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CONTENTS

PART I

Trends in Paddy Production and Productivity in the Gangetic Plains of Bihar as Influenced by Rainfall Pattern

A. Abdul Haris, Vandna Chhabra and Sandeep Biswas

Introduction

Rice is the staple food of our country and a predominant cereal foodgrain, accounting 43 per cent of the total foodgrain production. Bihar, situated in the eastern region of the country, is a low productivity region with high potential for better agricultural production with suitable agronomic interventions. In spite of all technological advancements and irrigation facilities, paddy cultivation in Bihar is largely dependent on the southwest monsoon rains received during June to September. The main rice-growing season in the Bihar is kharif (May-June to September-October) and 84% of the country's rice crop is grown in this season (Anonymous, 2006) and total rainfall as well as its distribution over time is vital for rice production. In undivided Bihar total rice area was 5.08 million hectares producing 6.7 million tonnes with a productivity of 1331 kg/ha. At present Bihar's total rice producing area is 3.18 m. ha, producing 2.62 m tonnes with a productivity of 823 kg/ha. Out of total 3.18 m. ha rice area; merely 1.6 m. ha is irrigated. In rainfed rice, rainfall is the only source of water and thereby any fluctuation in rainfall pattern and amount affects rice production in an adverse manner, this in turn affects the food security of this region. Water is one of the crucial inputs in conventional rice cultivation and its excess or deficit availability/application influences the yield adversely. In addition to total amount of irrigation, many factors like time of water application, depth of water application, natural rainfall and bund height around rice fields also affects the total crop production significantly. Mean monsoon rainfall over undivided Bihar, during June to September is 1052.2 mm with a coefficient of variation up to 15 per cent and these amounts to about 82 per cent of the annual precipitation (1279.8 mm). The number of pre-monsoon showers, delay in onset of monsoon, break in the monsoon, early cessation of monsoon, excess rainfall during crop season, rainfall shortage during north-east monsoon etc. adversely affects the crop yield. Several researchers (Parthasarathy *et al* 1992 and Gopinathan, 2000) attempted to study fluctuations of foodgrain production and southwest monsoon rainfall over India. Keeping this in view an attempt has been made to study the influence of monsoon on rice production and also to examine the influence of rainfall distribution on rice production over the study area (Bihar).

Methodology

In this study area, production and productivity of rice over Bihar from 1974 to 1999 was taken from "Rice in India", published by the Directorate of Rice Development, Ministry of Agriculture, Government of India.

The production of rice depends on non-meteorological components/inputs such as type of seeds used, crop area, availability of irrigation facilities, fertilizers, management practices, pesticides and also on the Govt. incentives in the farming sectors and meteorological parameters such as rainfall, temperature, relative humidity and solar energy. The total non-meteorological components that is, the total technological inputs to the farming sectors have been growing steadily and difficult to quantify. Therefore, to quantify the growth rate of total technological inputs to the agricultural sectors, the actual yield of 25 years was fitted into a linear curve.

The Technological Yield = ax+b......................................(1)

Where a and b are constants to be determined empirically and x is the reference year (1, 2.............n) from 1974 to 1999. The actual yield was fitted into a linear curve. To normalize the rainfall and yield data, the following indices were used.

The *Normalized Yield Index* was taken as the percentage of the Technological Trend

Yield to the actual yield. The Normalized Yield Index for the i^{th} year is

$NYI_i=(Y_i-TY_i)\times 100/TY_i$...(2)

Where NYI_i is Normalized Yield Index for the i^{th} year, Y_i is the actual yield for the i^{th} year and TY_i is the technological trend yield for the i^{th} year.

Monthly rainfall was indexed by taking the monthly rainfall in terms of percentage deviation from its mean. The rainfall index for any month is expressed as

$NRI_i = (R_i-R) \times 100/R$ ....(3)

1. *Senior Scientist (Agronomy) and corresponding author; 2. Senior Research Fellow (NPCC-ICAR RCER) ICAR Research Complex for Eastern Region, Patna-800014

Where NRI_i is the Normalized Monthly Rainfall index for the i^{th} year, R_i is the monthly rainfall for the i^{th} year and R is the mean monthly rainfall.

