

## Characterization of Nakshatra-Wise Rainfall, Its Trend and Relation with Paddy Yield of Anand District

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### ABSTRACT

Agricultural development in India depends primarily on the monsoon. Its auspicious beginning, nationwide spread and appropriation is essential to kharif crops. An Anand station is selected to the study the variability on a smaller period of the scale based on Nakshatras, which have an average period of 13-14 days. These daily rainfall data are recorded manually during 1958 to 2017 (60 years) are used to analyze Nakshatra-wise rainfall distribution in Anand (Middle Gujarat). It can be concluded that rainfall in Punarvasu and Pushya nakshatra is more assured than other nakshatra while it is the least assured in Magha and Purva nakshatra. Rainfall during June–July especially during Ardra and Uttarashadha nakshatra found positive 5% significant which is beneficial for paddy crop and while other nakashatra were non-significant with Pushya, Ashlesha. This knowledge will help in providing good knowledge having blend of experiences of old people and novel ideas of young generations for acceptability to farmers.

**Keywords:** Characterization, Kharif, Nakshatra, Probability, Paddy yield, Rainfall.

### INTRODUCTION

India has its own tradition of astronomical studies and treatises that predict rainfall in a region based on various parameters of astronomy. These techniques are based on observation and behavior of plants and animals. Generally, sowing is done during 22<sup>nd</sup> June to 16<sup>th</sup> August, sometime in one of the four nakshatras viz., Ardra, Punarvasu, Pushya and Ashlesha. Farmer's believe that sowing in Punarvasu (6<sup>th</sup>-19<sup>th</sup> July) is associated with

high yields, Pushya (20<sup>th</sup> July to 2<sup>nd</sup> August) being the next best sowing time. Sowing earlier in Ardra (22<sup>nd</sup> June to 5<sup>th</sup> July) or later in Ashlesha (3<sup>rd</sup>-16<sup>th</sup> August) is considered to be associated with high level of risk. This method gave approximately six months in advance forecast of start and withdrawal of monsoon and distribution of rainfall. Also it is possible for the farmer's to change the crops to decide area under *kharif* and *rabi* seasons (Vaidya, 2004).

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Not surprisingly, farmers have considerable knowledge of the nature of the impact of the rainfall variability in their region on traditional crops. This means that if the sowing is completed early in the sowing window (around 22 June), the harvest will have to be completed soon in October, whereas if it is completed early in August, the harvest will be in November. It is evident that the nature of yield variability with sowing date must be understood for the region's distinct precipitation patterns (Gadgil et al., 2000).

The panchang gives calculation of nakshatra based on three parameters viz., Astronomy, mathematics and astrology. Different stars, planets and constellations in the sky are split into 27 sections is called nakshatras. The time units used by the farmers all over India are not weeks or months, but 13–14 day periods called nakshatras based on the solar calendar. Sun is the source of whole energy on earth thus; phenomenon of rains was associated with celestial bodies like Sun, Moon, Saturn, Jupiter etc. The whole universe is made up of five elements viz., Akash, Vayu, Agni, Jal and Prithvi (Varshneya et al., 2002). Earth is influenced by the planets of solar family viz., Sun, Mercury, Venus, Mars, Saturn, Jupiter etc. The knowledge of the variability is thus in these time units rather than weeks or months.

The appropriate time for farming operations is also worked out in terms of these time periods (Subash et al., 2011). The interest for reorienting meteorological data, calibrating climatic examination and appropriate presentation for agricultural decision making and shielding farmers from bad weather (Varshneya et al., 2011). The series precipitation study conducted a time on various Nakshatra phases covering the Indian monsoon season (De et al., 2004) and assessment of nakshatra-wise precipitation for drought-prone Maharashtra regions (Bavadekar et al., 2008). In their research of rainfall variation at Anand in the center Gujarat region (Chinnchorkar et al., 2013) found that rainfall during Punarvasu and Pushya is more certain than in other naksh

atras, while it is less certain during Magha and Purva nakshatras found that rainfall during Punarvasu and Pushya is more certain than in other nakshatras, while it is less certain during Magha and Purva nakshatras.

