MAIZE CULTIVATION IN INDIA:
A Spatio-Temporal Analysis

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REGIONAL DEVELOPMENT
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CERTIFICATE

This is to certify that the dissertation entitled, **"MAIZE CULTIVATION IN INDIA : A SPATIO-TEMPORTAL ANAYSIS"**, submitted by SURESH KUMAR, is in partial fulfilment of the requirements for the degree of MASTER OF PHILOSOPHY of this University. This dissertation is his own work and is not submitted to any other University for any other Degree.

We recommend this dissertation to be placed before the examiners for evaluation.

Supervisor 21.7.92

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Chapter I

INTRODUCTION

Agriculture, historically, has always remained dominant sector of Indian economy. One can clearly see its influence not only on economic scenerio, but also on socio-cultural and politico-administrative set up of the country. "It provides livelihood to about 7Ø per cent of total labour force, contributes about 35 per cent of net national product and accounts for a sizeable share of total value of country's export. It supplies bulk of wage goods required by non-agricultural sector and raw material for a large section of Industry"[1].

However, under the population pressure, the agricultural economy of India is dominated by foodgrains cultivation, accounting for more than 7Ø per cent of the total cropped area. The production of foodgrains increased significantly after independence from 5Ø.8 million tonnes in 195Ø-51 to 171.Ø million tonnes in 1989-9Ø[2], first through physical increase in cropped area and then after green-revolution through growth in yield.

The growth of foodgrains production after independence was marked by regional imbalance in agricultural development, as

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1. Government of India, Ministry of Information and Broad Casting, India 199Ø - A Reference Annual, September, 199Ø, p. 383.

2. Government of India, Ministry of Finance, Economic Survey - 1991-92, Part II, Sectoral Development, pp. 5-16.

the production of foodgrains increased at faster rate in irrigated areas. Moreover, even among foodgrains the growth in production was confined to very few crops such as wheat and rice. On the other hand, other crops particularly coarsegrains have been assigned the status of inferior cereals and relatively low value crops[3]. Consequently, the output of coarsegrains has either experienced a declining trend, stagnation or very slow growth.

The coarsegrains are grown mostly in dry areas by small and marginal farmers[4]. But even after more than forty years of independence the problem of dryland agriculture remained unresolved. The coarse foodgrains of dryland have not experienced any technological breakthrough in seed technology. As a matter of fact, under existing natural, economic and technological constraints, the country is not in a position to provide required irrigation facilities. Moreover, in irrigated areas growth rate of foodgrain production may start declining.

Thus, there is need to increase the yield of coarse foodgrains to feed the growing population of the country. There is much scope of growth in production of coarsegrains like that jowar, bajra, maize, ragi, and barley. These grains have strong

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3. M.V. Nadkarni, "Backward Crop in Indian Agricultural Economy of Coarse Cereals and Pulses", Economic and Political Weekly, 27 Sept. 1986, vol. XXI, Nos 38 and 39.

4. Government of India, Ministry of Finance, Economic Survey 1989-90, p. 14.

influence on food economy of the country with 39 million hectare area as against 128 million hectare under total foodgrains in 1988-89 and contributing about 19 per cent of total foodgrain production[5]. The coarsegrains are grown mainly in semi-arid regions of the country which are subjected to erratic and inadequate rainfall and only 7-8 per cent of area under coarsegrains is irrigated[6]. But their advantage is that due to suitable agro-climatic condition in such regions, they can do reasonably well, where, so called superior foodgrains would not grow at all or they would give uneconomic yield. Therefore, study growth in foodgrains and other agricultural commodities can be achieved only when dryfarming technology gets breakthrough in dry areas.

Maize, one of the historically most controversial and important coarsegrains in India, has been chosen for the present study. It accounted for about 28 per cent of the total coarse cereals and 6 per cent of total foodgrains production of the country in 1989-90 and occupied about 5 per cent of total area under foodgrains[7]. The yield of maize in India is very low (1500 kg/hectare) in comparision to other countries (world's average

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5. Ibid, p. 14.

6. Ibid p. 14

7. Government of India, Ministry of Finance, Economic Survey 1991-92, Part II Sectoral Developments, pp. 5-16.

yield is 3633 kg per hectare). That is why, India accounts for 4.65 per cent of total maize area in the world and only 1.92 per cent of production of the world[8].

Maize in India in known an Yavanala in Sanskrit, Makka in Hindi, Buthhe, Bhutta and Makai in Bengali, Mukka-Jonnalu in Telugu, Mukkacholam in Tamil, Makaibonda in Marathi, Jagung in Malayalam, and Bottah in cannad languages[9].

Agro-climatic Conditions of Maize Growth

The cultivation of maize, as for other crops, is influenced by socio-economic, political, historical and environmental factors. The last factors, nevertheless, are most important. Agro-climatic conditions, soils and landforms are major components of environment. Following environmental conditions are better suited for the growth of maize.

Soils

Successful growth of maize plant requires fertile, deep and well drained soils. However, it can be grown on any type of

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8. United nations, Food and Agriculture Organisation, Bulletin of Statistics, vol. 4, 1991, p. 20.

9. P.K. Gode, Studies in Indian Cultural History, vol. 1, Hoshiarpur, Vishveshvarnand Vedic Research Institute, 1961, p. 290 and G.Watt, A Dictionary of the Economic Product of India, vol VI, part IV, Delhi Cosmo Publication, 1972, p. 327.

soil, ranging from deep heavy clays to light sandy ones. But pH of the soils must remain from 7.5 to 8.5. Maize, particularly in seedling stage, are highly susceptible to salinity and water logging, consequently, the proper drainage is essential for the successful growth of the crop[10].

Climate

Climatically, maize is a crop of warm weather. However, it is grown both in tropical and temperate climatic regions of the world. Its growth can be successful in the areas where night temperature never goes below 15.6°c celsius. Frost is very harmful at all stages of its growth[11].

As far as rainfall is concerned, essentially, maize is a dry land crop. It can successfully be grown in areas receiving 60 cms. well distributed rainfall[12].

Cultivation and Use of Maize in India

Maize in India is cultivated both in kharif and rabi seasons. But, the main season is kharif in which the time of sowing of this crop depends upon the onset of southwest monsoon.

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10. Indian Council of Agricultural Research, Handbook of Agriculture Facts and Figures for Farmers Students and all Interested in farming, New Delhi, 1984, pp. 791-2.

11. Ibid p. 792.

12. Ibid p. 792.

The cultivation of this crop during rabi season in Peninsular India and Bihar depends on irrigation[13]

Most of the varieties of maize cultivated in India are cream-yellow to orange flint early maturing. As far as use of maize is concerned, it is used for making chapatis, popcorn, roasted ear, green vegetable and starch.[14]. Moreover, a great part of maize grown in India is used as fodder.

Study Area

The study area comprises the whole territory of India. In fact, it also includes present Pakistan and Bangladesh while referring to pre-independence period. For analysis of district wise trend in area and yield of maize some states i.e. West Bengal, Orissa, Jammu and Kashmir, Assam and other north-eastern states, have been excluded because of non-availability of data. Moreover certain districts with negligible area under maize have also not been included in the analysis. Fig 1.1 shows the spatial spread of maize growing districts. The (Appendix 1.) may also be referred.

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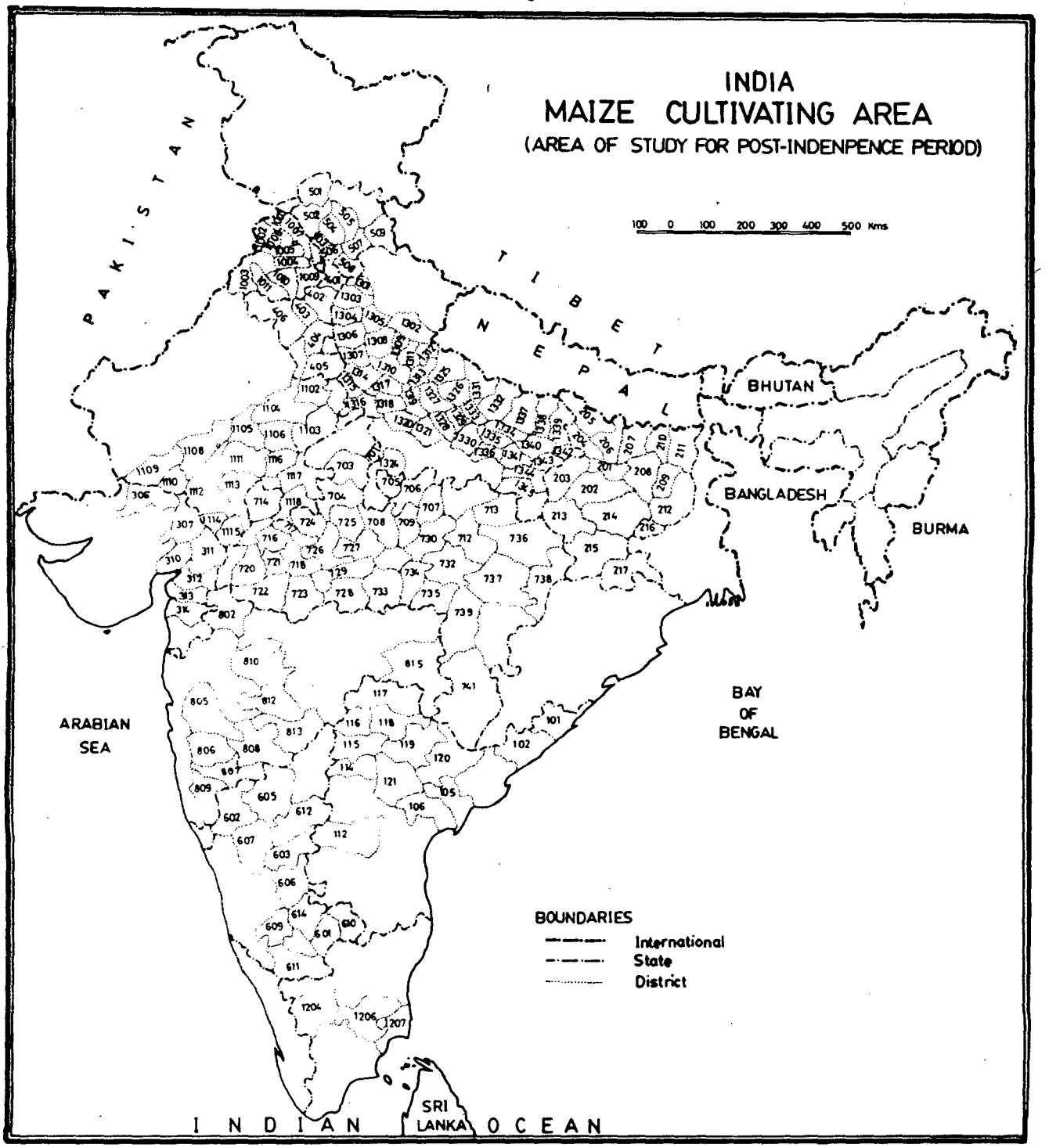
13. Ibid p. 794.