Multiple regression equation for the seasonal rainfall during June to September and yield indices and linear equation for the total monsoon rainfall and annual rainfall were developed.

Results and Discussion

In undivided Bihar, area, production and productivity of rice is showing an increasing trend from 1974 to 1999. The area is minimum during 1982 (4.49 m ha) and maximum area under rice is in 1977 (5.59 m ha). Production is highest i.e. 7.742 million tonnes in 1999. Productivity of rice has also been increased from 1974 to 1999 but maximum productivity value is achieved in 1999 to the tune of 1540 kg/ha from 868 kg/ha in 1974 i.e. almost two folds in 25 years. Area, production and productivity values fitted into linear curve and R^2 values are to the tune of 0.18, 0.42 and 0.59 respectively presented in fig 1, 2 and 3.

Statistical analysis of rainfall data showed that July is the rainiest month with an average amount 323.5 mm followed by August with a mean rainfall of 303.6 mm. Highest value of SD is observed for the month of September while maximum value of coefficient of variation is for the month of December.

The regression between Normalized Yield Index (NYI) and the Monthly Rainfall Indices (MRI) during the kharif months (Fig 6) show that rainfall amount of individual months is not significant. Multiple regression of Normalized Yield Index with Normalized Rainfall Indices of June, July, August and September are non significant with low value of R^2 (Table 1). It indicates that kharif season rainfall (Fig 4) accounts for 29 per cent and annual rainfall accounts for 34 per cent variability in rice productivity (Fig 5).

In the present Bihar state after separation of Jharkhand in year 2000, productivity of rice is showing a decreasing trend with R^2 value (0.47) from year 2000 to 2005. Rainfall during kharif season as well as annual rainfall is also showed a decrease during the same time period (Fig 7).

TABLE 1—LINEAR REGRESSION RELATIONSHIP BETWEEN RAINFALL AND YIELD

S. No.	Month	Regression equation	R^2 value
1.	June, July, August, September	$NYI = 0.156\ NRI_{(June)} + 0.1\ 82NRI_{(July)} +$ 0.018 $NRI_{(August)} + 0.156\ NRI_{(September)}) + 0.001$	R^2=0.337
2.	Kharif	NYI = 0.5254 NR1(Kharif) + 0.0012	R^2 = 0.290
3.	Annual	NYI = 0.594 NRI (Kharif) + 0.001 3	R^2 = 0.338