## MATERIALS AND METHODS

Anand district covers an area of 2941 sqkm, lies in the central part of the state. Anand district is situated between north latitudes 22°06' & 22°43' and east longitudes 72°20' & 73°12'. The district is bounded on the north by the Kheda District, on the west by Ahmedabad District and on the east by Vadodara District. This district receives an average annual rainfall of 850 mm.

The daily rainfall data archived from Department of Agricultural Meteorology, Anand Agricultural University (AAU), Anand, Gujarat has been used for the study. These daily rainfall data are recorded manually for 60 years during 1958 to 2017 are used to analyze nakshatra-wise rainfall distribution in Anand (Middle Gujarat). Among 27 nakshatra, 12 nakshatra are considered for study, starting from Rohini (25<sup>th</sup> May to 7<sup>th</sup> June) to Swati (24<sup>th</sup> October to 5<sup>th</sup> November) were used for analysis. The basic statistical analysis like Mean, Standard Deviation (SD), Coefficient of Variation (CV), range and significance of trend for nakshatra-wise rainfall were calculated. The frequency distribution of below normal, normal and above normal rainfall and initial probability of getting 30mm, 40mm and 50mm rainfall in each nakshatra were also calculated.

## RESULTS AND DISCUSSION

### Characterization of Nakshatra wise Rainfall:-

The daily rainfall data of Anand (Middle Gujarat Zone) was converted into nakshatra period rainfall in Table 1 and Fig. 1 and computed mean, standard deviation and coefficient of variance for the selected station are given in Table 2. Maximum rainfall occurred in Magha nakshatra (July 20<sup>th</sup> to Aug 2<sup>nd</sup>) 588.7 mm followed by Punarvasu 130.4 mm (July 6<sup>th</sup> to July 19<sup>th</sup>). Mean rainfall shows

that rainfall received in all nakshatra and good amount of rainfall received from Ardra (June 22<sup>nd</sup> to July 5<sup>th</sup>) to Purva (Aug 31<sup>st</sup> to Sep 12<sup>th</sup>). The CV of rainfall shows below 100% from Mrigashira (8 to 21<sup>st</sup> June) to Ashlesha (3-16<sup>th</sup> Aug). The Mrigashira (8-21<sup>st</sup> June) nakshatra rainfall showed lowest CV of 70%, while it was highest 498.1% for Swati nakshatra. Rainfall shows positive trend from end of June to mid-August except Uttarashadha nakshatra where decreasing trend of rainfall is observed for 13-14 days period. Negative trend was observed from end of August to end of November. Thereafter a mixed trend (alternatively two nakshatra showing downward and one nakshatra showing upward trend) in rainfall was observed. (Chhabra et al., 2014).

From Table 2 it reveals that the highest amount of mean rainfall occurred in Ardra nakshatra (22<sup>nd</sup> June-5<sup>th</sup> July) 146.7 mm and lowest amount of mean rainfall occurred in Swati nakshatra (Oct 24<sup>th</sup> to Nov 5<sup>th</sup>) 2.5mm (Table 1). The variability in rainfall was the highest in Swati nakshatra (498.1%) and lowest occurred in Mrigashira (8-21<sup>st</sup> June) at 74%. The variability was less than 90 % in Mrigashira (8-21 June) to Ashlesha nakshatra (Aug 3-16) which is coinciding with “*Narali Purnima*”. The day when tidal waves and wind changes their direction. Tidal waves starts moving away from coast while wind changes from South- Westerly to North-Easterly. The commencement of South-Westerly wind is termed as “monsoon” while commencement of North-Easterly wind is called as “receding monsoon”.

However, onward variability becomes more than 100 per cent. It indicates that some year rainfall will be more while other years will be dry. This is supported by minimum rainfall of zero. Amongst the years under study the highest rainfall occurred in Magha nakshatra (Aug 17-30<sup>th</sup>) was 588.7mm (1990). It was followed by Pushya nakshatra (July 20<sup>th</sup> to Aug 2<sup>nd</sup>) was 580.5 mm (2006) was followed by Ardra nakshatra (June 22<sup>nd</sup> to July 5<sup>th</sup>) was 485.4mm (1977).

