generation to other. Though there is lack of scientific basis, the experiences of the people pooled over generations cannot be ruled out.

These beliefs have been further classified as rain request, rain offering, rain beliefs and beliefs based on almanac. These have been documented district wise as follows:

2.2.1. Rain request

A) Visakhapatnam

1) 'Singing Songs'

Before January 15 (*Sankranthi* – festival of harvest), farmers perform *Ram bhajans* (singing songs in praise

of Lord Rama) in five villages hoping for a good season ahead with copious amount of rain.

2) '**Nela Panduga**' (Month festival) – A priest collects rice along with other grains in his daily requests to the farmers from December 15 – January 15 every year. He goes to Bhadrachalam to worship God along with the collected grains. He returns to the village with the blessings of Lord Rama such that the ensuing season would be very fruitful for the farmers. The duration between December 15 – January 15 is known as *Nela Panduga*.

B) Ranga Reddy

1) '**Singing in batches**' - For appeasing the Rain God around 50-60 farmers form into 5-6 batches of 10 members each. Then they go around the village and sing *bhajans* (songs). They follow a rhythm in which a batch takes active part at a time followed by other batches in a sequential manner during the entire night. By doing so farmers believe that rain occurs in a manner they wish for better crop production.

2) '**Reciting holy books**' - It is believed that by reading *Virata Parvam, Gita,*

Sundara Kanda, brings good rain.

C) Ananthapur

1) '**Festival singing**' - Farmers chant *Ramakoti bhajan* (chanting Lord Rama's name one crore times) on *Vinayaka Chaturthi* festival (Lord Siva anoints Lord Vinayaka as the remover of hurdles on this day). This would be performed in five villages by lighting a sacred lamp and carrying it in all the streets of the villages. By doing so, they believe that the Rain God shows mercy on them.

2) '**Chanting for a week**' - Farmers chant *Ram bhajans* (Lord Rama's name) for seven days for appeasing the Rain God.

2.2.2. Rain offering

A) Visakhapatnam

1) '**Milk and Banana offerings**' - By praying and later on offering boiled milk and banana bunches to Hills, farmers believe that good rains would come with the blessings of the Almighty.

B) Ranga Reddy

Farmers perform *Navadanya homam* (a ritual performed by way of offering on fire a mix of nine different types of grains) as a ritual to seek the mercy

of the Rain God. The reason may be that during the conduct of this ritual, the microscopic particles that are released into the atmosphere act as nuclei of condensation, which result in formation of clouds, thereby rain.

2.2.3. Rain Beliefs

A) Visakhapatnam

1) **'Boiling milk'** - Farmers boil the milk in a traditional way over dung cakes used as firewood in their homes. The direction in which milk overflows with foam indicate that rain will come in that direction. Later on they prepare sugarless porridge and eat.

2) **'Flowering of Palm'** - Good flowering of palm tree (*Borassus flabellifer*) in the preceding year ensures very good and timely rains in the succeeding year.

3) **'Frog in water'** - Farmers keep frogs in an earthen pot around which a new cloth, which is smeared with turmeric is tied. They continuously pour water over it, shout continuously 'Frog in water' and move around the village streets. Also, they pour water over other people of the village and also on themselves. Then it is believed that it rains soon.

4) **'Flowering of psydrax sp.'** - If the trees of *Psydrax dicoccus* flower profusely in a season, the same is considered as fruitful for the farmers not only with rain sufficient but also with good harvest.

5) **'Rain on Festivals'** - Rain is certain on *Vinayaka Chaturthi*, *Vijaya Dasami* (festival signifying the defeat of demons in the hands of Goddess Durga) and *Deepavali* (festival of lights) days.

B) Ranga Reddy

1) **'Licking of jaggery juice'** - Jaggery juice is poured atop a big flat stone. It would be licked by youngsters of 10-15 years old in the village. Then they believe that Lord will show mercy by giving rains.

2) **'Cattle sucking'** - When cattle suck in air by looking at the sky at an acute angle, farmers expect rains in the direction in which the air was blowing.

3) **'Lightning in North'** - If lightning occurs in the North, then rains occurs in a few seconds like a flash that can be compared to the time it takes to remove the rope used for tying the cow.

C) Ananthapur

1) '**Discarding evil**' - Farmers throw items like *rolu*, dried and useless straw, winnowers, chappal etc. from their houses to outskirts of the village. They believe that by doing so all the evils go out of the village and the Rain God gives rain.

2) '**Katamanna**' (Parched hands, throat) – After having noon meal without taking any water, farmers numbering (50-60) and their children about (60-70) of the village go to the already dried tank (main source of drinking water of the village) without washing their hands. They make some rhythmic sounds for a long duration. It is believed that Rain God will show mercy on them and give good rains.

3) '**Tatta Sanketam**' (Basket indicator) – A little boy is asked to lift a basket of jowar on his head, in which a tumbler is kept. While doing so, the tumbler falls. The direction in which it falls is the direction in which rain occurs in that *nakshatra*.

4) '**Donkey marriage**' - Farmers perform marriages to donkeys by decorating them with clothes, flowers and garlands etc. They allow them

to proceed in a procession in the village. This process is believed to bring rains immediately.

5) Reading *Nalacharithra* by farmers is believed to bring rain especially, if drought occurs in the villages.

6) Idol of Lord Vinayaka when kept in a dried well is believed to bring sufficient rains.

2.2.4. Beliefs based on Almanac

A) Visakhapatnam

1) '**Nela Kommu**' (Curve in a month) – Geographically the appearance of moon after every *amavasya* looks like an arc. It looks very thin but angular (drooping) to one side. However, during rainy season if the moon appears evenly balanced on the third day after *amavasya* between 6-7 PM then, it is believed as auspicious and farmers expect good rains.