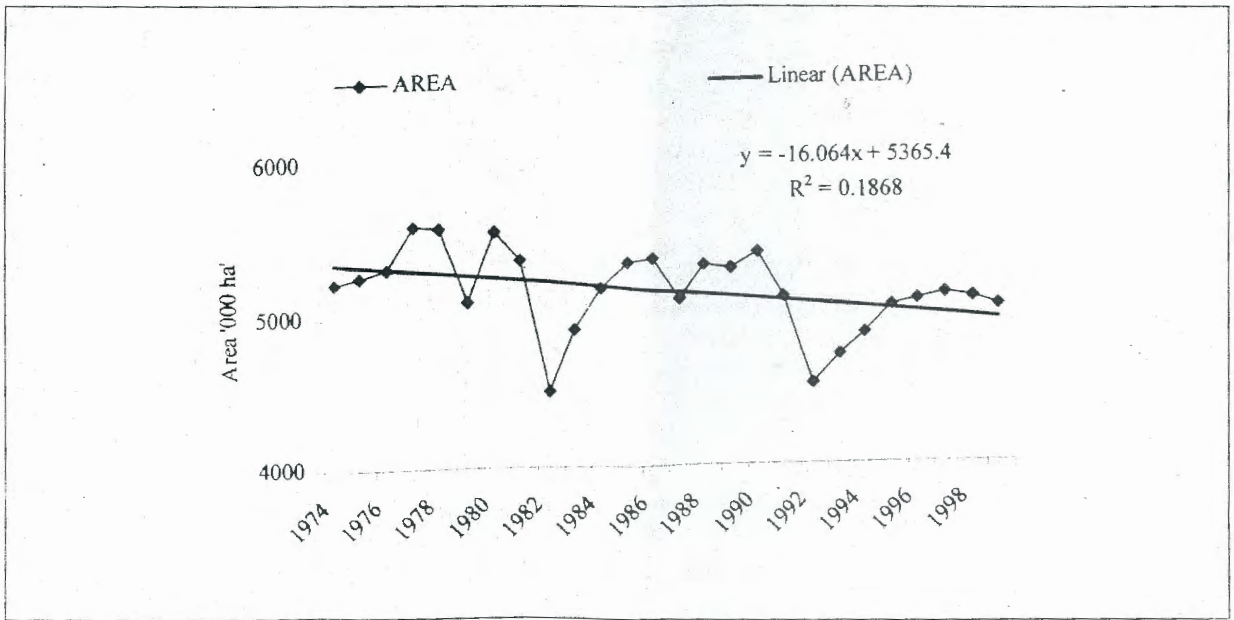

Fig. 1. **Area under paddy cultivation in Bihar (1974-1999)**

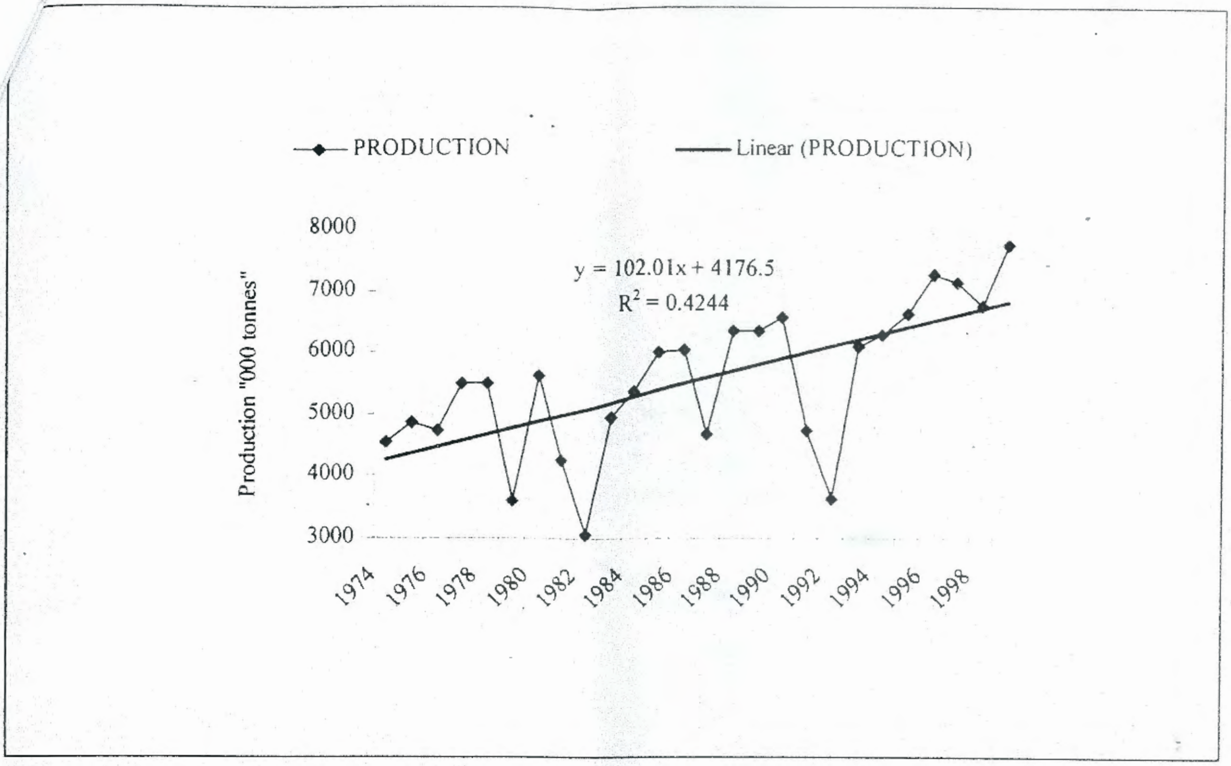

Fig. 2. Total paddy production in Bihar (1974-1999)