14. V.P. Chadha, "Marketing of Maize", in C. Chanana (ed.), Marketing of Farm Product in India, New Delhi, Marketing and Economic Research Bureau, 1971, p. 33.

Fig. 1-1


INDIA
MAIZE CULTIVATING AREA
(AREA OF STUDY FOR POST-INDENPENCE PERIOD)
100 0 100 200 300 400 500 Kms
PAKISTAN
TIBET
NEPAL
BHUTAN
BANGLADESH
BURMA
ARABIAN SEA
BAY OF BENGAL
INDIAN OCEAN
SRI LANKA
BOUNDARIES
International
State
District

Period of Study

The first reference of maize in Indian history is available during the middle of 16th century. Hence, period for the present study is from mid 16th century to last quarter of 20th century i.e, 1988-89. For detailed district wise time-series analysis, the data from 1950-51 to 1988-89 have been used. The patterns of level of the area under maize, its concentration and the yield level have been described at three periods of time. The first time period (1950-53) is the starting period of detailed districtwise analysis during post-independence period. The second time period is 1965-68 pertaining to the period when package technology was initially introduced. This period marks the begninning of the green revolution in the country. The third time period, 1979-82, pertains to the latest period for which all India districtwise data for area and production of the crop and independent variables were available. For the description of growth rate of acreage and yield of maize in post-independence period, time period has been divided into pre green revolution period (1950-51 to 1996-69) and post green revolution (1967-68 to 1980-81 in case of the area and 1967-68 to 1988-89 in case of yield). The growth rates for whole time period since independence also described. For explanatory purpose, the periods of 1951-52, 1966-67 and 1980-81 pertaining to middle years of the triennium used for spatio-temporal analysis of area under maize and its yield have been chosen.

Objectives of the Study

The present study is an attempt to explore the origin, diffusion and spatial shifts in maize cultivation in India. The main objectives of the study are :

1. To bring out the approximate time and place of origin or introduction of this crop on Indian territory

2. To trace out the process and pattern of the diffusion of this crop in India till independence and afterwards.

3. To bring out the spatio-temporal variations in area, and yield of this crop during post independence period.

4. To analyse the impact of some factors i.e., seasonal rainfall, irrigation and price on acreage and yield level of maize during post independence period.

Hypothesis

The present study has attempted to examine and test the following hypotheses :

1. Maize is not an indigenéous crop of India and has diffused in the country over time from certain croes.

2. There is shift in maize acreage from irrigated to unirrigated regions in post independence period and more particularly in post green-revolution time.

3. Being a dryland crop, the acreage and yield of maize and rainfall are inversely related.

4. Maize cultivation is confined to marginal dryland and area under this crop has negative relationship with irrigatin. Whereas yield level of this crop is higher where irrigation facility is available.

5. Higher the price of maize in lagged year, higher will be acreage and yield level of maize.

Data - Base

Although chapter on historical account of maize is based upon different historical accounts, administrative reports, descriptive and analytical works of modern historians and scientists. However, in quantitative part of the study following main source of data have been used :

1. Indian Agricultural Statistics, vol 11 (various issues from 1950-51 to 1981-82).

2. Various issues of, Agricultural situation in India starting from 1950-51 to 1989-90.

3. Various volumes of, The Farm Harvest Prices of Principle crops in India.

4. From 1950-51 to 1980 issues of, India : Weather Review, Monthly Weather Report.

5. Census of India, series 1, General Population Table iv A, 1951, 1961, 1971 and 1981 and for 1991 the data of boundary change have been collected from Registrar's office, Census of India, Seva Bhawan, New Delhi.

Methodology

There are numerous studies dealing with area, production, yield, etc. of all crops or a group of crops in a particular time and in a particular region. However, there is very little work on a single crop using commodity approach of agricultural Geography. Considering this gap in the field of agricultural Geography commodity approach has been applied in the present study. Moreover, in many of studies regional approach was used, but, in this study systematic approach is under consideration. In order to give the data and other information analytical way following statistical techniques and cartographical methods have been used :-

Statistical Techniques :

1. For finding out the districts with negligible area under maize which were excluded from the study, percentage of area under maize to the GCA and to the total maize acreage of the country were used. The districts, recording less than Ø.5 per cent of GCA under maize and contributing below .Ø5 per cent of total maize areage of the country throughout

the time of analysis (1950-51 to 1981-82), have been regarded as districts with negligible area under maize and excluded from the analysis. All these percentages have been calculated from the three yearly moving averages. The districts fulfilling any of the two criteria have been included in the study. These two criteria have been chosen considering the fact that a district negligible from national point of view, can be important maize growing district considering the proportion of maize in its cropping battern and vice versa. Moreover, Furthermore, the districts with negligible area under maize can be found out taking the figures of one or two point of time, but basic purpose of the study is to bring out areal spread in maize cultivation. So one district, negligible at some point of time, can be important at another time due to areal spread in maize cultivation. That is why, whole span of time has been taken here for finding districts from view point of maize cultivation.

2. For making the data temporally comparable certain adjustments have been made which are as follows :-

   a. As noted earlier, districts have been chosen as the units of the study and there are continuous change in the boundaries of districts. In order to make data comparable overtime the data of area under maize, its production, gross cropped area and irrigated area under

maize has been adjusted on the districts boundaries as in 1970-71. Adjustment have been made according to the procedure applied by Census of India. According to it, supposing the area of a district homogeneous from the view point of variable for which adjustment is needed, the variable is fragmented in proportionate to the area excluded from or included in a district. Thus, through clubbing and fragmenting the above mentioned variables have been adjusted on 1970-71 boundaries. However, minor changes overtime have not been considered significant for adjustments. For some districts in case of area under maize, irrigated area under maize and production certain subjective adjustments also made taking into account their future or past trends. e.g. if there is no area under maize after the formation of adistrict, it was not proper to assign area to it in the past.

b. The data of gross cropped area, area under maize and production is not available for some year (s) either for all districts of the country or for certain districts. Such gaps in data have been filled through calculating the compound growth rates of preceding five years.

c. The districts for which data of harvest prices of maize and kharif rainfall is not available, either data of

the adjacent district or averages of adjacent districts have been used for them.

3. **Three Yearly Moving Averages**

Indian agriculture by nature fluctuate from year to year, in order to minimise these weather induced fluctuations and find out normal trend in maize acreage and the yield, three yearly moving averages of the time-series data of area under maize, its production and gross cropped area have been calculated.

4. **Index of Concentration**

Index of Concentration for area under maize has also been applied in the present study i.e.,

$$\text{Index of concentration} = \frac{\text{Area under maize in a district}}{\text{Total maize acreage in the country}} \times 100$$

5. **Exponential Annual Compound Growth Rates**

For finding out the trends in maize cultivation, exponential annual compound growth rates of percentage of area under maize to gross cropped area and yield rates in each district has been calculated.

6. **Multiple Correlation**

In order to see the degree and direction of association between yield and kharif rainfall, irrigated area under

maize and maize prices, multiple correlation has been found out. The other similar exercise has been done to see the association between area under maize and the explanatory variables.

7. **Step-wise regression**

The step wise regression analysis was applied to understand the role of explanatory variables and the dependent variables. The variables, are as under :

(a) Dependent Variables

Y_1 = Percentage of area under maize to gross cropped area

Y_2 = Yield of maize in kilogram per hectare.

(b) Independent Variables

X_1 = Farm harvest price of maize of previous year (Rupees per quital).

X_2 = Seasonal (June-Sept.) rainfall in centimeters.

X_3 = Percentage of irrigated maize acreage in a district to total area under maize in the district.

Cartographic Techniques

Cartographic methods like choropleth, dot maps and graphical methods have been used to depict the statistical informations.

Organisation of the Study

The present study has been divided into six chapters. Chapter I, deals with general introduction of the study. This chapter includs introduction of the problem, agroclimatic conditions of growth of maize, area of the study, period of the study, objectives and hypotheses, data base and methodology used.

Chapter II, gives the historical background of maize cultivation in pre-independence India covering the time and place of origin or introduction of this crop in India, processes and patterns of its diffusion after its introduction here during Mughal and colonial periods of Indian history.

Chapter III, presents the spatio-temporal patterns of level, concentration and growth rates of area under maize in post-independence period. Patterns are described at 1950-53, 1965-68 and 1981-82. The core-pheripher areas of maize are also described in this chapter. Chapter IV, gives the spatial and temporal patterns of yield of maize. The time and techniques are same as in chapter III.

Chapter V, explains the spatial patterns of level of acreage and yield of maize at above noted three points of time taking the middle year's indicators of the trienniums. The analysis therefore, is for the year 1951-52, 1966-67 and 1980-81.

Chapter VI gives the summary of conclusions of the study.

Chapter II

MAIZE CULTIVATION IN INDIA : ITS ORIGIN AND DIFFUSION

Introduction

In this chapter as attempt has been made to analyse the introduction of maize cultivation in India and its diffusion in the past. This study is based on secondary sources particular standard bibliographic works. Before commenting upon India, some light has been thrown on the origin and diffusion of maize cultivation in the world. Historians and scientists have attempted to asceertian the time and place of maize cultivation in India as well as outside India. Scholars have their opinions divided on the question of time and place of origin of maize crop and process of its diffusion. Some of them argue that maize is an Asiatic plant and some have projected it as an European crop. Some others have refuted the arguments of Asiatic and European origin of maize and have established that maize originally belonged to Latin American countries and from there Columbus (1492) brought it to Europe. It is believed that in India it was introduced by Portuguese traders during sixteenth century. This crop very quickly diffused in India and widely accepted by the Indian peasants.

As far as the native place of maize is concerned two contrary arguments have been debated. First is about the old world origin of maize and its knowledge in non-American countries

in pre-Columbian time. The second argument supports that maize along with other plants like that of potatoes, sweet potatoes, beans, peanuts, manioc, cucurbit, sunflower, chillies, tobacco, guava, custard - apple, pine-apple etc. is new world origin and was unknown in the old world before the discovery of America.

The argument of origin of maize cultivation in non-American countries has been corroborated with the belief of Asiatic and European origin of the crop. Some historians and scientists believed that maize crop was grown in Europe before the period of discovery of America. "The principal argument... is based upon the charter of the thirteenth century, published by Molinari, according to which two crusaders.... gave in 12Ø4 to the town of Incisa a piece of true cross... and a purse containing a kind of seed of golden colour and partly white, unknown in the country and brought from Anatoli, where it was called Meliga etc"[1]. Another evidence generally cited is that of finding of specimen of maize by Rifaud in a Tomb at Thebes[2]. G. Renard also claimed that maize is an Asiatic crop and was well cultivated in ancient Egypt[3].