B) Ranga Reddy

1) '**Stiffy jowar silage**' - When jowar silage is plucked in bundles from the large heaps located in the fields and is broken in the process, it is considered as still dry weather. If the bundles, dried leaves of jowar are intact along with the small bundle when plucked, it is considered as

arrival of *mrigashira nakshatra* along with rains.

2) If the arrival of *nakshatras* coincides with the animals viz., frog, he-buffaloes, elephant, then it is considered as good period for rain.

3) If it rains a day before *mrigashira* enters, then rain does not occur in the entire *mrigashira*. This holds good for all *nakshatras*.

C) Ananthapur

1) '**Head lice movement**' - When a head lice is dropped in a heap of rice over which the *nakshatras* are written, then the direction in which the head lice travels is the *nakshatra* in which rain will occur.

2) '**Conveyance mode of the Lord**' - It is believed that Lord Shiva arrives on earth by different *vahanas* (vehicles). Future rain depends on the *vahana* in which he arrives on January 15 (*Sankranti* festival).

2.3. Proverbs

Some of the proverbs mentioned by the farmers related to onset of rains were as follows:

1) If *Hastha* constellation (27 September – 9 October) does not interfere, then it will rain copiously

in *Chitra* (10-23 October).

2) Thunder in *Makha* (1-15 September), certain rain in *Uttara* (16-30 September).

3) Rainbow in *Arudra* (22 June – 5 July) means heavy rain.

4) Wait and watch for half an hour in *Hastha* to experience heavy rain.

5) If when eyes are red or sky is red, be ready for down pour.

3. Rainfall prediction from *panchang*s

Secondary data from IMD and different *panchang*s has been gathered for studying this objective.

A comparative study was undertaken to study the impact of weather forecasting in terms of reliability as predicted in *panchang*s. The predictions were compared with that of actual meteorological data (IMD) on *nakshatra* basis. Rainfall is referred amongst the farmers in terms of star movement / position or the *nakshatra* period. *Nakshatras* are referred as asterisms. The *nakshatra* periods are based on solar calendar and 13 *nakshatras* from *Rohini* to *Visakha* (major rain giving) were

selected for the study. The selected nakshatras along with the dates are given in Appendix – I. Generally, the *panchangs* predict rainfall, cyclones, drought, fortune and misfortune of the people in the society based on *nakshatras*. Prediction of rainfall (which is an important weather element) by the panchangs has been considered as an important factor in weather forecasting. Rain prediction by the panchangs in terms of vernacular and linguistic usage were standardized appropriately and were compared with actual rainfall data recorded by IMD so as to estimate the reliability of prediction. The following procedure was adopted:

3.1. Selection of area

3.2. Selection of *panchangs*

3.3. Quantification of rainfall prediction

3.4. Collection of actual rainfall data

3.5. Comparison of *Panchang* rain prediction with actual rainfall data

3.1. Selection of area

The three districts namely Visakhapatnam, Ananthapur and

Rangareddy were selected in Andhra Pradesh representing the three different regions of the state.

3.2. Selection of *Panchangs*

The *panchangs* usually predict rain for the entire country. For the present study they were applied to the selected districts for comparison. Thus, four *panchangs* that are popular in the selected districts were chosen randomly.

The selected *panchangs* along with the name and address of Editor are presented below in Table 3.

The sample of the study consisted of *Panchangs* for ten years period (1994-2003) for all the four selected *Panchangs*, thus a total of $10 \times 4 = 40$ *Panchangs*. All the *Panchangs* were made available by consulting respective editors for noting down relevant information.

3.2.1. Basis for rain prediction in *panchangs*

The authors of panchang consider (1) the time of sun's entrance and also the combination of nakshatras with zodiac signs (12 in number) to foretell the amount and time of rain in a year. In the zodiac signs, some are completely water bearing, some

Table 3: Selection of *Panchangs* for the study

S. No.	Name of the <i>Panchang</i>	Name & address of the Editor
1.	Sri Nemani Vari Gantala <i>Panchang</i>	Sri Nemani Suryanarayana Murthy and Sri Anantha Padmanabha Siddhanti, C/o Sri Saraswathi Jyothishalayam, Temple Street, Kakinada (East Godavari district), A.P.
2.	Mukteswara Siddhanti <i>Panchang</i>	Sri Rambhatla Mukteswara Siddhanti, Q.No. F-127, P.O. Devapur, D.C. Works, Via Mancherial, Adilabad district, A.P.
3.	Pidaparathi Vari <i>Panchang</i>	Sri Pidaparathi Subrahmanya Sastry, Podagatlapalli P.O., (Via) Ryali, East Godavari district, A.P.
4.	Vissapragada Vari <i>Panchang</i>	Sri Vissapragada Subrahmanya Sarma Siddhanti, Vanapalli, East Godavari district, A.P.

semi water bearing while some are non-water bearing. (2) Changes in weather were associated with the sun, the moon and seven other planets in certain positions and act alone or in combination. (3) Planets and nakshatras have been classified into three genders i.e., masculine, feminine and Neutral. There will be rains when there is a union between masculine and feminine genders. The other method of foretelling rain was

by seeing the arrival of nakshatras on a particular animal (animal as a vehicle). Eg: heavy rain is predicted if it arrives on a frog or elephant. No rain is predicted if it is on a goat.

3.3. Quantification of rainfall prediction

The question, why only 'rainfall' aspect of agro-predictions made in *Panchangs* has been taken for the study purpose, can rightly be

answered with the following agreement of Biswas (1990). Rainfall is the dominant factor in the tropics especially the regions that are under the influence of monsoon. Also, in countries like India, this single factor of rainfall outweighs the effects of

any other factor responsible for agricultural production and productivity. In *panchangs* qualitative terms like 'rains sufficient for crop', 'rains with wind', as also 'rains here and there' are often noticed.