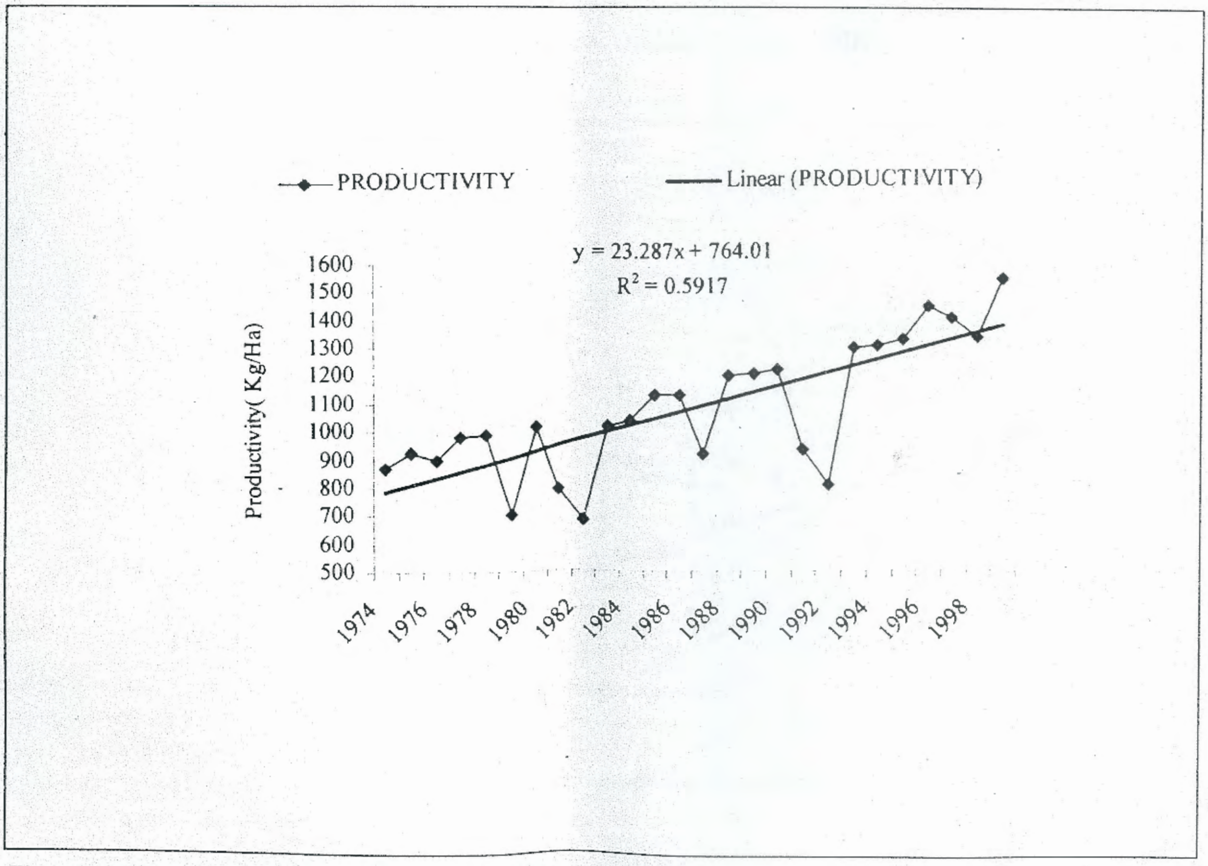

Fig. 3. Productivity of paddy in Bihar (1974-1999)