The frequency distribution of below normal, normal and above normal nakshatrawise rainfall of Anand (middle Gujarat zone) with its characteristics is given in Table 3 and Fig 2. The frequency of below normal rainfall (< 75 % of the mean rainfall) ranged between 42% in Mrigashira and Ardra nakshatra to 93 % in Swati nakshatra. The frequency of normal rainfall (>75 to 125% of the mean rainfall) ranged between 0% in Swati to 25 % Ardra and Punarvasu nakshatra, which occurred less as compared to frequency of below and above normal rainfall. The frequency of above normal rainfall (> 125 of the mean rainfall) ranged between 7% in Swati to 40% in Punarvasu nakshatra.

The probabilities of getting of 30, 40 and 50 mm assured rainfall in various nakshatra were shown in Table 3 and Fig 3. The probability of 30 mm assured rainfall ranged between 2% in Swati and 85% in Punarvasu nakshatra. The probability of 40 mm assured rainfall ranged between 2% in Swati and 83% in Punarvasu nakshatra. The probability of 50 mm assured rainfall ranged between 2% in Swati and 78% in Punarvasu nakshatra. It can be concluded that rainfall in Ardra, Punarvasu, Pushya nakshatra and Ashlesha is more assured than other nakshatra while it is the least assured in Magha and Purva nakshatra.

#### **Crop selection for rainfall in different Nakshatra periods**

The Nakshatra-wise mean precipitation is depicted in Fig.1. The figure demonstrates that during Rohini nakshatra a decent measure of precipitation was gotten. This period can be used for planting groundnut and red gram. Mrigashirha and Ardra nakshatras got less precipitation during which one can take up yields like finger millet, sunflower, pigeon pea and groundnut. The period Rohini to Uttara got great precipitation which is reasonable for finger millet, sunflower, maize, and pulses like red gram, pigeon pea, chick pea.

#### **Nakshatra wise rainfall pearson correlation with paddy yield**

The relationship between rainfall and paddy crop yield was shown in table 4, it was found

that rainfall during June followed by August month has more pronounced effect on Paddy yield. Rainfall during June–July especially during Ardra and Uttarashadha nakshatra found positive 5% significant which is beneficial for paddy crop and while other

nakshatra were non-significant with Pushya, Ashlesha. It shows that the one variable such as precipitation is statistically significant for the regression model as P-value is less than 0.05. The R<sup>2</sup> shows a strong interrelationship between rice yield and precipitation.

**Table 1: Normal Dates of Nakshatra**

Season	Nakshatra	Period	No of days
Pre- monsoon	Rohini	25 May-7June	14
	Mrigashira	8-21 June	14
Monsoon	Ardra	22 June-5July	14
	Punarvasu	6-19 July	14
	Pushya	20 July-2 Aug	14
	Ashlesha	3-16 Aug	14
	Magha	17-30 Aug	14
	Purva	31 Aug-12 Sep	13
Post-monsoon	Uttarashadha	13-26Sep	14
	Hasta	27 Sep-9Oct	13
	Chitra	10-23 Oct	14
	Swati	24 Oct-5 Nov	13

**Table 2: Rainfall pattern for different Nakshatra in Anand station over the period (1958-2017)**

Statistical analysis	Rohini	Mrigashira	Ardra	Punasvaru	Pushya	Ashlesha	Magha	Purva	Uttarashadha	Hasta	Chitra	Swati
Mean	14.2	115.4	146.7	116.3	139.5	124.0	106.9	90.5	57.0	15.7	17.4	2.5
Standard deviation	47.7	85.4	123.5	121.7	121.7	111.7	120.3	102.7	80.3	36.0	47.4	12.5
Coefficient of variance	336.1	74.00	84.4	87.2	87.2	90.1	112.5	113.4	140.9	229.2	272.8	498.1
Range	323.1	614.5	318.9	580.5	580.5	462.4	588.7	388.8	302.3	59.0	261.3	91.6
Highest rainfall (mm)	323.1 (1976)	398.6 (1962)	614.5 (2006)	318.9 (1977)	580.5 (2006)	462.4 (2004)	588.7 (1990)	388.8 (1970)	302.2 (2013)	239.0 (1985)	261.3 (1982)	91.6 (1981)
Linear trend	D	D	I	D	I	I	D	D	I	D	D	D