Table 4: Qualitative terms for rain as mentioned in *panchangs* in telugu with their equivalents in english

S. No.	Telugu terms	English equivalent
1.	<i>Anavrusti</i>	No rain
	<i>Meghadambaram</i>	Cloudy weather
	<i>Vrustibhanga</i>	No rain
2.	<i>Swalpa vrusti</i>	Light rain
	<i>Alpa vrusti</i>	Light rain
	<i>Chirujallulu</i>	Light rain
	<i>Metta varshamulu</i>	Dry rains
	<i>Akkadakkada chirujallulu</i>	Light rains here and there
	<i>Swalpa tuphanu</i>	Light cyclonic rain
	<i>Galito jallulu</i>	Rains with wind
	<i>Tolakari jallulu</i>	First rains
	<i>Mabbulato kudina varshalu</i>	Cloud bearing rains
	<i>Tushara vrusti</i>	Light rain
	<i>Savatalpa vrusti</i>	Light rain
3.	<i>Samanyalpa vrusti</i>	Normal light rains
	<i>Misrama vatavaranam</i>	Mixed weather (some rain, some sunshine, some wind etc.)
	<i>Madhyama vrusti</i>	Moderate rain
	<i>Sama vrusti</i>	Moderate rain
	<i>Chitra vrusti</i>	Rain at one place and absent at other
	<i>Samanya jallulu</i>	Normal rain
	<i>Akkadakkada samanya varsham</i>	Normal rains here and there

	<i>Oka madiri vrusti</i>	Moderate rains
	<i>Madhyamamonata vrusti</i>	Moderate rains
4.	<i>Suvrusti</i>	Heavy rains
	<i>Varshadikyata</i>	Heavy rains
	<i>Ativrusti</i>	Heavy rains
	<i>Sasyanukula varshalu</i>	Good crop rains
	<i>Tuphanu suchanalu</i>	Cyclone indication
	<i>Savata suvrusti</i>	Heavy rains

Based on the work of Mishra (1998) and Murthy (2002, 2005), the following ranges of actual rainfall per

nakshatra were computed. The ranges that were followed are:

No rain (0 mm / <i>nakshatra</i>)	Moderate rain (16-40 mm / <i>nakshatra</i>)
Light rain (< 16 mm / <i>nakshatra</i>)	Heavy rain (> 40 mm / <i>nakshatra</i>)

The above ranges were arrived based on (1) The number of rainy days of A.P. On an average 31, 52 and 59 rainy days occur in Ananthapur, Rangareddy and Visakhapatnam districts respectively in a year. Each rainy day is greater than or equal to 4 mm. (2) When average annual rainfall of Andhra Pradesh was examined for a 10-year period, the lowest rainfall was 450 mm and highest rainfall was 1250 mm in a year. (3) Long term seasonal average rainfall was considered as normal rainfall for the district. If summer rains were considered, it was called normal for the year. Decoding

the qualitative terms from *Panchangs* into quantitative terms and comparing the same with IMD actuals received was done based on simple analogy (ratio metric). When 'no rainfall' (0 mm / *nakshatra*) was received as per *Panchangs* it was recorded as zero. However, 'light' or 'moderate rains' were recorded as follows:

a) When 'light rain' (< 16 mm / *nakshatra*) was tallied with actuals of IMD, then IMD rain figure itself was taken for *Panchangs*. If IMD and *Panchang* figures did not tally, then the rainfall for the *Panchangs* was taken as 8 mm (average of 0-16 mm / *nakshatra*) and IMD rainfall figure

was taken as it is.

b) For 'moderate rain' (16-40 mm / *nakshatra*), when IMD rain figures were more than 40 mm, 28 mm / *nakshatra* were recorded for the *Panchangs*. However when IMD rain figure fall in the above range, then IMD rain figure itself was taken for *Panchangs*.

When the rainfall was more than 40 mm as per the IMD records and when 'heavy rain' (> 40 mm / *nakshatra*) was predicted in *Panchangs*, then the actual rainfall that occurred as per IMD recordings was considered in both the cases. However, when the rainfall that occurred as per IMD was less than 40 mm and *Panchangs* predicted heavy rain, then the actual IMD rain figure was added to 40 mm and mentioned against *Panchangs*.

3.4. Collection of actual rainfall data

The daily rainfall data of Ananthapur, Visakhapatnam station and Hayathnagar station representing Rangareddy district from 1994-2003 were collected from the agro-met data bank of CRIDA.

3.5. Comparison of *Panchang* rain prediction with actual rainfall data

The total rainfall (mm) and percentage for the selected 13 nakshatra periods from 1994-2003 (10 years) for all the selected four *panchangs* were computed in relation to the amount of rainfall (mm) recorded by IMD for all the three districts. Then the analysis of variance among the four *panchangs* for the selected districts for 10 years (1994-2003) was carried out to find out the significant difference among *panchangs* predicting rain.

The results in Table 5 indicate the total rainfall (mm) and percentage for the selected 13 nakshatra periods from 1994-2003 in relation to the amount of rainfall (mm) recorded by IMD* for Ananthapur district. Nakshatra-wise rainfall (mm) for the four *panchangs* as against IMD actual rainfall from 1994-2003 for Ananthapur, Rangareddy and Visakhapatnam districts have been provided in Appendix – II for ease in understanding and interpretation.

Source: Agro-met data bank, CRIDA.