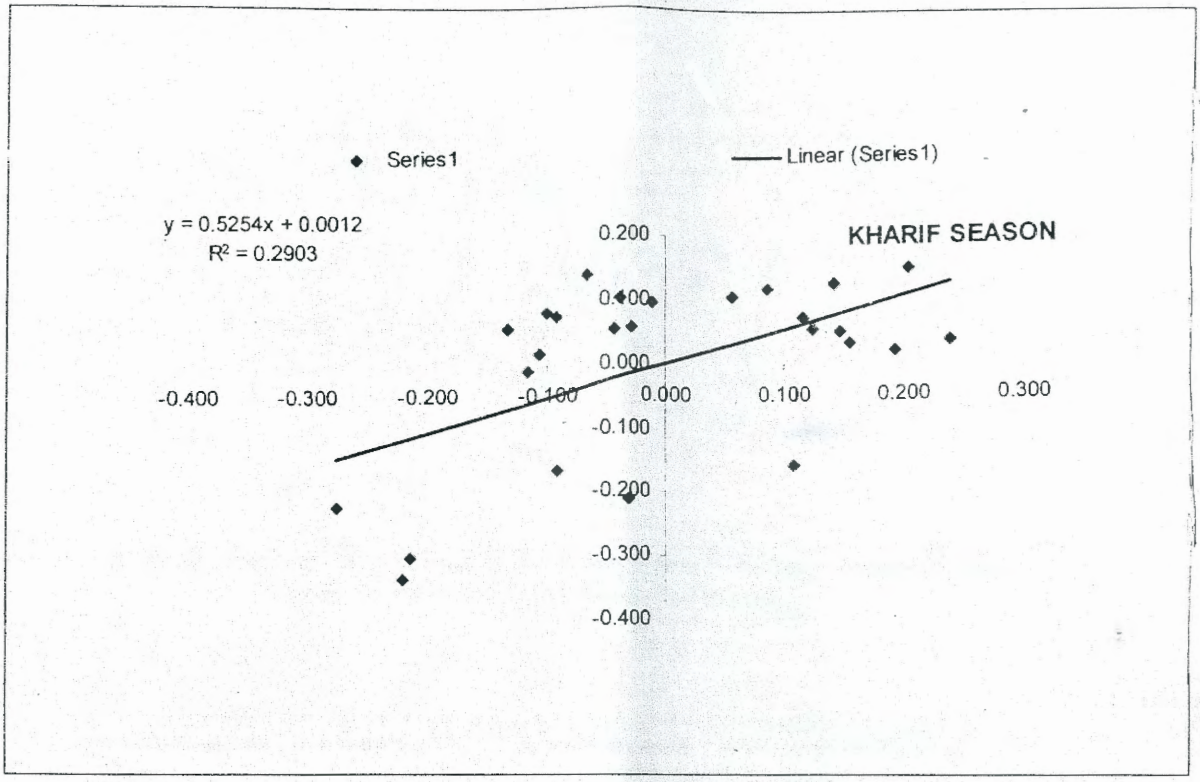

Fig. 4. Relationship between Normalized Monsoon Rainfall Index (NMRI) and Normalized Yield Index (NYI)