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1. G. Watt, A Dictionary of Economic Product of India, vol. vi, part iv, Delhi, Cosmo Publishings, 1893, p. 333.

2. P.K. Gode, Studies in Indian Cultural History, vol. 1, Hoshiarpur, Vishveshvarnand Vedic Research Institute, 1961, p. 285.

3. Cf. Gode, Ibid p. 287-88. Renard states, "Corn (maize) which was the conquering grain in nearer Asia, in Egypt and all over Europe seems to be a native of the first named country (i.e. Asia). It has been found in a wild state near Mount Hermon in the North of Palestine..... we find it in oldest Egyptian tombs. We find it in the ruins of Lucustron cities".

On the contrary, many historians and scientists reject these arguments by insisting that if maize was raised before 1492 in old world, certainly it would have certainly been mentioned in the old world literature like that of Bible, Rigveda and other vedas. However, maize has not been mentioned in the old world literature and there is no Hebrew, Sanskrit, Greek and Egyptian world for it[4]. The evidences of finding of specimen of maize in a Tomb at Thebes are now conceded to have been the work of an impostor[5]. Comte de Riaut's discovery has already proved that charter of Incisa is the fabrication of a modern imposter[6]. Gode has rightly pointed out about the maize cultivation in Egypt, that it is not easy to sum up the views about the origin of maize cultivation in Asia because of numerous qualifications[7]. Thus, it can be believed that maize was unknown in the old world before the end of fifteenth century.

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4. Gode, 1961, Ibid, pp. 285-86, and Watt, ibid p. 333.

5. Gode, Ibid, p. 286.

6. Cf., G. Watt, Ibid, p. 333. and Gode, Ibid, p. 286.

7. Gode, Ibid, pp. 287-88. quotes (1) A Lucas in his book "Ancient Egyptian Materials and Industries" (3rd Edition, 1945) p. 61 (foot-note 2) definitely mentions maize as "a modern importation into Egypt". This opinion of a scholar who has made a thorough study of ancient Egyptian materials discovered in the ancient tombs of Egypt contradicts the statement of G. Renard that maize was found in the oldest Egyptian tombs (foot note No. 1). Attempt to prove the native home of a plant in a particular region by the fact of its growing in such a region in a wild state in modern times have often misled botanists about its true home, (foot note No. 2).

The second argument, which is about the American origin of this plant, is widely supported. Today, it can safely be said in the Words of G. Watt that 'it is now universally admitted that maize.... is a native of America[8]', or in terms of the ascertion of Mongeldarf and Reeves that 'it is now generally agreed that maize was confined to America before its discovery[9]. Crawford puts it in more clear form that 'maize is beyond all questions a native of America and before the discovery of new world was wholly unknown to the old world[10].

Although, as a consequence of absence of maize from history, archaeology, geology and paleobotany, it is very difficult to trace out exact place and time of its origin in America, yet it is believed that maize has been cultivated in new world from stone age[11]. As far as the native place of this important foodgrain is concerned some historians and botanists suggest that Peru[12] has been the native place of maize but believe it to be New Mexico[13]. Some of them maintain that maize

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8. G.Watt, Ibid, p. 333.
9. Cf. Gode, Ibid, p. 287.
10. Cf, Watt, Ibid, p. 334.
11. Howards Reed (p. 22 of his plant sciences) cf, Gode, p. 289.
12. Howards Reed (p. 22 of his plant seiences) cf, Gode, p. 289.
13. G. W. Beadle, "Origin of Zea. Mays", in Charles, A., Reed, (ed.) Origin of Agriculture; Chicago, Mouton publishers, 1977, p. 615.

originated form New Granada[14].

One can safely summarise that maize is undoubtedly a crop which diffused from new world[15]. Its native place seems to be some where in Latin American countries. It was columbus, who on his return to Europe in 1493, took seeds of maize from Cuba and he gave it the name "maize[16]".

Introduction of maize cultivation in India. It is clear from the above discussion that maize was not a native of India. It was introduced here as an exogeneous plant. Scholars generally accepted that maize was introduced in India sometime in sixteenth century[17]. This plant along with other foreign articles has been brought in India by Portuguese. These facts about introduction of

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14. De Candalle presumes that maize was originally a native of new Granada from the circumstance that, since it can be shown to have been cultivated from a remote antiquity by both the Peruvians and the Mexicans, it most likely to diffuse from intermediate region. G. Watt, Ibid, p. 334.

15. Gode, Ibid, p. 289.

16. P.C. Mangelsdorf and R.G. Reeves, "The origin of Indian born and its Relatives" p. 7-9, c.f. Gode, Ibid, p. 285.

17. Before 1960s, in the absence of any supporting historical source some historians suggests that maize was well cultivated in Akbar's regime as Moreland in, India at the Death of Akbar - An Economic Study, Delhi, Sunita Publications, 1988, pp. 102-3, G. Watt, ibid p. 334, while other like that Irfan Habib in his celebrated work, The Agrarian system of Mughal India (1556-1707), New Delhi, Asian Publishing House, 1963, p. 38-39 criticised the suggestions of Moreland and watt and justified maize as a nineteenth century crop.

maize in India sometime in sixteenth century by Portuguese is corroborated by historical sources[18].

It can easily be believed that in initial stages maize crop was raised in or near those areas where the Portuguese had their own colonies. This observation gets support from Gode's research which more exactly proved Pune and Satara districts of modern Maharashtra state as the area where maize was grown i sixteenth and Seventeenth Centuries[19].

Diffusion of Maize Cultivation in India

For more precise analysis, this part has been divided into two broad temporal phases. In the first phase the spatial spread of maize in Mughal period has been presented, whereas, second phase deals with the diffustion of maize during the colonial period.

Maize Cultivation during Mughal Period

As already mentioned, maize was introduced in India

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18. Gode (ibid, p. 291) quotes, carl whiting Bishop (origin of Eastern civilizations : A Brief Handbook), Indian corn brought by portuguese to India during sixteenth century. G. Watt (ibid, p. 234) emphasized this quoting Royle who believe that maize has been introduced by Portuguese in India.

    P.K. Gode (ibid, p. 294) summarises that it is believed that the Spanish or Protuguese traders took maize to India from Europe sometime before A. D. 154Ø.

19. Gode, Ibid, p. 291-5, Justified this with the help of reference of maize by Lolimbarajo (1575-162Ø, an native of Poona) and Verse about maize by Raghunatha Ganesha Navahasta (164Ø-171Ø, an native of Stara District).

sometime before 154Ø A.D. The diffusion process of its cultivation during the Mughal period (1526-1751) has been analysed here . Amongst all the Persian chronicles of Mughal period, Abul Fazel's Ain-e-Akbari[2Ø] provides authentic information on the crop system during the end of the sixteenth century. Ain-e-Akbari has listed the name of all crops which was raised in Mughal subahs separately for every subah. But the name of maize crop is not given in Ain. The fact is that Indian peasants have widely accepted this crop during sixteenth and seventeenth centuries. As proved by some recent studies, maize was one of the most important food crops in eastern Rajasthan which occupied a significant area during the latter half of the seventeenth century[21]. Therefore, when maize was such an important crop in Agra Subah in 1664 A.D., why Abul-Fazl has not listed the name of this important crop in Ain ? This aroused many questions among historians. Moreover, maize is neither mentioned in any of the other Persian chronicles nor in any traveller's account[22]. But now this absence can be considered as an accidental illusion from these sources.

2Ø. Abul Fazl (1595), A'in-e-Akbari; ed. Blochmann, 2 vols., Bib. Ind., Calcutta, 1867-77. Translated in 3 vols., vol. I by H Blochmann, revised by D.C. Phillott, and vol. II and III by H.S. Jarrett, revised by J. Sarkar, Calcutta, 1927-39 (vol. I), 1949 (vol. II), 1948 (vol. III).

21. S. Nurul Hassan et. al., "The Pattern of Agricultural Production in the Territories of Amber (C. 165Ø-175Ø)", Proceedings, Indian History Congress, 1966, pp. 244-64.

22. Many European travellers came to India during Mughal Period, prominent among them who gave excellent information regarding cropping pattern were Francisco Pelsaert (162Ø-27), Niccolas Manucci (1653-17Ø8) and M. Francois Bernier (1665-1668).

On the basis of modern works in which maize cultivation during Mughal period has been discussed, the analysis of spatial spread of maize can be worked out (Fig. 2.1). Firstly, as already mentioned, the cultivation and use of maize has been proved in Maharashtra during this time[23]. Secondly,from 1664 A.D. onwards, maize was ascertained as one of the important food crops raised in Eastern Rajasthan between 165Ø-18ØØ[24]. In local land revenue Rajasthan sources (Arsatta Record), maize was found recorded under its usual name makka[25]. Maize has been found to besuch an important and widely accepted crop that in some parganas some year (s) alone occupied more than 1Ø per cent of the total cropped area and derived more than 2Ø per cent of revenue derived from all crops[26]. Thirdly,' Moreland justified that maize was grown in Bengal, Delhi and northern portion of Agra Subahs and hilly tract of Vijay nagar Kingdom in 16Ø5[27]. It can be observed, today, that when maize was such an important crop in eastern Rajasthan in the last quarter of seventeenth century, it might have acquired the position described by Moreland. About Bengal

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23. P.K. Gode, Ibid, p. 289-94.