Table 5: Total rainfall (mm) for the selected 13 nakshatras in relation to the amount of rainfall (mm) recorded by IMD for Ananthapur district

Source / Year	P ₁		P ₂		P ₃		P ₄		IMD	
	Total	%	Total	%	Total	%	Total	%	Total	%
1994	223	85	422	162	413	158	543	208	261	100
1995	300	40	383	51	591	79	795	106	750	100
1996	834	86	385	40	588	60	966	99	971	100
1997	755	132	278	48	463	81	739	129	573	100
1998	599	89	336	50	659	98	637	95	673	100
1999	403	74	324	60	297	54	642	118	544	100
2000	433	97	490	110	170	38	292	65	446	100
2001	428	67	401	63	484	76	515	81	638	100
2002	583	156	210	56	473	127	302	81	373	100
2003	420	114	595	162	459	125	375	102	367	100

P₁, P₂, P₃ and P₄ are *panchangs* 1, 2, 3 and 4 respectively in order as per Table 3.

Table 6 indicates the total rainfall in relation to the amount of rainfall (mm) and percentage for the 13 (mm) recorded by IMD for nakshatra periods from 1994-2003 Rangareddy district.

Table 6: Rainfall (mm) for the selected 13 nakshatras in relation to the amount of rainfall (mm) recorded by IMD for Rangareddy district

Source / Year	P ₁		P ₂		P ₃		P ₄		IMD	
	Total	%	Total	%	Total	%	Total	%	Total	%
1994	353	47	767	101	680	90	870	115	755	100
1995	352	100	246	70	474	135	466	133	351	100
1996	564	175	303	94	509	158	656	204	322	100
1997	629	118	322	60	600	113	672	126	532	100
1998	531	201	289	109	476	180	580	220	264	100
1999	408	193	329	156	324	153	547	259	211	100

2000	447	125	376	106	176	49	266	75	356	100
2001	499	67	513	69	605	81	656	88	744	100
2002	445	97	190	42	357	78	400	88	456	100
2003	570	110	544	105	341	66	383	74	516	100

Table 7 indicates the total rainfall in relation to the amount of rainfall (mm) and percentage for the 13 (mm) recorded by IMD for nakshatra periods from 1994-2003 Visakhapatnam district.

Table 7: Total rainfall (mm) for the selected 13 nakshatras in relation to the amount of rainfall (mm) recorded by IMD for Visakhapatnam district

Source / Year	P ₁		P ₂		P ₃		P ₄		IMD	
	Total	%	Total	%	Total	%	Total	%	Total	%
1994	389	46	788	93	608	72	875	104	842	100
1995	601	56	233	21	684	63	698	65	1079	100
1996	1028	73	500	36	775	55	1234	88	1397	100
1997	693	89	468	60	713	92	852	110	776	100
1998	938	62	468	31	864	57	1135	75	1518	100
1999	561	92	314	51	292	48	772	126	612	100
2000	579	79	562	77	218	30	428	58	731	100
2001	626	74	664	78	622	74	796	94	845	100
2002	417	85	212	43	329	67	362	74	491	100
2003	458	42	983	91	601	55	548	51	1083	100

Further, the analysis of variance among the four *panchangs* for the selected districts was carried for 10 years (1994-2003) and the inferences are furnished below.

Table 8: Analysis of variance results for the selected *panchangs* and districts

District / Source	Ananthapur Mean	Rangareddy Mean	Visakhapatnam Mean
P ₁	497.8	479.8	629.0
P ₂	382.4	387.9	519.2
P ₃	459.7	454.2	570.2
P ₄	580.6	549.6	770.0
Sem _±	70.89	55.15	85.39
CD (0.05%)	145.48	113.16	175.23

There was no significant difference among all the four *panchangs* (P₁, P₂, P₃ and P₄) in Ananthapur district, which indicated that all were on par. The mean values ranged from 382.4 to 580.6.

For Rangareddy district, P₄ was nearer to actual than the other three *panchangs* (P₁, P₂ and P₃), which were on par with each other. Hence P₄ was found to be reliable for Rangareddy district. The mean values ranged from 387.9 to 549.6.

Fig.2. Comparison of rainfall prediction in Panchangs with IMD actuals of Ananthapur district

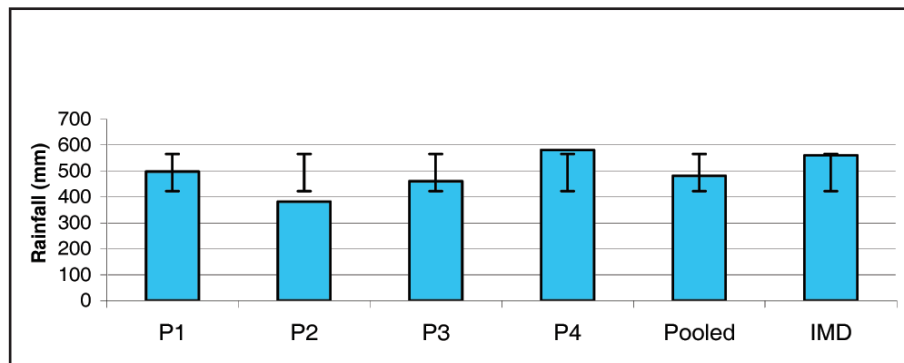


Fig.3. Comparison of rainfall prediction in Panchangs with IMD actuals of Rangareddy district