I - increasing trend, D - decreasing trend

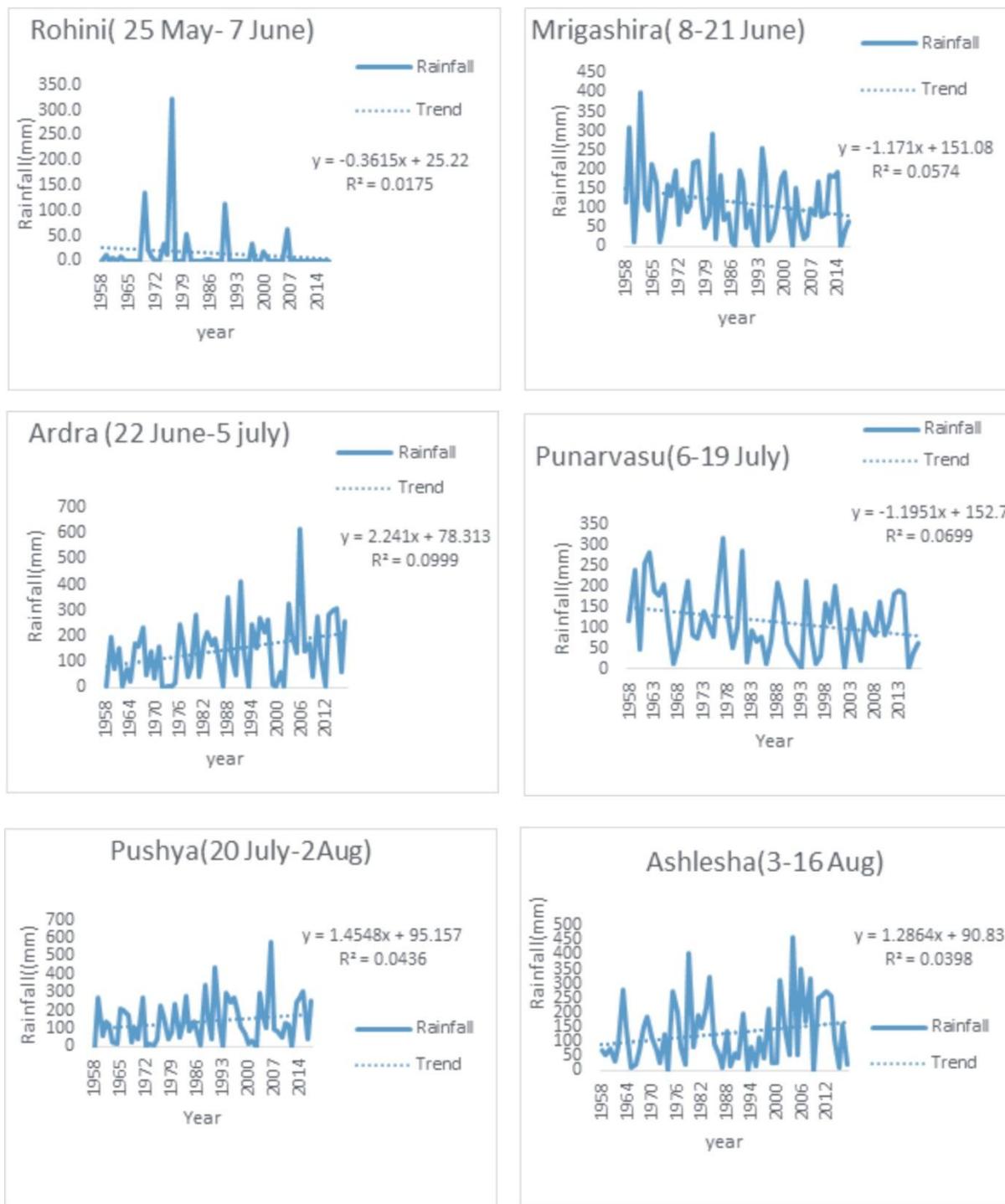
**Table 3: Frequency distribution and initial probability of rainfall in Nakshatra period in Anand**