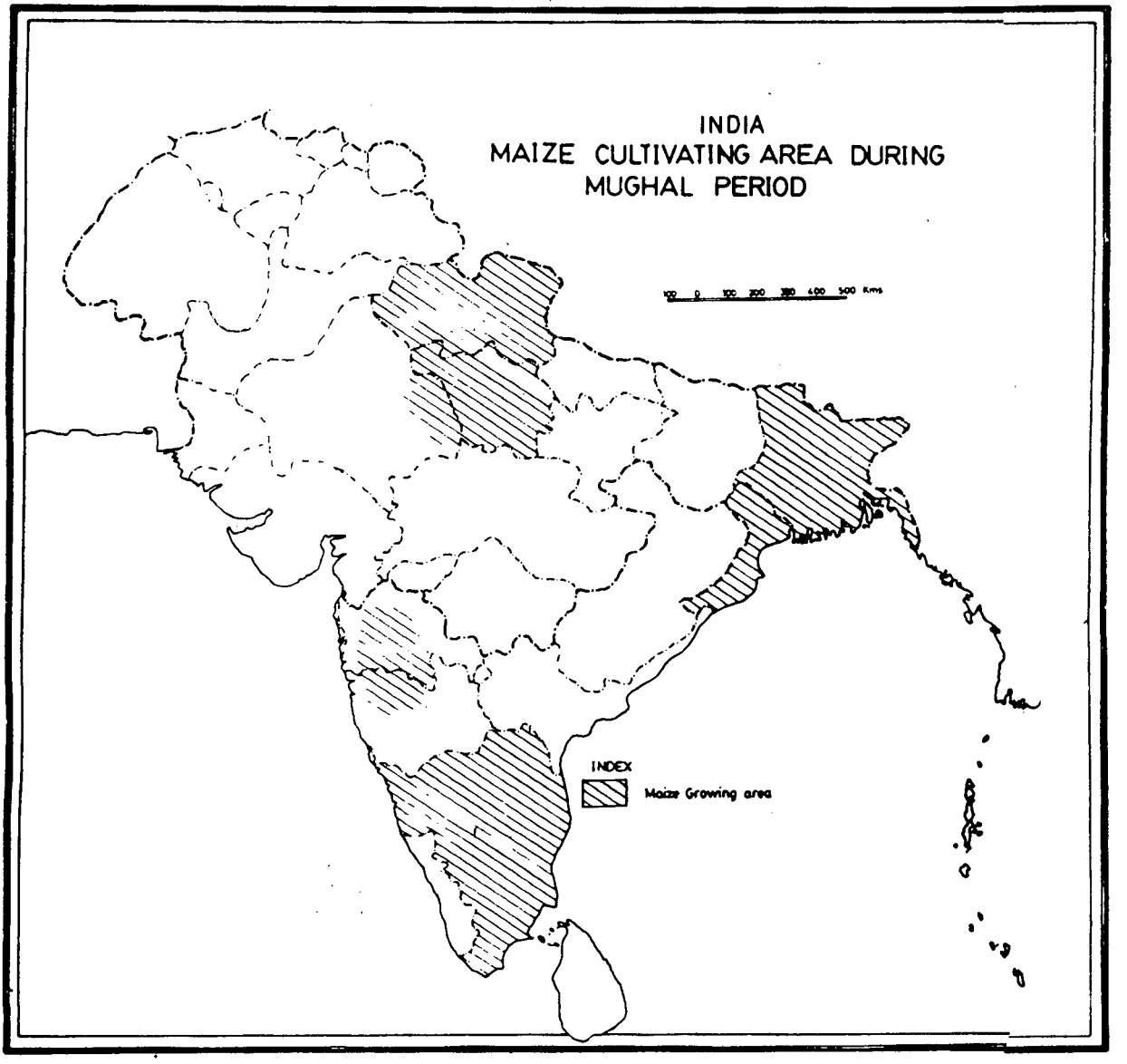
24. S. Nurual Hassan et. al, Ibid and Dilbagh Singh, "Local and Land Revenue Administration of the State of Jaipur (C. 175Ø-18ØØ), Phd. Thesis submitted to Jawaharlal Nehru University, New Delhi, 1975, pp. 98-1Ø5.

25. S. Nurul Hassan et. al, ibid and Dilbagh Singh ibid

26. Ibid.

27. Moreland, op.cit, pp. 1Ø2-3 and appendix B. pp. 283-4

Fig 2·1


INDIA
MAIZE CULTIVATING AREA DURING
MUGHAL PERIOD
100 0 100 200 300 400 500 Kms
INDEX
Maize Growing area

which includes the area of orissa, Moreland stated that maize has assumed its 1920s position since the time of Akbar. In this part maize was not an important crop in 1920s as it occupied only about 3 per cent of the total cropped area during this time. In northern Agra and Delhi Subahs maize has been described as an irrigated crop (Fig. 2.1).

As shown by above noted description maize was a significant crop in some regions, considering this fact and agroclimatic conditions of other regions one can accept the existence of this crop in other parts of the country. But in the absence of any historical evidence, it is very difficult to prove it.

Diffusion of Maize During Colonial Period

As far as the information regarding the spatial spread of maize during colonial period is concerned, these are given in administrative reports, survey reports of Government, descriptive studies of European scholars and analytical studies of modern historians. In the later period of eighteenth century due to political instability, there is lack of information related to agrarian systems.

In the beginning of nineteenth century, maize has been described as being cultivated in Kitchen gardens near

Bangalore[28], Boda-Bula Pura[29], and in an extensive form in hilly tribal tract of Canara[30]. Maize grown in these gardens was mainly used by Children, who ate it as parched, whereas, in tribal tract it is one of the subsistence crops of people. However, after few years, maize had occupied the place as one of the staple grains of hilly tract of Cuttack district[31] of Orissa, of Ganjam[32] and Vizapatnam district[33]. Fully grown maize has been described as principal crop of Guntur district[34] of Northern circas and second important crop after wheat in Berar Province[35]. Moreover, toward more South maize has acquired the place of principal grain in Salem and Barramahal Province[36]. Thus, one can say that till the second decade of nineteenth century, this important crop was diffused in almost all the southern India, somewhere as a principal crop and somewhere as garden crop (Fig. 2.2).

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28. Francis Buchanan, A Journey From Madras through the countries of Mysore, Canara and Malabar, London, East India Co., 1807, vol. 1, pp. 327-28.

29. Ibid, vol. I, p. 355.

30. Ibid, vol. II, p. 177.

31. Walter Homilton, A Geographical, Statistical and Historical Description of Hindustan and the Adjacent Countries, New Delhi, Oriental Publishers, 1820, vol. 2, p. 39.

32. Ibid vol. 2 p. 72.

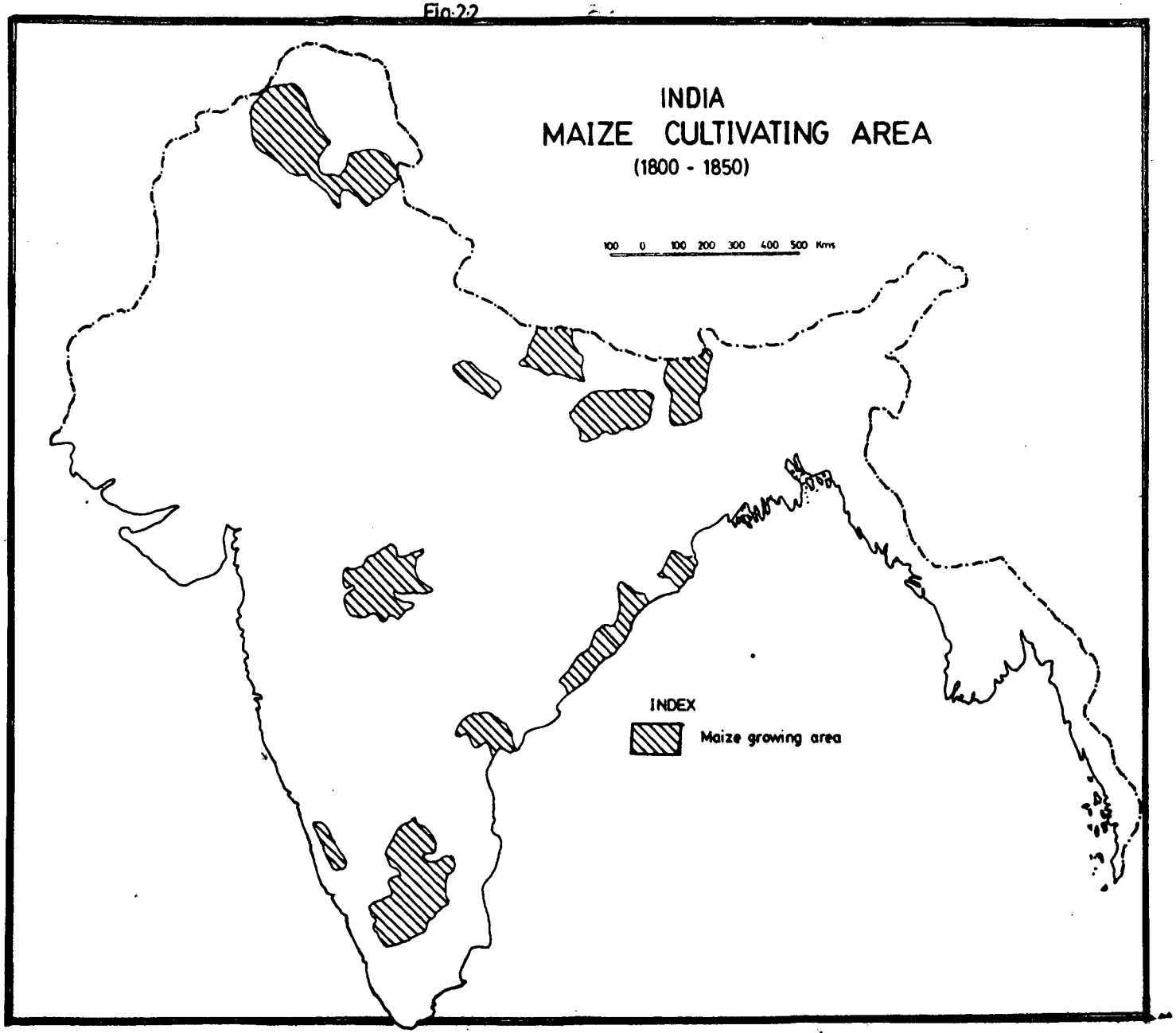
33. Ibid vol. 2 p. 74.

34. Ibid vol. 2 p. 88.

35. Ibid vol. 2 p. 108.

36. Ibid vol. 2 p. 394.

Fig:2.2


INDIA
MAIZE CULTIVATING AREA
(1800 - 1850)
100 0 100 200 300 400 500 Kms
INDEX
Maize growing area

During the first half of nineteenth century, it was cultivated and used in extensive form in Purnea district[37] and on the area adjacent to the Ganges in Patna district[38] of Bihar province in 18Ø9-1Ø and 1811-12 respectively. The cultivation of maize its use, export and import has also been recorded in Gorukhpoor[39] and Shahabad[4Ø] and on the higher lands of Bhagalpur[41] districts. Moreover, Indian corn has also been described as one of the principal crop cultivated in Kanpur district[42].

Maize, during this time has been mentioned as a common crop of irregular surface of Western India[43]. In Kangra district, in the starting of the nineteenth century, this crop has been recorded as a staple food of poor people[44] and also observed

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37. Francis Buchanan, An Account of the District of Purnea in 18Ø9-1Ø, New Delhi, Usha Publishing, 1934, p. 352.

38. Francis Buchanan, An account of the Districts of Bihar and Patna in 1811-12, New Delhi, Usha publishing, 1934, p. 498.

39. Montogomery Martin, The History, Antiquities, Topography and Statistics of Estern India, 5 vols., New Delhi, Cosmo publications, 1838, vol. II, p. 529 and appendix p. 38.

4Ø. Ibid, vol. IV, appendix p. 48.

