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A Study on Variation in Rainfall and Its Impact on Crop Yields in Kovilpatti Block

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A study was carried out in Kovilpatti Block of Tirunelveli District to study the variations in crop yields and rainfall and the effect of rainfall on crop yield. Daily rainfall data for a period of 75 years from the records of the Cotton and Millets Experimental Station were used for studying the distribution pattern of rainfall and time series data on yield of major crops were gathered from the issues of Season and Crop report for studying the variation in crop yields. It was found that the probability of failure was the highest for the month of October. Bajra had exhibited the highest variation in yield followed by cotton and sorghum. A functional analysis to identify the relative contribution of rainfall and percentage of irrigated and to gross cropped area of Bajra and time trend on the yield of crop revealed that the rainfall and percentage of irrigated area to gross cropped area of Bajra significantly contributed to the yield of Bajra.

In dryland agriculture, conservation and effective utilisation of the available moisture are prime factors. Extremes of weather have extensive and definite effects on limiting crop productivity. Proper understanding of the pattern of variation of climatic parameters, particularly rainfall, would go a long way in bringing dryland agriculture in tune with the climate (Ratinam and Hegde, 1977). This will also help in assessing how far crop insurance, diversification of crops or such other measures might help farmers in facing the instability. An attempt was made to evaluate the effect of rainfall on crop yield in the predominantly dry tract of Kovilpatti. The specific objectives of the study were : (i) to analyse the seasonwise and monthwise distribution of rainfall over a period of 75 years and (ii) to analyse the variations in crop yields and the impact of rainfall.

MATERIAL AND METHODS

The daily rainfall data of Kovilpatti since 1904 were collected from the records of the Cotton and Millets Experimental Station, Kovilpatti and the time series data on yield and area under principal crops of Tirunelveli district were gleaned from the issues of Season and Crop Reports.

RESULTS AND DISCUSSION

Variability in Rainfall :

The monthwise average rainfall, their shares in the annual total and the coefficient of variation in the same for the years 1904 through 1978 are given in Table I. Instability, as seen from coefficient of variation in rainfall, is

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TABLE I Average Rainfall Shares of Months and Variation

Particulars	Jan.	Feb.	Mar.	April.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Average rainfall (mm)	28.45	19.15	26.14	78.38	57.44	14.53	19.57	42.57	59.08	175.15	163.88	66.58	750.5
C. V. (% of 1)	168.14	163.84	132.28	73.78	110.47	139.87	146.86	112.09	71.91	57.06	64.38	95.41	—
Average share (% in annual)	3.79	2.55	3.48	10.44	7.64	1.95	2.60	5.60	7.87	23.36	21.82	8.88	100.00
C. V. (% of 3)	189.89	205.91	119.27	74.25	64.02	134.02	151.23	100.26	75.95	51.75	48.64	90.03	—

TABLE II Frequency and Probability Distribution of Rainfall in North East Monsoon

Period		Rainfall ranges in per cent from the average								
		Below normal				Normal			Above normal	
		Below -50%	-50 to -30%	-30 to -10%	Sum of cols 1 to 3	-10 to +10%	+10% to +30%	+30 to +50%	Above 50%	Sum of col. (to 6 to 8)
Sep.	F	21	9	9	29	7	7	6	16	29
	P	27.99	12.00	12.00	51.99	9.33	9.33	7.99	21.33	38.66
Oct.	F	11	18	6	38	20	6	3	11	20
	P	14.67	23.99	8.00	46.66	26.66	7.99	4.00	14.66	26.66
Nov.	F	15	13	10	38	7	12	8	11	30
	P	20.00	17.33	13.33	50.67	9.33	14.66	10.66	14.66	40.00
Dec.	F	30	10	4	44	5	2	5	19	26
	P	40.00	13.33	5.33	58.66	6.67	2.67	6.67	25.33	34.67
Annual	F	5	4	26	35	15	14	9	2	25
	P	6.67	5.33	34.67	46.67	20.00	18.67	12.00	2.67	33.33