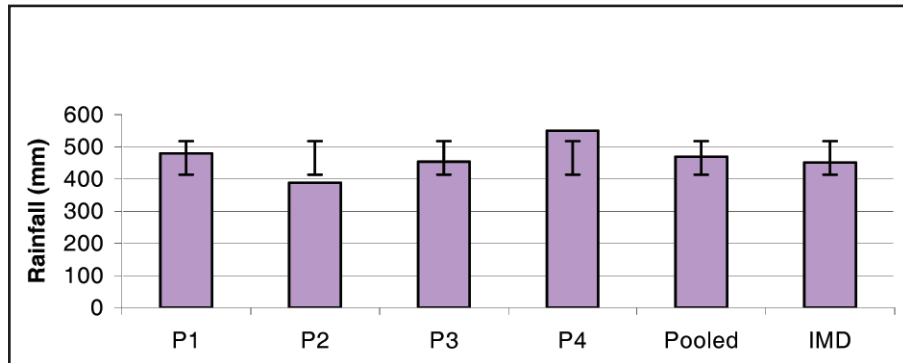
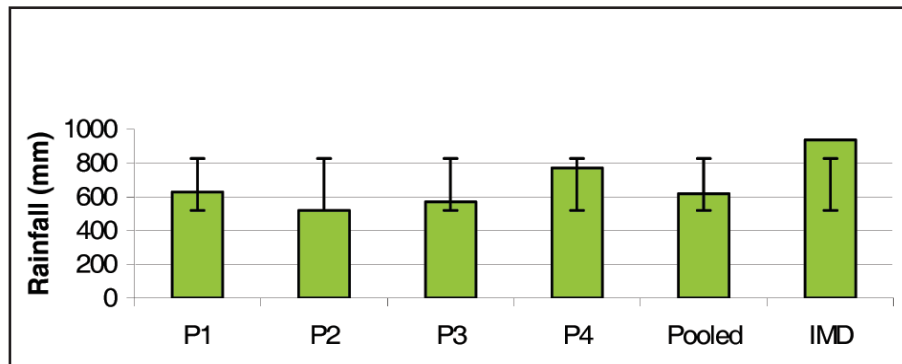


Fig.4. Comparison of rainfall prediction in Panchangs with IMD actuals of Visakhapatnam district



For Visakhapatnam district, P_4 was nearer to actual than the remaining three *panchangs* (P_1 , P_2 and P_3), which were on par. Hence, P_4 was found to be reliable for Visakhapatnam district among all *panchangs*. The mean values ranged from 519.2 to 770.

The above trends indicated that there was a significant difference among *panchangs* for Rangareddy and Visakhapatnam districts in predicting rain. Further, it was noticed that P_4 was significantly superior to the remaining three *panchangs*, which were on par for both the above

districts. There was no significant difference among the four *panchang*s in case of Ananthapur district, which indicated that all of them were on par in relation to the actual values recorded by IMD. The results indicate that the procedure practiced by the *panchang* editors for predicting rain i.e., the time of sun's entrance into the *nakshatras* along with the combination of *nakshatras* with zodiac signs, movement of sun and moon, union among different genders of *nakshatras*, and arrival of *nakshatras* on an animal as vehicle etc. cannot be undermined. When provided with scientific knowledge of elements of weather and their dynamic interaction, the *panchang* editors can more reliably predict rain and other weather phenomena. Rain prediction from *panchang*s though traditional in nature, is a well established and economical process. It is a one-man effort.

4. Rain Forecasting Experiences

Tripathi (1996) in his attempt to compare the prediction made in *panchang*s with actual meteorological data for a period of sixteen years from 1980-1995 found that the extent of

correct prediction was between 53.3-81.5 %.

Mishra (1998) from Banaras Hindu University, Varanasi reported that rain prediction made in *panchang*s based on ancient astrological theories are on an average better than and in some cases at par with the predictions made by the government meteorological departments through modern techniques and procedures.

A One-day Workshop-cum-Group Meeting on "**Relevance of Ancient Wisdom on Weather Forecasting for Improving Agro-advisories**" was held at CRIDA, Hyderabad on 29th May, 2006. The experiences of different participating experts are summarized as follows:

Prof. M. C. Varshneya, Vice-Chancellor, Anand Agricultural University highlighted the influence of planetary system on the gaseous atmosphere. Under his leadership, a rainfall forecast calendar based on *nakshatras* was prepared for the year 2006 and the same was validated in the villages of Gujarat. The important feature of this calendar is the probability of occurrence of rainfall

in different agro-climatic zones along with the forecast. The accuracy of rainfall forecast ranged between 40-70 percent across the state.

Mrs. Gayatri Devi Vasudev, an astro-meteorologist from Bangalore correlates weather prediction with movement of different planets in different houses. Accordingly, when Sun ingresses into Scorpio and Saturn in seventh position, below normal rainfall was predicted for 2006.

According to Dr. V.V.Ravi, Agricultural Research Institute, ANGRAU, the nature of long-range forecast of monsoon rainfall can be predicted depending upon the movement of Sun and Mars. Mars is ahead of Sun in 2006, hence below normal rainfall is expected which came true. He further elaborated that based on three *yogas* viz., ***Rohini Yoga, Swati Yoga and Ashadi Yoga***, medium range and now casting of rainfall can be given.

Dr. Sudhakar Joshi, astro-meteorologist from Maharashtra indicated two methods of rainfall prediction, viz., ***Anthariksha Paddhati*** which predicts rain events 5-10 days in advance and the ***Bhowma Paddhati***

which considers the behavioural pattern of plants and animals for predicting the rainfall.

Shri. Dhansukh Shah, an astro-meteorologist from Pune, Maharashtra stated the various indications in ancient literature regarding rain forecasting. He is attempting to codify and correlate such indications with modern science, there by developing a model to forecast day-to-day monsoon trends in terms of onset, dry spell, wet spell, floods, withdrawal etc. He has been giving this model one month ahead of monsoon onset and five months prior to its' withdrawal for Saurashtra region of Gujarat. He claims the average accuracy level of his forecast is 65%.