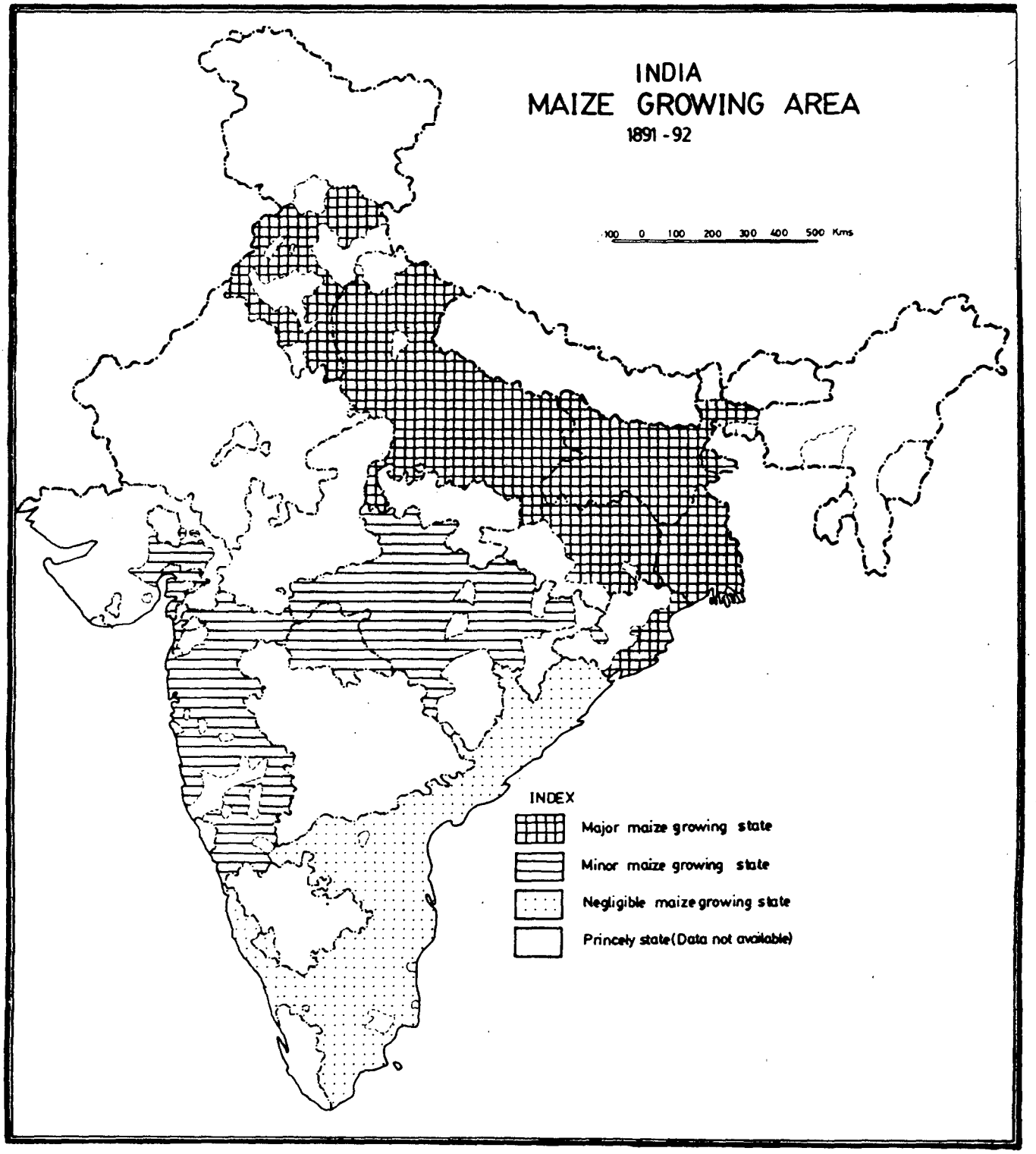
41. Ibid, vol. II, p. 2Ø3 and Walter Hamilton (192Ø), op.cit, vol. I, p.247.

42. Walter Hamilton (192Ø), Ibid, vol. I, p. 334.

43. Walter Hamilton, Ibid, vol. I. p. 22 and G. Watt, op. cit., p. 335.

44. Francis Buchanan Hamilton, An Account of the Kingdom of Nepal and Territories Annexed to the Dominion by the House of Gorkha, New Delhi, Majusri Publishing House, 1819, p. 312.

Fig·2·3


INDIA
MAIZE GROWING AREA
1891 - 92
100 0 100 200 300 400 500 Kms
INDEX
Major maize growing state
Minor maize growing state
Negligible maize growing state
Princely state(Data not available)

cultivated one hundred and twenty square Koses alongwith other crops in the ancient state of Yamila (territory between Garhawal and Mastang[45]). Furthermore, in Kashmir during Sikh rule (1819-1857), maize was second principal crop after paddy in kharif season. The major areas of its cultivation were the reclaimed swamps and peaty lands on the banks of Jhelum and mountain slopes occupied by the Gujars[46].

Maize was diffused throughout the length and breadth of the country before the end of the nineteenth century [47]. Fortunately, this statement about that time quantitatively can be proved, because by 1891-92 all British Provinces in India except that of sparsely populated Baluchistan had reported agricultural data. The states ruled by their traditional rulers lacked such type of information, but on the basis of their adjacent British province, their climate, soil, and other agro-climatic conditions certain rough judgements about maize cultivation can be made. However, here the quantitative analysis is made only about British Provinces, (Fig. 2.3), which contain 51 per cent of total area of the country in 1941. As shown in Table 2.1 and Figure 2.3, the cultivation of maize was mainly concentrated in three provinces of northern India, viz., Greater Punjab (including

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45. Ibid, p. 312.

46. D.C. Sharma, Kashmir under the Sikhs, Delhi Seema Publications, 1983, p. 125.

47. G. Watt, (1893), op. cit., p. 338.

North West Frontier, Punjab and Delhi), United Province; and Greater Bengal (including Bihar, Bengal and Orissa). These states accounted for 59.3 per cent of total cropped area of of the British India, and about 94 per cent of total area under maize in British India. These states also produced more than 93 per cent of total maize of British India[48]. As shown in Table 2.1 even with in these provinces maize acquired comparatively good share in total cropped area.

Table 2.1

Area, production and Yield of Maize in British India 1891-92

Province	Area (000 acre)	Production (tonnes)	Yield kg/acre	%age of area under maize to GCA of the Province	%age of Maize area of province to maize area of country	%age of Maize production to total produ. of country
Greater Punjab	1269	582	1029	7.38	25.43	35.68
United Province	1428	508	802	4.98	28.45	31.15
Greater Bengal	2000	434	486	3.71	40.07	26.61

. Bombay-Sindh and Central provinces have been categorized as minor maize producing states having only about 3 and 2 per cent of total area under maize in British India respectively; Madras had negligible area under maize which had less than 1 per cent of total acreage of British India[49]. Although, the data of

48. The data analysed in this section have been taken from George Blyn, Agricultural Trends in India, 1891-1947, output, Availability and Productivity, Philadelphia, University of Pennsylvania Press, 1966.

Fig 2.4

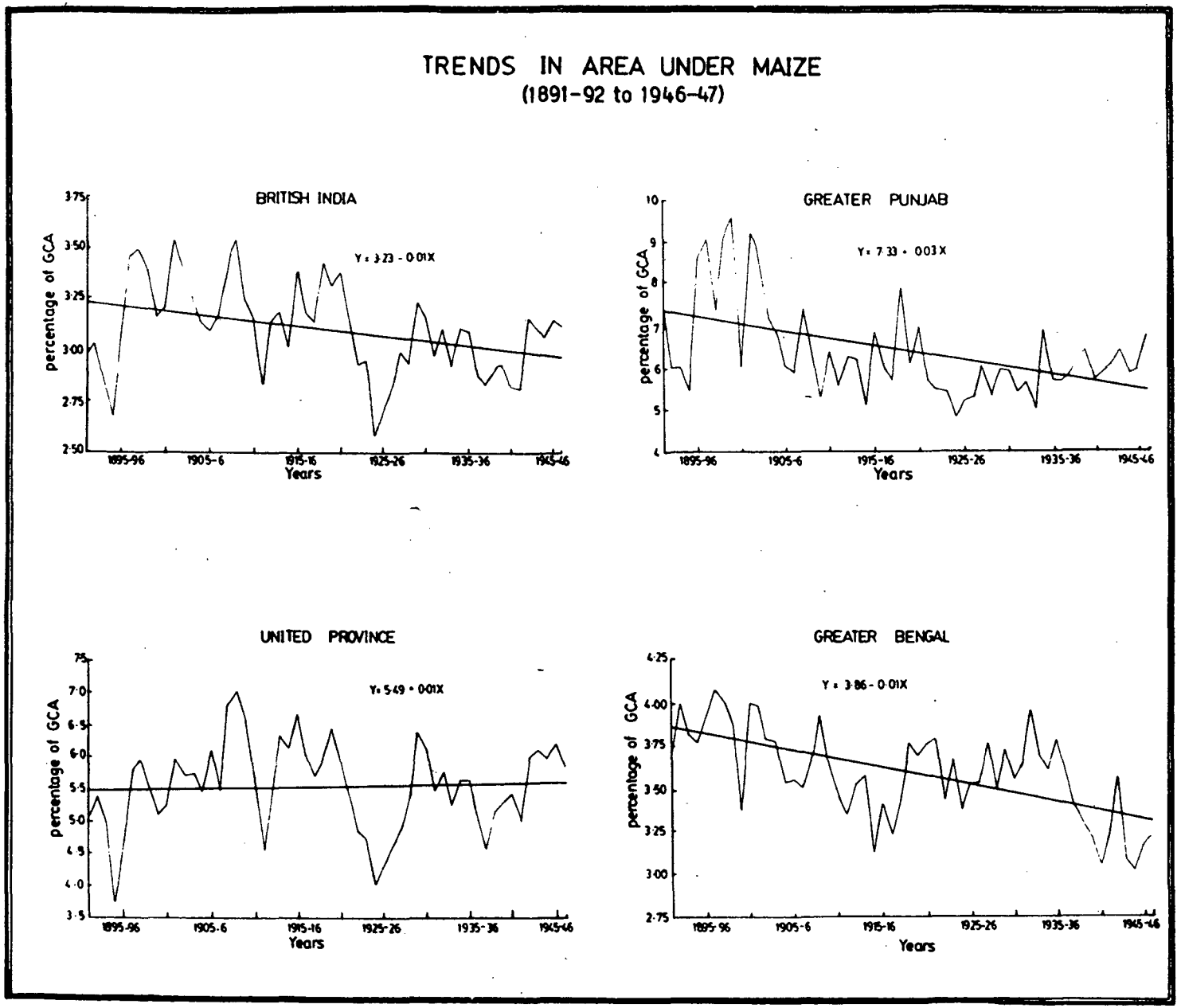
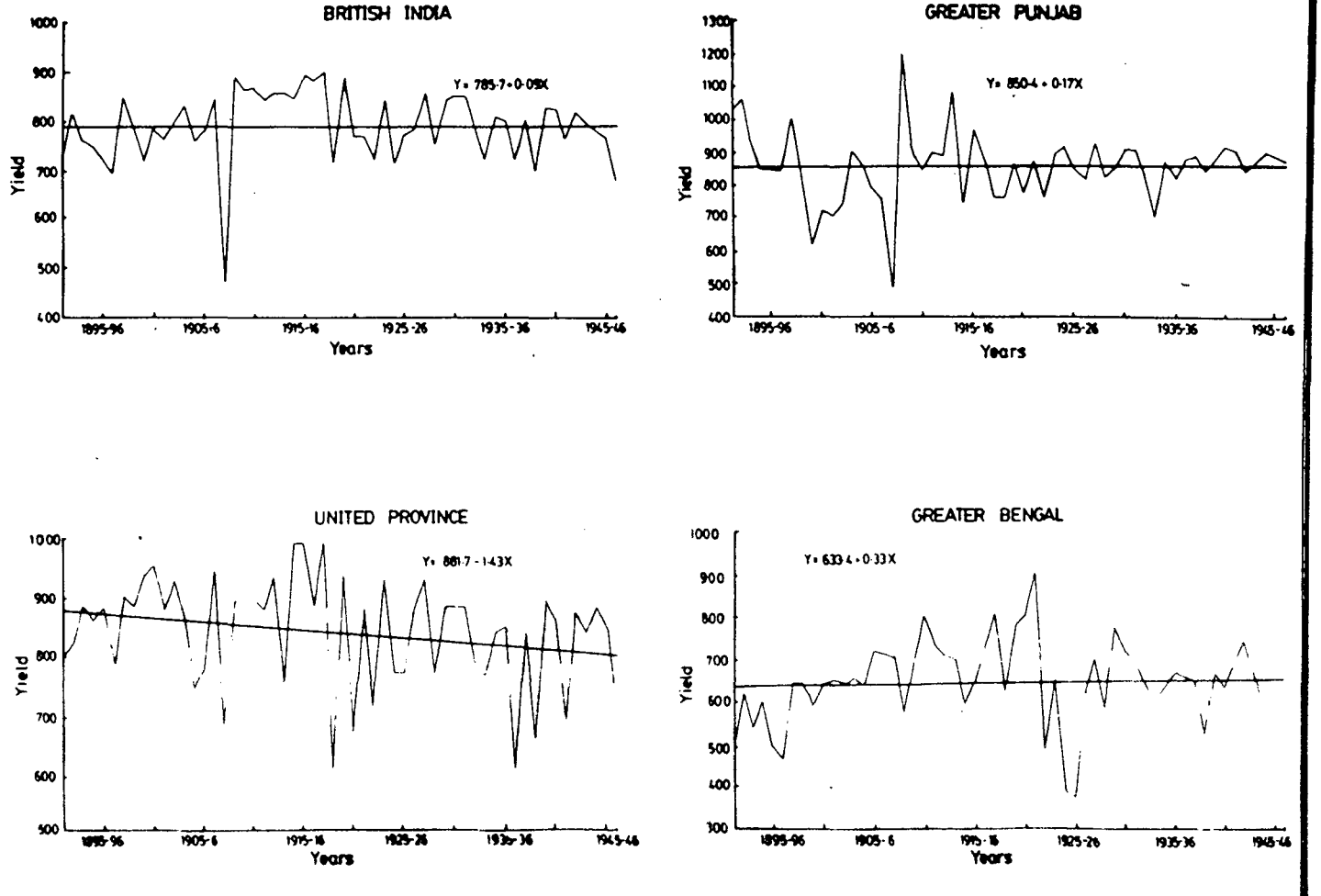