F : Frequency in Number P : Probability in per cent

Note : Total frequency is 75 and total probability is 100 per cent

TABLE III Yield Variability of Major Crops in Tirunelveli District

Crop	Mean yield (kg/ha)	Standard deviation	Coefficient of variation	Range (Kg/ha) Min.	Max	Range expressed as % over mean
Bajra	531	147.72	27.81	278	1193	172.26
Sorghum	1088	259.66	23.86	646	1841	109.83
Cotton	112	22.79	20.32	63	146	74.85

TABLE IV Linear Regression on Factors Determining Per Hectare Production of Bajra in Triunelvel District (1940–41 to 1976–77)

Variables	Mean	bi	Standard error	Value	Significance
Yield of bajra in kg/ha (y)	531.16	—			
Annual rainfall in mm (X_1 t)	741.10	1.11754	0.12585	9.34006	**
Percentage of area irrigated to gross cropped area of bajra (X_2 t)	2.32	55.02099	17.80258	3.12573	*
Time trend (t)	19	4.49222	2.33460	1.92419	NS
Constant (at)	—	231.04476			
R^2 : 0.41181					
R : 0.64172					

* = Significant at 5 per cent level

** = Significant at 1 per cent level

very high for individual months, particularly for the months which receive scanty rainfall. The coefficient of variation of rainfall for January to March is between 130 and 145 per cent and for June to August it is between 110 and 146 per cent. For the other months it is between 57 and 72 per cent.

The shares of individual months also show almost as much variability as the absolute rainfall.

In Table II the frequency and probability distribution of rainfall are given in seven ranges of 20 per centage points of average for the period 1904 to 1978 both for annual rainfall and rainfall for different months of North East Monsoon period. Among the seven principal months commencing from June, the probability of failure is the highest for June (63 per cent) followed by July (61.33 per cent), December (58·66 per cent), August (54.66 per cent) September (51.99 per cent) and October (46.66 per cent) and November (50.67 per cent). It is the lowest in the month of May with 48 per cent. Incidentally both October and November have the highest rainfall together accounting for 45 per cent of the annual total. These months have the lowest risk of failure of rainfall and hence are more dependable. The crop patterns and sowing operation of the district are naturally adjusted to this factor.

Yield Variability

Bajra, cotton and sorghum were grown to an extent of 80.85 per cent of the gross cropped area in 1978—79 and any variation in yield of these crops would affect the farmers considerably. In order to study the deviation in yield and its distribution pattern, the average yield of these three major crops for the district for a period of 37 years were collected and measures such as standard deviation, coefficient of variation, range, range expressed as percentage over the mean and year to year variability in yield from the mean yield were computed and are presented in Table III.

Bajra recorded the highest deviation in yield followed by sorghum and cotton in that order. The highest yield variability in bajra was predominant in this tract because bajra has been found to be season bound in this region and any delay in sowing even by a week would lower the yield considerably.

In order to identify the determinants, their relative contribution and the significance of part played by them in determining the yield of major crop of the study region *viz.*, bajra, a functional analysis was carriedout by fitting a linear regression. The yield of bajra was taken as dependent variable and the annual rainfall, percentage of area irrigated to gross cropped area of bajra and time trend were taken as the independent variables. The time trend was considered to take into account the improvement in technology. The district level observation for Tirunelveli district was carried out for this analysis and the estimated function is shown in Table IV.

The coefficient of muliple determination was 0.4118 indicating the goodness of fit and implying that 41.18

per cent of variations in yield of bajra could be explained by the independent variables. Except the time trend, all the other variables were found to have significant influence on this crop. This would mean that an increase in rainfall by one *mm* would, *ceteris paribus*, increase the yield of bajra by 1.1175 kg/ha. Likewise if area under irrigation to gross cropped area were to increase by one per cent the yield of bajra would increase 55.0209 kg/ha. The co-efficient of determination indicates that only 40 per cent of variation in yield of bajra could be explained by the selected variables, Perhaps the inclusion of variables, such as rainfall during the critical periods, level of soil moisture etc., may further improve the goodness of fit.

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