The present authors validated certain ITKs through personal observation for rain forecasting in Andhra Pradesh in 2005 and classified them into long range, medium range and short range based on the time taken for rain occurrence. Accordingly, positioning of nest by weaverbird can be considered as long-range rain forecast, movement of termites in rows as medium range rain forecast and, singing of cuckoo

bird and appearance of red clouds at sunrise as short range rain forecast indicators.

Continuously changing weather patterns are being acknowledged more than ever now. Precision in weather forecasts can be achieved only by strengthening the knowledge base of different available methods for improving agro-advisories. This study has lead the way in combining the efforts of both indigenous and scientific weather forecast methods in improving the opportunities

towards their application in farm management. Achieving location specific weather forecasts depend on farmers' own experiences in addition to scientific information. Improved adoption of dependable weather forecasts would save farmers crores of rupees a year in terms of reducing costs associated with crop losses along with pest and disease control. Towards this end, farmers' participation in the development of procedures for improved weather forecasts is imperative.

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APPENDIX – I

SELECTED NAKSHATRAS WITH PERIOD

S. No.	Nakshatra	Period
1.	Rohini	May 28 – June 7
2.	Mrugashira	June 8 – 21
3.	Arudra	June 22 – July 5
4.	Punarvasu	July 6 – 19
5.	Pushyami	July 20 – August 3
6.	Ashlesha	August 4 – 16
7.	Makha	August 17 – 30
8.	Poorva Phalguni	August 31 – September 13
9.	Uttara Phalguni	September 14 – 27
10.	Hastha	September 28 – October 10
11.	Chittha	October 11 – 24
12.	Swathi	October 25 – November 6
13.	Visakha	November 7 – 19

APPENDIX – II
A) NAKSHATRA-WISE RAINFALL (MM) FOR THE FOUR PANCHANGS AS AGAINST IMD ACTUAL RAINFALL FROM 1994-2003
FOR ANANTHAPUR DISTRICT

S.No.	Date	P1											P2										
		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003		
1.	28.05-07.06	0	0	0	28	28	19	28	24	28	28	28	28	0	0	0	0	51	59	81	24	47	44
2.	08.06-21.06	0	28	8	66	40	62	43	17	39	28	28	40	40	28	66	40	0	3	0	0	0	42
3.	22.06-05.07	8	40	40	0	11	0	8	1	0	28	28	0	0	0	0	0	40	142	41	0	0	45
4.	06.07-19.07	6	43	69	40	108	79	63	59	58	52	28	0	0	69	40	108	79	0	8	58	12	12
5.	20.07-03.08	47	28	8	28	28	28	28	28	28	28	28	47	192	0	0	0	0	0	54	0	0	53
6.	04.08-16.08	8	8	78	65	60	41	56	66	56	91	28	8	0	78	65	60	28	56	0	0	0	91
7.	17.08-30.08	58	8	111	40	8	28	27	21	28	28	28	58	28	111	0	0	8	0	0	0	0	0
8.	31.08-13.09	40	8	134	285	73	42	43	28	28	28	28	0	8	0	0	0	42	43	56	0	41	41
9.	14.09-27.09	0	71	8	17	28	28	26	28	28	28	28	40	71	71	57	0	0	8	57	46	46	46
10.	28.09-10.10	28	54	131	58	59	0	0	0	0	13	28	88	0	0	8	8	0	70	167	0	53	53
11.	11.10-24.10	0	8	159	28	69	48	55	85	214	28	28	48	0	0	40	69	28	55	0	0	168	168
12.	25.10-06.11	28	4	48	58	28	0	28	28	28	40	40	53	44	28	0	0	0	0	0	0	0	0
13.	07.11-19.11	0	0	40	42	59	28	28	43	48	0	48	40	0	0	2	0	40	40	43	48	0	0

Appendix – II contd...

ANANTHAPUR

S.No.	Date	P3										P4										
		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	
1.	28.05-07.06	42	40	40	8	28	19	8	8	8	28	28	42	40	40	8	51	0	28	24	47	44
2.	08.06-21.06	0	0	8	66	40	22	28	8	8	2	2	40	0	290	66	28	62	0	17	8	2
3.	22.06-05.07	18	40	40	40	28	0	8	1	28	45	45	58	40	40	40	51	40	8	1	40	45
4.	06.07-19.07	28	3	69	8	108	8	8	59	8	0	0	28	43	69	40	28	79	8	19	0	28
5.	20.07-03.08	7	192	28	52	106	28	28	54	7	28	28	47	192	40	52	106	55	28	54	0	53
6.	04.08-16.08	8	73	78	28	60	1	28	26	16	91	91	61	0	78	65	60	41	8	0	56	8
7.	17.08-30.08	58	8	28	40	171	28	8	21	28	12	12	58	315	28	40	28	97	27	21	41	52
8.	31.08-13.09	28	61	134	8	8	42	3	28	28	1	1	0	28	134	285	73	28	0	56	43	41
9.	14.09-27.09	40	71	31	57	55	77	8	28	57	28	28	40	71	0	57	55	77	66	28	28	46
10.	28.09-10.10	88	54	28	58	28	8	28	167	0	28	28	88	54	0	8	59	0	8	167	0	0
11.	11.10-24.10	28	17	28	28	8	28	15	28	214	168	168	28	8	159	28	28	48	55	85	8	28
12.	25.10-06.11	28	4	48	28	11	8	0	28	3	28	28	53	4	48	8	51	75	28	0	3	28
13.	07.11-19.11	40	28	28	42	8	28	0	28	48	0	0	0	0	40	42	19	40	28	43	28	0

Appendix – II contd...