TRENDS IN AREA UNDER MAIZE
(1891-92 to 1946-47)
BRITISH INDIA
Y = 3·23 - 0·01X
percentage of GCA
3·75
3·50
3·25
3·00
2·75
2·50
1895-96
1905-6
1915-16
1925-26
1935-36
1945-46
Years
GREATER PUNJAB
Y = 7·33 + 0·03X
percentage of GCA
10
9
8
7
6
5
4
1895-96
1905-6
1915-16
1925-26
1935-36
1945-46
Years
UNITED PROVINCE
Y = 5·49 + 0·01X
percentage of GCA
7·5
7·0
6·5
6·0
5·5
5·0
4·5
4·0
3·5
1895-96
1905-6
1915-16
1925-26
1935-36
1945-46
Years
GREATER BENGAL
Y = 3·86 - 0·01X
percentage of GCA
4·25
4·00
3·75
3·50
3·25
3·00
2·75
1895-96
1905-6
1915-16
1925-26
1935-36
1945-46
Years

Fig 2·5

TRENDS IN YIELD OF MAIZE
(1891–92 to 1946–47)



Assam and Ajmer-Marwar have been included in total of the state, separate data for these states is not given. But as the state total and its share by different provinces show that these states can also be included in the category of negligible.

This above mentioned pattern of production, yield and area remained stagnent till 1947 for the British india as a whole and separately for the three provinces which, throughout this span of time, contained more than 9Ø per cent of area and production of maize in British India (Fig. 2.4 and 2.5). The trend is remained insignificant in most of the cases even at the 5 per cent level of significance. This shows the stagnant pattern of acerage and yield of maize during period.

Sum up

Maize, an American plant, is believed to have been introduced in India sometime in 16th century and somewhere on Konkan or nearby area by Portuguese. It diffused on Indian territory very quickly and become one of the important crops of some territories in the seventeenth century. By the end of nineteenth century, maize was found disseminated all over India, but till 1947, major area of maize cultivation remained confined in North India, and it stagnated as a garden crop in south India.

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49. Due to not availability of area under maize for Bombay-Sindh Central province and Madras during 1891-92 the data of 189Ø-91 has been used, which is given in G. Watt (1893) op. cit. pp. 347-48.

Chapter III

SPATIO-TEMPORAL PATTERN OF AREA UNDER MAIZE IN POST-INDEPENDENCE INDIA

The preceding chapter deals with the origin of maize and its diffusion in the country during the historical past. An attempt has been made in the present chapter to analyse the spatio-temporal pattern of area under maize after independence. Here, after giving state-wise pattern of area, district-wise detailed analysis of area under maize and its concentration, has been made on three points of time i.e. 1950-53, 1965-68 and 1979-82. The growth rates in area under maize have been described at three points of time (1950-51 to 1966-67, 1967-68 to 1981-82 and 1950-51 to 1981-82).

Statewise Pattern of Area Under Maize

During 1950-53, the area under maize in the country was 3358 thousand hectares and during 1965-68, 5152 thousand hectares. It increased to 5887 thousand hectare in 1979-82. Uttar Pradesh, Bihar, Madhya Pradesh, Punjab and Rajasthan accounted for more than 75 per cent of the total area under maize in the country during 1950-53 and 1965-68. During 1979-82, their share in total area under maize in the country decreased to 62.5 per cent. As shown in the Table 3.1, the percentage share of the states in area under maize varied between 3 to 5 per cent in case of Gujarat, Andhra Pradesh, Jammu and Kashmir and Himachal

Table 3.1

Relative Contributions of the States to All India Maize Acreage (per cent)

State	Triennium Averages of		
	1950-53	1965-68	1979-82
1. Uttar Pradesh	25.00	25.15	20.11
2. Bihar	19.03	16.76	14.51
3. Madhya Pradesh	11.76	10.88	13.13
4. Punjab	11.33	8.44	6.27
5. Rajasthan	11.27	14.42	15.28
6. Gujarat	4.69	4.61	5.24
7. Andhra Pradesh	4.61	4.33	5.34
8. Jammu and Kashmir	4.47	4.79	4.66
9. Himachal Pradesh	3.46	4.75	4.85
10. Haryana	-	1.88	1.27
11. West Bengal	1.78	0.98	0.86
12. Maharashtra	0.90	0.78	1.31
13. Orissa	0.84	1.06	2.63
14. Assam	0.49	0.47	0.37
15. Karnataka	0.30	0.47	2.53
16. Tamil Nadu	0.21	0.10	0.39
17. Manipur	-	0.12	0.15
18. Arunachal Pradesh	-	-	0.33
19. Mizoram	-	-	0.07
20. Delhi	0.05	0.03	0.01

Pradesh during all the three periods. Each of the remaining states accounted for less than 3 per cent of the total maize acreage in the country. Although, there are minor changes in relative contribution of different states in maize acreage during these three periods of time, there was remarkable decrease of relative share of country's total maize acreage in Punjab[1] and increase in Karnataka and Orissa.

Districtwise Pattern of Area Under Maize

The statewise variations in the area under maize highlight only some broad regional variations. The agricultural processes and patterns are largely influenced by physical, economic and institutional factors. Therefore, the regional dimension of area, production and yield variations can be better evaluated when the areal units are smaller and more homogeneous than the states. Therefore, districtwise analysis of spatial and temporal variations in area under maize was thought to be more logical.

As mentioned earlier in the chapter, in order to bring out the clear picture of spatio-temporal variations in area under maize, proportion of GCA under maize and concentration of of area under maize have been described at three points of time. However, this description at three selected points of time could present