Nakshatra	Below normal (<75%)	Normal (>75to125%)	Above normal (>125%)	Initial probability (%)		
				30mm	40mm	50mm
Rohini	83	2	15	12	8	8
Mrigashira	42	22	37	80	77	70
Ardra	42	25	33	78	77	70
Punarvasu	43	25	40	85	83	78
Pushya	47	18	35	80	75	68
Ashlesha	50	15	35	77	75	60
Magha	58	10	31	70	67	62
Purva	60	7	33	58	55	53
Uttarashadha	65	5	30	45	38	33
Hasta	72	5	23	18	15	12
Chitra	77	3	20	15	10	8
Swati	93	0	7	2	2	2

**Table 4: Correlation between rainfall and paddy yield for Anand (1960-2015)**

CROP	Ardra	Punarvasu	Pushya	Ashlesha	Magha	Purva	Uttarashadha
Paddy (Pearson Correlation)	0.27	-0.23	0.20	0.23	-0.01	-0.21	0.28
P Value	.04417 (0.05)S	.088141 NS	.139439 NS	.0881419 NS	0.941689 NS	0.12032	0.36611 (0.05)S

S- Singificant, NS-Non Significant



**Fig. 1a: Rainfall variability and trends according to nakshatras at Anand during 1958-2017**

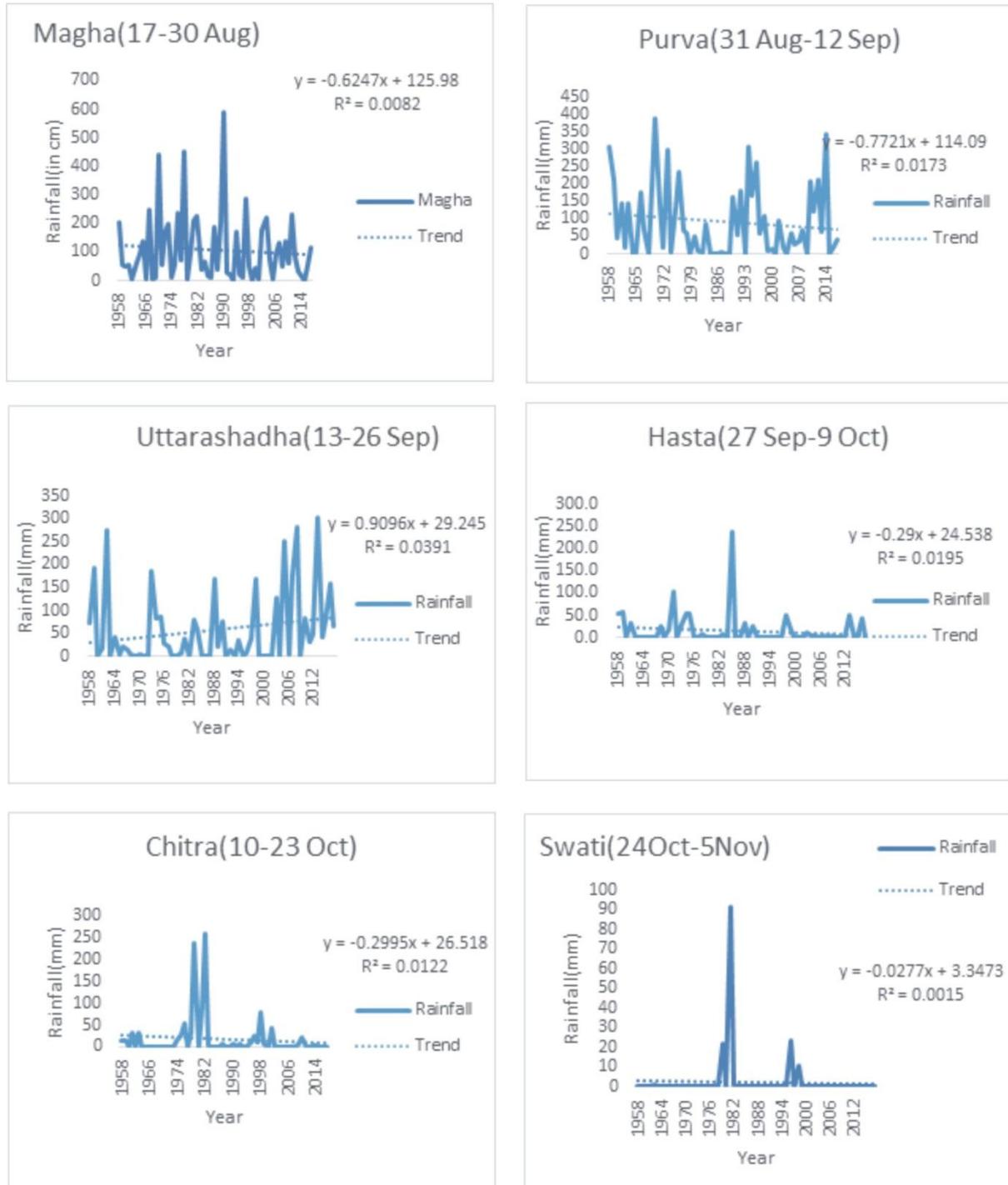


Fig. 1b: Rainfall variability and trends according to nakshatras at Anand during 1958-2017