ANANTHAPUR

S.No.	Date	IMD	1994 1995 1996 1997 1998 1999 2000 2001 2002 2003															
1.	28.05-07.06	2	0	0	50	11	19	81	24	7	4							
2.	08.06-21.06	0	0	290	66	0	22	3	17	39	2							
3.	22.06-05.07	18	0	0	0	11	0	142	1	0	5							
4.	06.07-19.07	6	3	69	0	108	39	23	19	18	12							
5.	20.07-03.08	7	192	0	12	106	15	0	14	7	53							
6.	04.08-16.08	21	33	38	65	20	1	56	26	16	91							
7.	17.08-30.08	18	315	111	0	171	97	27	21	1	12							
8.	31.08-13.09	0	61	134	285	33	42	3	56	3	1							
9.	14.09-27.09	0	71	31	17	55	77	26	202	57	6							
10.	28.09-10.10	88	54	131	18	59	149	70	167	0	13							
11.	11.10-24.10	48	17	159	0	69	8	15	85	214	168							
12.	25.10-06.11	53	4	8	58	11	75	0	3	3	0							
13.	07.11-19.11	0	0	0	2	19	0	0	3	8	0							

Appendix – II contd...
B) NAKSHATRA-WISE RAINFALL (MM) FOR THE FOUR PANCHANGS AS AGAINST IMD ACTUAL RAINFALL FROM 1994-2003 FOR RANGA REDDY DISTRICT

S.No.	Date	P2																						
		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003			
1.	28.05-07.06	0	0	11	28	28	28	28	39	28	28	28	28	0	0	0	0	0	40	45	81	39	52	40
2.	08.06-21.06	0	28	8	80	53	47	73	28	28	28	28	28	50	58	28	80	53	0	8	0	0	0	68
3.	22.06-05.07	8	73	64	8	7	8	8	0	0	28	28	28	0	0	0	8	0	70	66	40	0	0	43
4.	06.07-19.07	8	60	79	48	60	44	58	71	48	198	28	28	0	0	79	48	60	44	0	8	48	8	8
5.	20.07-03.08	79	28	8	28	27	37	28	28	28	28	28	28	79	43	0	0	0	0	0	0	68	0	40
6.	04.08-16.08	8	8	46	47	59	49	44	84	73	72	72	72	8	0	46	47	59	28	44	0	0	0	72
7.	17.08-30.08	141	8	73	69	8	28	29	28	35	28	28	28	141	33	73	0	0	14	0	0	0	0	0
8.	31.08-13.09	53	6	70	95	64	59	50	37	28	28	28	28	0	6	0	0	0	59	50	77	0	44	44
9.	14.09-27.09	0	63	9	28	19	28	28	28	28	28	28	28	59	63	49	83	0	0	0	8	50	82	82
10.	28.09-10.10	28	67	57	56	62	0	0	0	0	8	8	8	224	0	0	8	8	0	42	229	0	81	81
11.	11.10-24.10	0	8	56	28	69	52	45	84	81	28	28	28	113	0	0	40	69	29	45	0	0	66	66
12.	25.10-06.11	28	3	40	42	28	0	28	28	28	68	68	68	53	43	28	0	0	0	0	0	0	0	0
13.	07.11-19.11	0	0	43	72	47	28	28	44	40	0	0	0	40	0	0	8	0	40	40	44	40	40	0

Appendix – II contd...
RANGA REDDY DISTRICT

S.No.	Date	P3											P4										
		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003		
1.	28.05-07.06	45	40	51	0	28	28	8	8	28	28	45	40	51	0	40	0	28	39	52	40		
2.	08.06-21.06	8	8	8	80	53	28	28	8	8	8	50	8	105	80	28	47	0	28	8	8		
3.	22.06-05.07	29	73	64	72	28	8	8	0	28	43	69	73	64	72	47	70	8	0	40	43		
4.	06.07-19.07	34	8	79	8	60	8	8	71	8	0	34	60	79	48	20	44	8	31	0	28		
5.	20.07-03.08	8	43	29	68	67	37	28	68	8	28	79	43	69	68	67	77	28	68	0	40		
6.	04.08-16.08	8	59	46	28	59	9	28	28	28	72	75	0	46	47	59	49	8	0	73	8		
7.	17.08-30.08	141	8	33	69	63	28	8	44	35	8	141	73	33	69	23	54	29	28	75	74		
8.	31.08-3.09	28	46	70	8	8	59	10	37	28	4	13	28	70	95	64	19	0	77	73	44		
9.	14.09-27.09	59	63	28	83	59	55	14	28	50	28	59	63	0	83	59	55	54	28	28	42		
10.	28.09-10.10	224	67	17	56	22	8	28	229	15	28	224	67	0	8	62	0	2	229	15	0		
11.	11.10-24.10	28	28	16	28	8	28	5	28	81	66	28	8	56	28	29	52	45	84	8	28		
12.	25.10-06.11	28	3	40	28	14	0	3	28	0	28	53	3	40	2	54	40	28	0	0	28		
13.	07.11-19.11	40	28	28	72	7	28	0	28	40	0	0	0	43	72	28	40	28	44	28	0		

Appendix – II contd...