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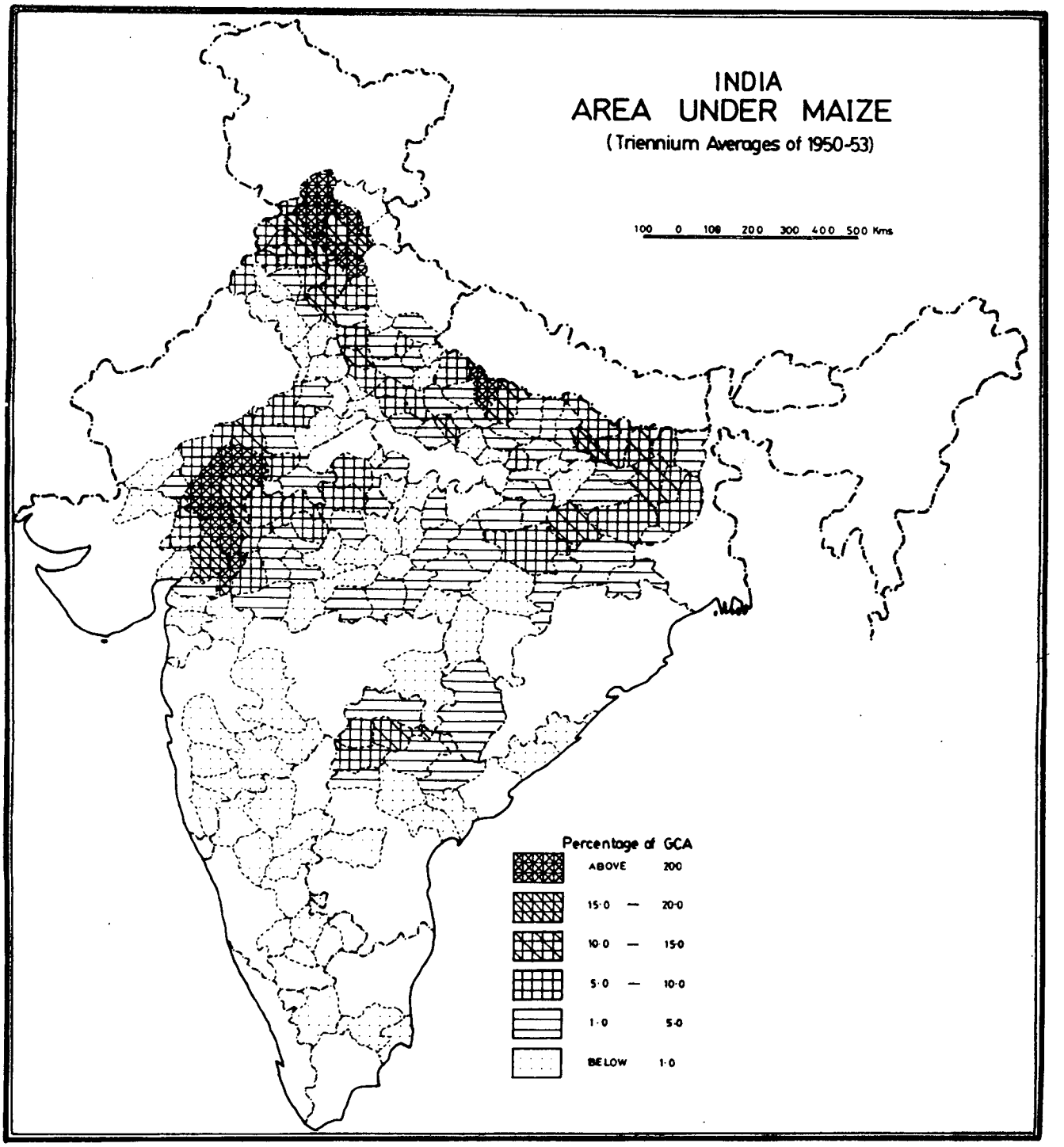
1. The decrease of maize acreage in Punjab between 1950-53 to 1965-68 is mainly due to formation of Haryana and four districts of Himachal Pradesh from Punjab.

Fig.3.1


INDIA
AREA UNDER MAIZE
(Triennium Averages of 1950-53)
100 0 100 200 300 400 500 Kms
Percentage of GCA
ABOVE 20·0
15·0 — 20·0
10·0 — 15·0
5·0 — 10·0
1·0 5·0
BELOW 1·0

only a broad idea about the changes in area under maize during post-independence period. Thus, for presenting a explicit spatial patterns of trend or growth rate in the area during post-independences period, the exponential annual compound growth rate calculated from continuous annual time series data of proportion of GCA under maize have been analysed at three points of time (pre-green revolution, post green revolution and whole time period after independence). The districts recording growth rates insignificant at 5 per cent level of significance have been considered insignificant from the view point of rate of change in area under maize. The districts have been divided into three categories, viz., high, medium and low for levels of the area, concentration of the area and growth rates of the area under maize. For presenting more minute variations in the area under the crop, each category has been divided into two groups. In this way, patterns of levels, concentration and growth rates of area undermaize have been described through classifying the calculated statistical information into six groups.

(i) 1950-53

a) Level of Area under Maize

Figure 3.1 and Table 3.2 indicate that area under maize during 1950-53 was high (more than 15 per cent of the gross cropped area) in 17 districts. Twelve, districts of this category had more than 20 per cent of their gross cropped

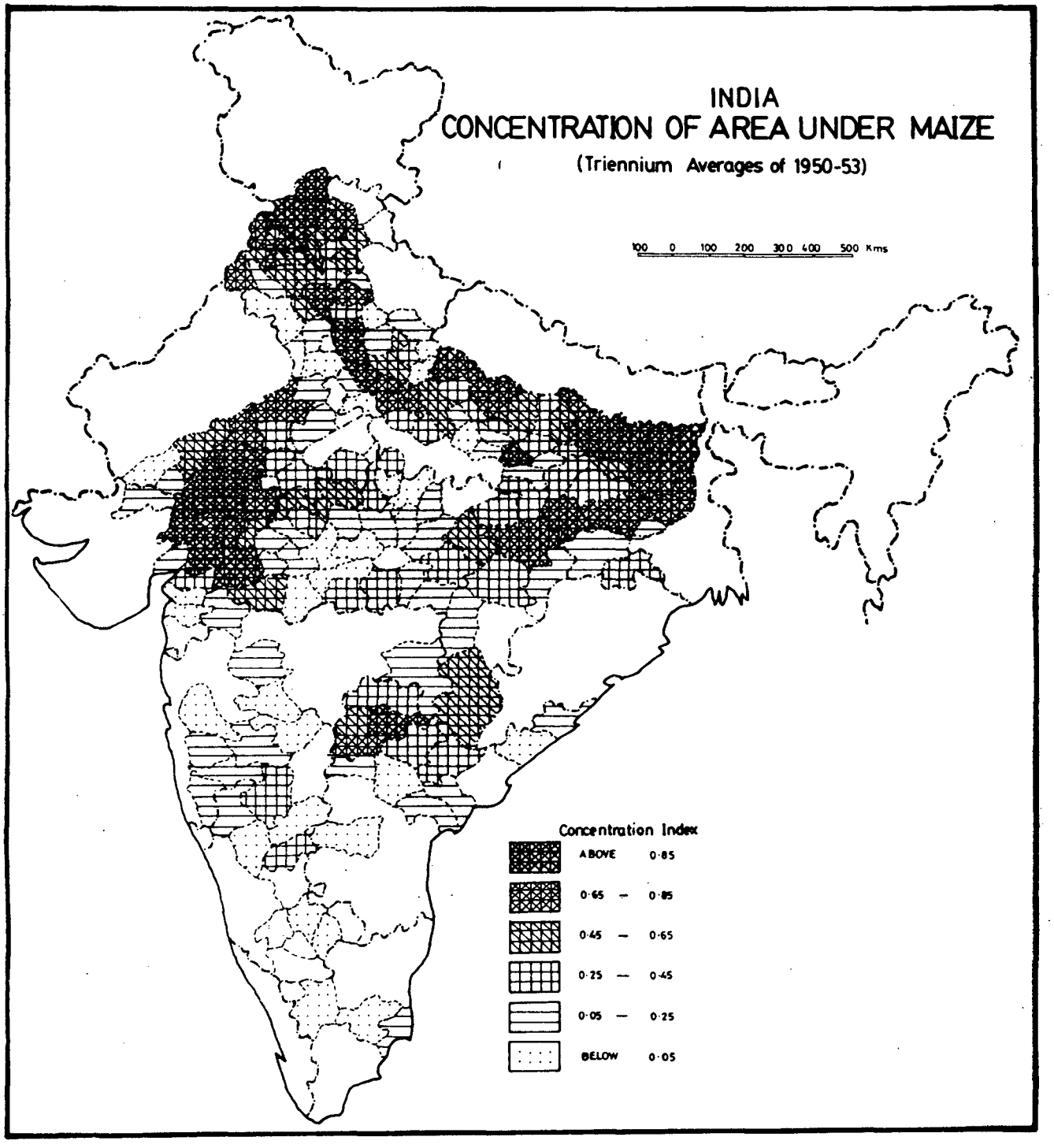
Table 3.2

Frequency Distribution of Districts by Percentage Categories of Area Under Maize to Gross Cropped Area
(Triennium Averages of 1950-53)

S.No.	State	Percentage Categories						
		Below 1.00	1.00 to 5.00	5.00 to 10.00	10.00 to 15.00	15.00 to 20.00	Above 20.00	Total
1.	Andhra Pradesh	6	4	2	1	-	-	13
2.	Bihar	1	6	5	4	1	-	17
3.	Gujarat	4	1	1	-	1	-	7
4.	Haryana	3	1	1	1	-	-	6
5.	Himachal Pradesh	-	-	-	1	1	6	8
6.	Karnataka	7	-	-	-	-	-	7
7.	Madhya Pradesh	12	16	7	-	-	1	36
8.	Maharashtra	10	-	-	-	-	-	10
9.	Punjab	1	1	6	2	1	-	11
10.	Rajasthan	2	4	4	1	1	4	16
11.	Tamil Nadu	3	-	-	-	-	-	3
12.	Uttar Pradesh	8	21	10	3	-	1	43
	Total	57	54	36	13	5	12	177

area devoted to maize. The district having high proportion of their GCA under maize were mainly concentrated into two belts, viz, Himachal- Punjab belt of middle and lower Himalayas and Rajasthan-Gujarat-Madhya Pradesh belt of Aravali ranges and Western Malwa Plateau. Highest maize

Fig. 32


INDIA
CONCENTRATION OF AREA UNDER MAIZE
(Triennium Averages of 1950-53)
100 0 100 200 300 400 500 Kms
Concentration Index
ABOVE 0·85
0·65 — 0·85
0·45 — 0·65
0·25 — 0·45
0·05 — 0·25
BELOW 0·05

acreage was recorded in Chamba and Bilaspur districts of Himachal Pradesh accounting for 49.79 and 40.98 per cent of their gross cropped area respectively, whereas, Udaipur and Banswara districts of Rajasthan and Sirmaur of Himachal pradesh also have a large proportion of GCA devoted to maize cultivation.

The districts where maize accounted for medium area in their cropping pattern (5.00 to 15.00 per cent area of GCA under maize), are mainly distributed in Telengana region of Andhra Pradesh, Western Madhya Pradesh and parts of Rajasthan, Punjab, Uttar Pradesh and Bihar.

However, 62.71 per cent of total identified maize growing district have devoted less than 5 per cent of their gross cropped area to maize. Such districts of lower category were spread over Deccan plateau (except Telengana), coastal Gujarat, Chotta Nagpur plateau region of Bihar and Madhya Pradesh, Western Punjab and Haryana, and parts of Uttar Pradesh.

b) Concentration of Area under Maize

As is evident by the comparison between Table 3.2 and 3.3; and between Figure 3.1 and 3.2, the spatial distribution of concentration in maize acreage is different from the distributional pattern of proportionate area under maize to

GCA in the same period of time. Certain districts which are not so important from the viewpoint of maize acreage are significant from the viewpoint of concentration of area under maize.

Table 3.3 and Figure 3.7 show that the higher category with index value of more than Ø.65 include 46 districts which accounted 79.33 per cent of total maize acreage in the country. Moreover, there are 32 districts with index value above Ø.85 of which Bihar alone accounts for II, Uttar pradesh 7 and Rajasthan 7 districts. These 32 districts accounted for 68.56 per cent of the total area under maize in the country. There are six districts, Saran and Mungher in Bihar, Panchmahals in Gujarat, Udaipur in Rajasthan and Bahraich and Gonda in Uttar Pradesh, which have recorded more than 2 per cent of country's area under maize each and together they accounted for 17.17 per cent of nation's maize acreage. There are six clusters of hige category of maize acreage concentration. in the country.