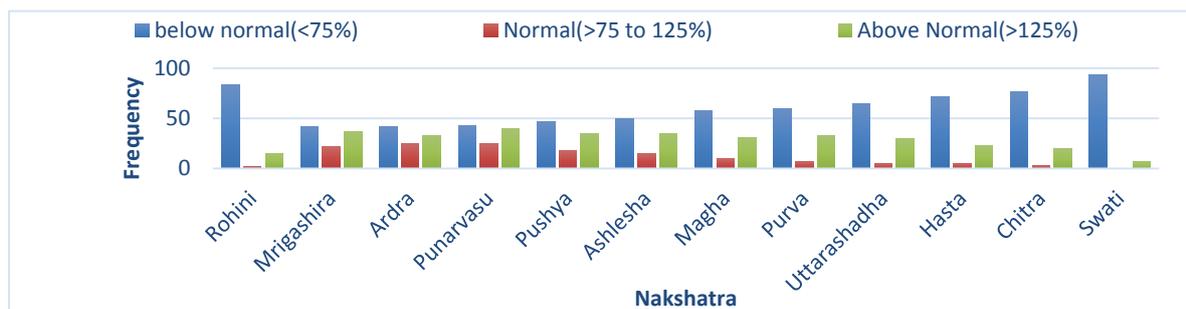


Fig. 2: The frequency distribution of below normal, normal and above normal nakshatra

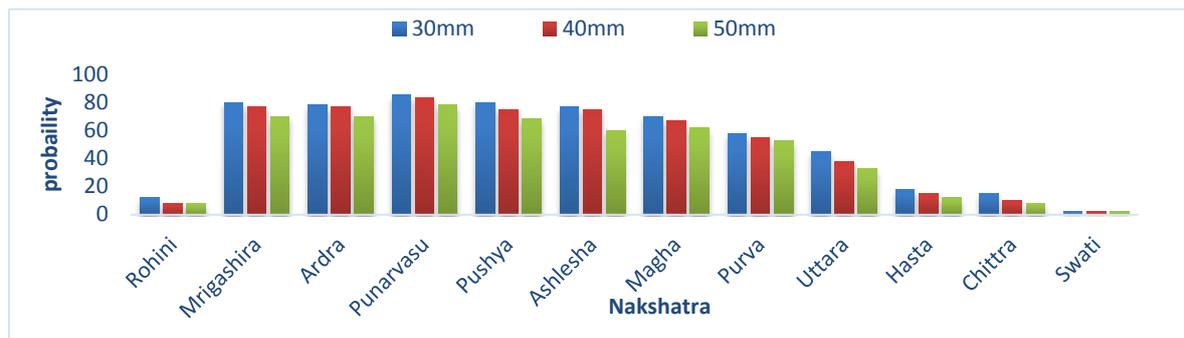


Fig. 3: The probabilities of getting of 30, 40 and 50 mm assured rainfall in various nakshatra

### CONCLUSION

It can be concluded that rainfall in Punarvasu and Pushya nakshatra is more assured than other nakshatra while it is the least assured in Magha and Purva nakshatra. Similar, results were reported by (Varshneya et al., 2002). Rainfall during June–July especially during Ardra and uttarashadha nakshatra found positive 5% significant which is beneficial for paddy crop and while other nakashatra were non-significant with pushya, ashlesha. This knowledge will help in providing good knowledge having blend of experiences of old people and novel ideas of young generations for acceptability to farmers.

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