RANGA REDDY DISTRICT

S.No.	Date	IMD	1994 1995 1996 1997 1998 1999 2000 2001 2002 2003											
1.	28.05-07.06	5	0	11	0	0	0	5	81	39	12	0		
2.	08.06-21.06	50	58	105	80	53	7	73	99	42	28			
3.	22.06-05.07	29	73	24	32	7	30	66	0	0	3			
4.	06.07-19.07	34	20	39	48	20	44	18	31	8	198			
5.	20.07-03.08	39	43	29	28	27	37	11	28	67	0			
6.	04.08-16.08	35	19	6	7	19	9	44	84	73	32			
7.	17.08-30.08	141	33	33	69	23	14	29	4	35	74			
8.	31.08-3.09	13	6	30	95	24	19	10	37	73	4			
9.	14.09-27.09	19	23	9	83	19	15	14	105	50	42			
10.	28.09-10.10	224	27	17	56	22	19	2	229	15	41			
11.	11.10-24.10	113	43	16	0	29	12	5	84	81	66			
12.	25.10-06.11	53	3	0	2	14	0	3	0	0	28			
13.	07.11-19.11	0	3	3	32	7	0	0	4	0	0			

Appendix – II contd....
C) NAKSHATRA-WISE RAINFALL (MM) FOR THE FOUR PANCHANGS AS AGAINST IMD ACTUAL RAINFALL FROM 1994-2003 FOR VISAKHAPATNAM DISTRICT

S.No.	Date	P1											P2											
		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003			
1	28.05-07.06	0	0	8	28	28	28	28	28	28	28	28	28	28	0	0	0	0	40	47	117	28	52	40
2	08.06-21.06	0	28	8	68	150	166	47	32	28	28	28	28	28	58	40	28	68	150	0	7	0	0	41
3	22.06-05.07	8	46	114	8	8	0	8	8	4	28	28	28	28	0	0	0	8	0	40	70	48	0	45
4	06.07-19.07	8	126	200	40	105	62	70	79	68	121	121	121	121	0	0	200	40	105	62	0	8	68	8
5	20.07-03.08	139	28	8	28	28	25	28	28	19	28	28	28	28	139	50	0	0	0	0	0	50	0	94
6	04.08-16.08	8	14	89	107	44	80	71	56	56	51	51	51	8	0	89	107	44	40	71	0	0	51	
7	17.08-30.08	97	8	124	103	8	28	28	28	18	28	28	28	97	28	124	0	0	8	0	0	0	0	0
8	31.08-13.09	65	8	41	90	115	49	79	32	28	20	20	20	0	8	0	0	0	49	79	72	0	60	
9	14.09-27.09	0	57	0	28	28	28	28	26	28	28	28	28	55	57	40	189	0	0	0	8	44	128	
10	28.09-10.10	28	268	147	50	207	0	0	0	0	8	8	8	208	0	0	8	8	0	42	232	0	176	
11	11.10-24.10	0	8	149	28	121	67	136	63	64	28	28	28	56	0	0	40	121	28	136	0	0	340	
12	25.10-06.11	28	10	59	66	28	0	28	28	28	62	62	62	111	50	19	0	0	0	0	0	0	0	
13	07.11-19.11	8	0	81	49	68	28	28	218	48	48	48	48	56	0	0	8	0	40	40	218	48	0	

Appendix – II contd...
VISAKHAPATNAM DISTRICT

S.No.	Date	P3											P4										
		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003		
1	28.05-07.06	40	40	96	5	28	28	8	7	28	28	40	40	96	5	40	0	28	28	52	40		
2	08.06-21.06	8	0	8	68	150	28	28	8	8	1	58	0	310	68	28	166	0	32	8	1		
3	22.06-05.07	28	46	114	48	36	0	8	8	28	45	69	46	114	48	76	40	8	8	44	45		
4	06.07-19.07	28	8	200	0	105	8	8	79	8	0	28	126	200	40	28	62	8	39	0	28		
5	20.07-03.08	8	50	28	109	118	25	28	50	8	28	139	50	67	109	118	65	28	50	0	94		
6	04.08-16.08	8	54	89	28	44	8	31	28	28	51	46	0	89	107	44	80	8	0	56	11		
7	17.08-30.08	97	8	28	103	159	28	8	68	18	8	97	65	28	103	28	119	28	28	58	85		
8	31.08-13.09	28	87	41	8	8	49	8	32	28	8	8	28	41	90	115	28	0	72	61	60		
9	14.09-27.09	55	57	28	189	164	46	8	26	44	28	55	57	0	189	164	46	126	26	28	128		
10	28.09-10.10	208	268	28	50	28	8	28	232	11	28	208	268	0	8	207	0	2	232	11	0		
11	11.10-24.10	16	28	28	28	8	28	8	28	64	340	16	8	149	28	28	67	136	63	8	28		
12	25.10-06.11	28	10	59	28	8	8	8	28	8	28	111	10	59	8	231	59	28	0	8	28		
13	07.11-19.11	56	28	28	49	8	28	8	28	48	8	0	0	81	49	28	40	28	218	28	0		

Appendix – II contd...
VISAKHAPATNAM DISTRICT

S.No.	Date	IMD											
		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003		
1	28.05-07.06	0	0	96	5	0	7	117	7	12	0		
2	08.06-21.06	18	0	310	28	150	166	7	32	121	1		
3	22.06-05.07	69	6	114	8	36	0	39	8	4	45		
4	06.07-19.07	42	126	200	0	105	22	30	39	68	121		
5	20.07-03.08	139	50	67	109	118	25	4	10	19	94		
6	04.08-16.08	46	14	89	107	44	40	31	56	56	11		
7	17.08-30.08	97	65	124	103	159	119	160	68	18	85		
8	31.08-13.09	65	87	1	90	115	49	79	32	61	20		
9	14.09-27.09	15	17	0	189	164	6	126	26	4	128		
10	28.09-10.10	208	268	147	50	207	92	2	232	11	176		
11	11.10-24.10	16	353	149	0	121	67	136	63	64	340		
12	25.10-06.11	111	10	19	66	231	19	0	54	45	62		
13	07.11-19.11	16	83	81	49	68	0	0	218	8	0		