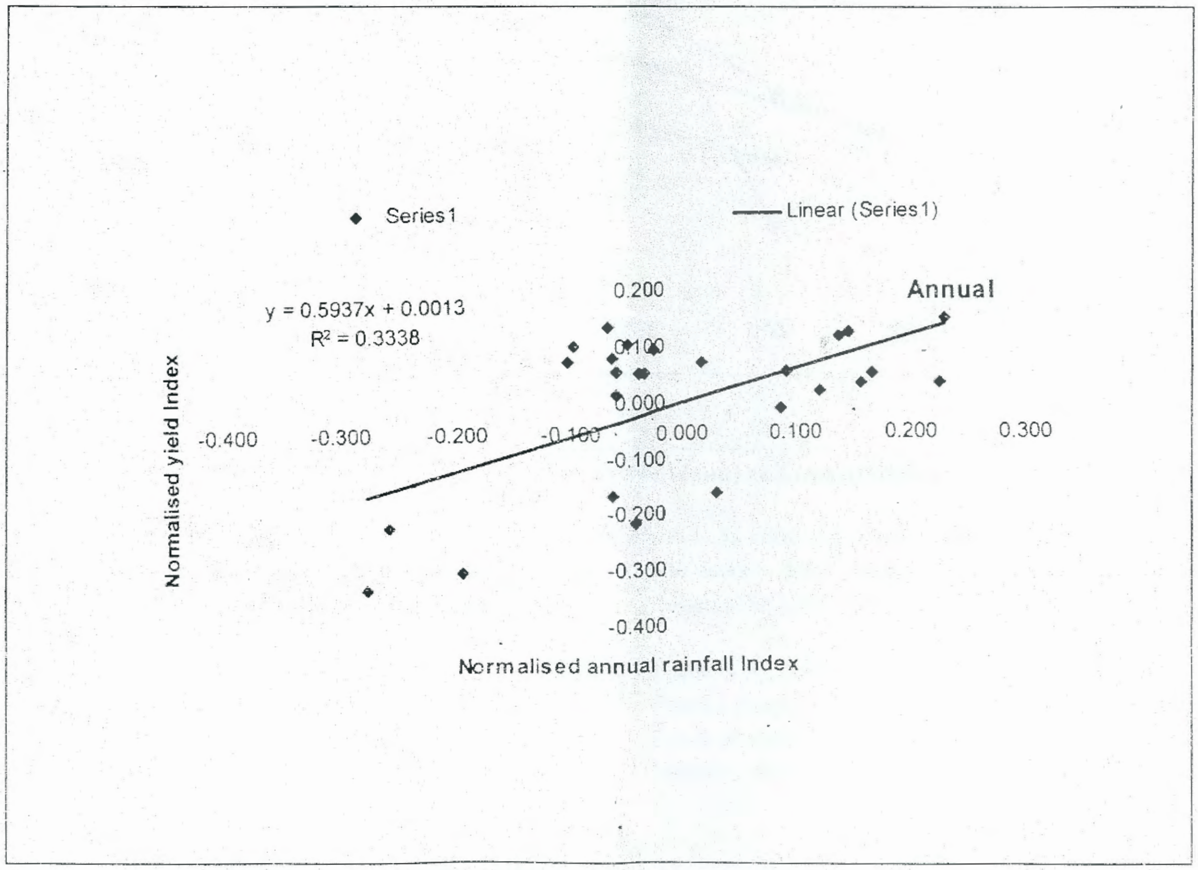

Fig. 5. Relationship between Normalized Annual Rainfall Index (NARI) and Normalized Yield Index (NYI)

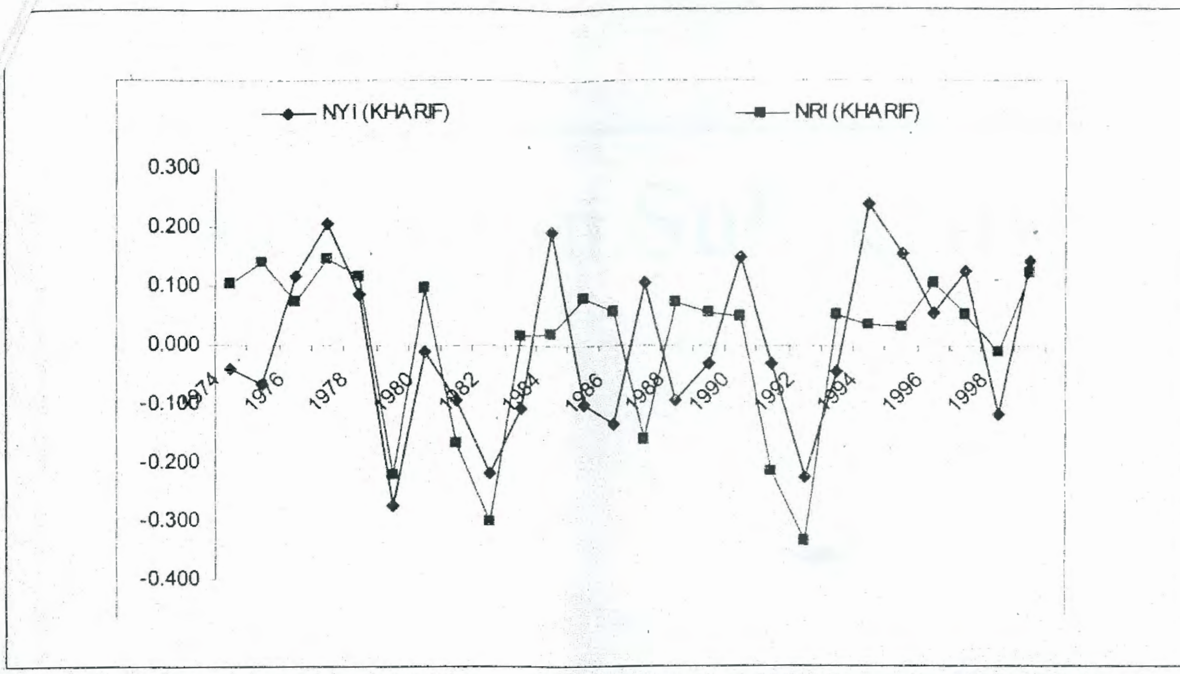

Fig. 6. Relationship between NYI (Normalized Yield Index) and NRI (Normalized Rainfall Index during Monsoon) for total time period in years

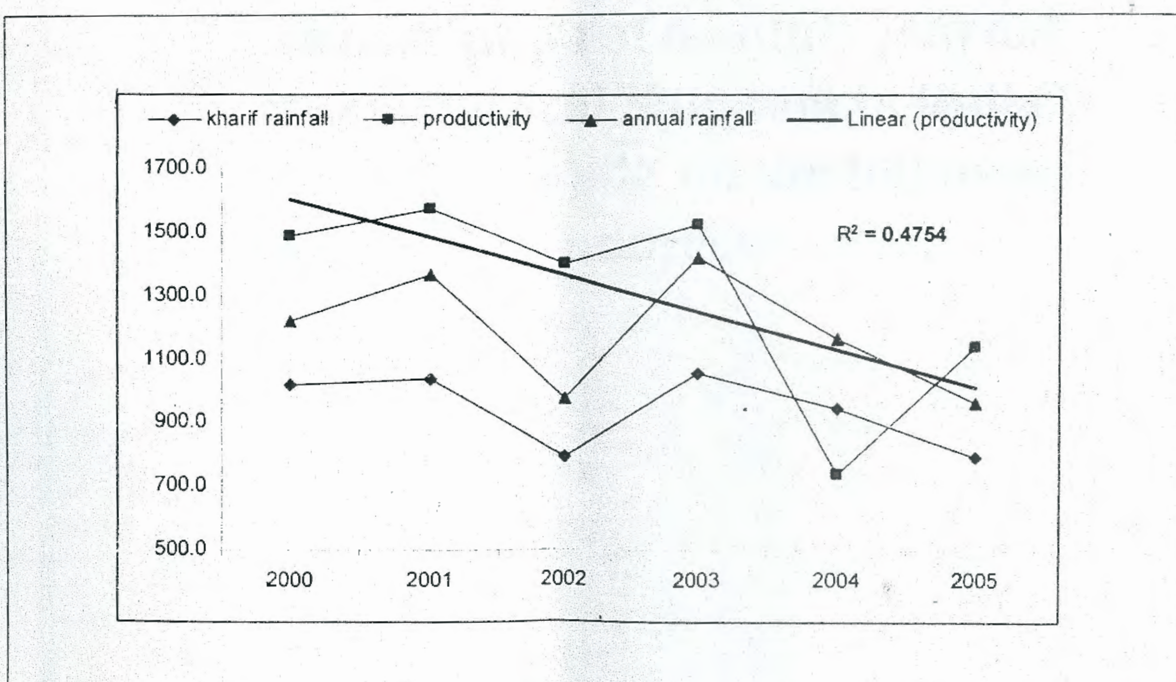

Fig. 7. Time (years) trend of productivity (kg/ha), annual rainfall (mm) and kharif season rainfall (mm)

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