The high maize concentration belt in Bihar comprises of 12 districts which accounted for about 17 per cent of the country's total maize acreage. However, as above description of level ofthe area under maize indicate, maize is not an important crop in the cropping pattern of the region.

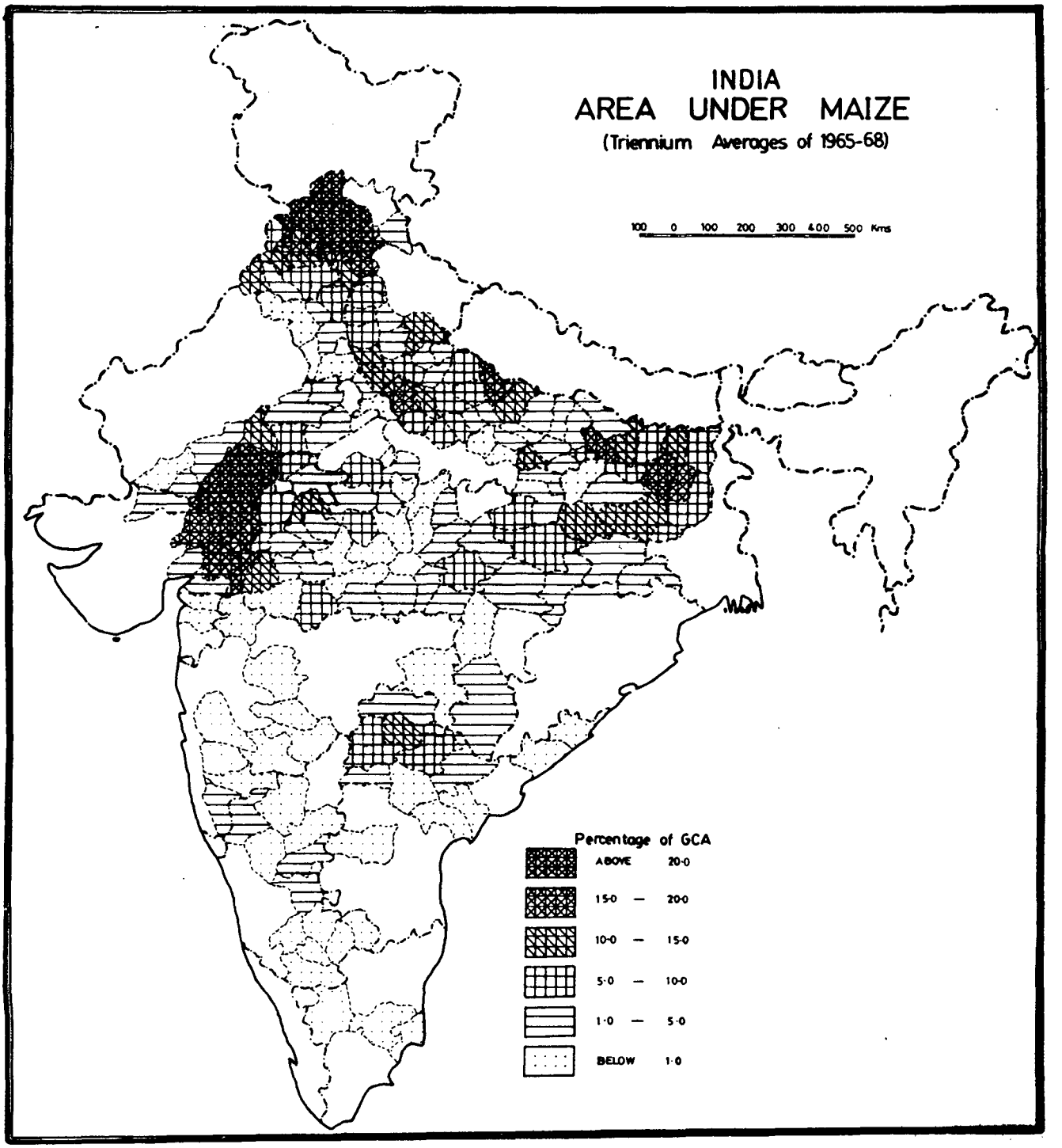
Table 3.3

Frequency Distribution of Districts by Percentage Categories of Area Under Maize in a District to Total Area Under Maize in the Country
(Triennium Averages of 1950-53)

S.No.	State	Percentage Categories						
		Below 0.05	0.05 to 0.25	0.25 to 0.45	0.45 to 0.65	0.65 to 0.85	Above 0.85	Total
1.	Andhra Pradesh	3	4	3	1	1	1	13
2.	Bihar	-	2	3	1	-	11	17
3.	Gujarat	2	2	1	-	-	2	7
4.	Haryana	2	1	2	-	-	1	6
5.	Himachal Pradesh	-	-	1	3	2	2	8
6.	Karnataka	5	2	-	-	-	-	7
7.	Madhya Pradesh	7	13	7	5	2	2	36
8.	Maharashtra	3	7	-	-	-	-	10
9.	Punjab	-	2	-	4	3	2	11
10.	Rajasthan	1	3	3	3	2	4	16
11.	Tamil Nadu	2	1	-	-	-	-	3
12.	Uttar Pradesh	5	9	11	7	4	7	43
	Total	30	46	31	24	14	32	177

The areal spread of the other clusters of maize concentration coincide with the maize belts identified in the earlier description of spatial pattern of area.

Fig. 33


INDIA
AREA UNDER MAIZE
(Triennium Averages of 1965-68)
100 0 100 200 300 400 500 Kms
Percentage of GCA
ABOVE 20·0
15·0 — 20·0
10·0 — 15·0
5·0 — 10·0
1·0 — 5·0
BELOW 1·0

The districts, having index value between Ø.25 to Ø.65, are spread mainly in three major clusters. First is a contiguous cluster starting from Lucknow district in Uttar Pradesh, extending northward till Sitapur district, then spreading eastward till Patna district in Bihar and finally goes till Mandla district in central Madhya Pradesh. Second is also a compact cluster of eastern Rajasthan and north-western Madhya Pradesh. Districts of Himachal Pradesh, Haryana and Punjab in north and districts in and around Telangana region of Andhra Pradesh in South are other important clusters of medium category of maize acreage concentration in the country.

The districts of low concentration which numerically dominant (76 out of 177) are mainly concentrated in almost whole of the south India selected for analysis (except Telengana region), central Madhya Pradesh, coastal Gujarat, western Haryana, Punjab, Uttar Pradesh and north eastern Rajasthan.

(ii) 1965-68

a) Levels of Area under Maize

Table 3.4 and Figure 3.3 indicate that the high proportion of area under maize cultivation in 1965-68 not only concentrated in two compact belts of Himachal, Himalaya and Aravali - Malwa Plateau region but also extended to

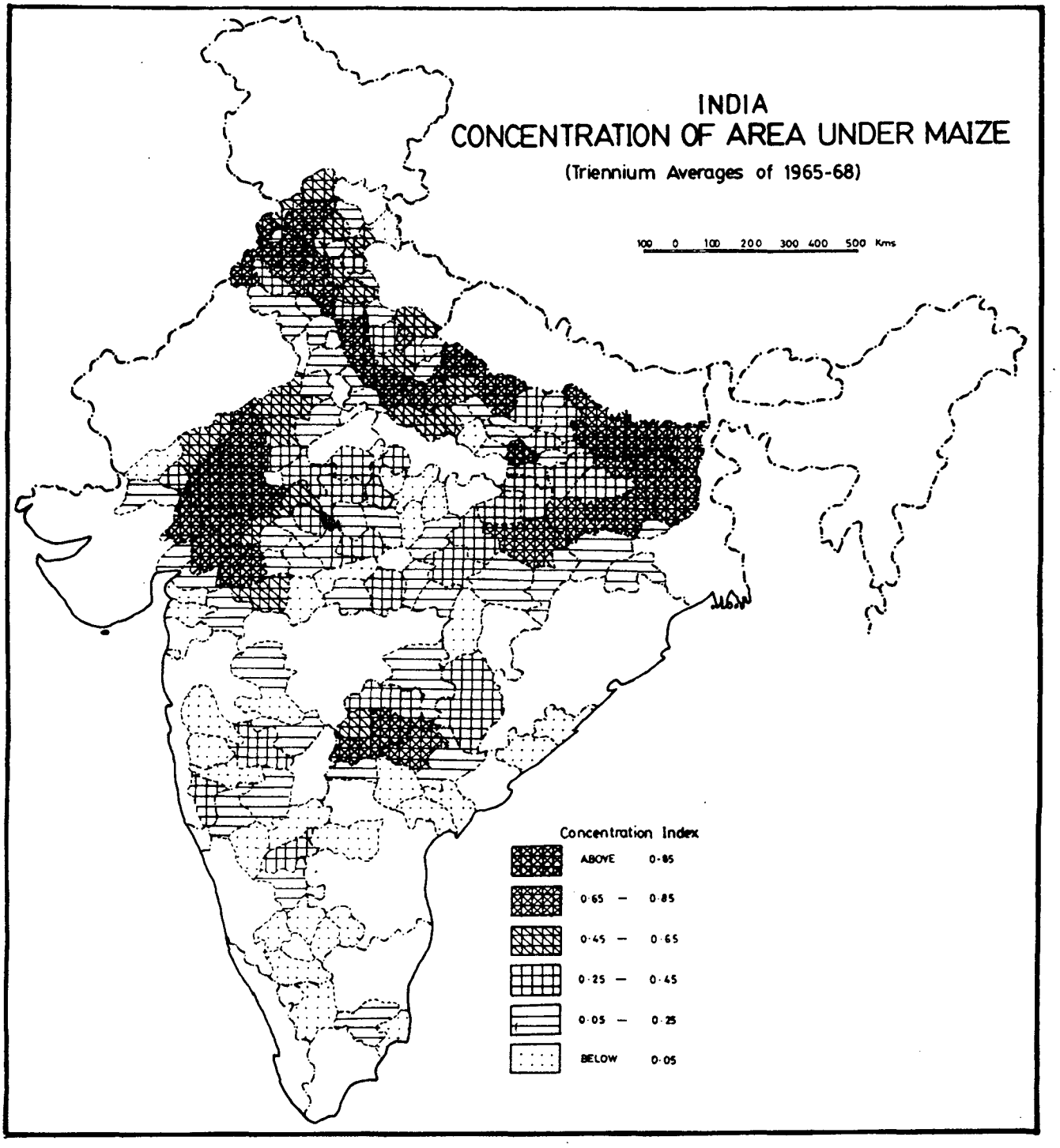
Table 3.4

Frequency Distribution of Districts by Percentage Categories of Area Under Maize to Gross Cropped Area (Triennium Averages of 1965-68)

S.No.	State	Percentage Categories						
		Below 1.ØØ	1.ØØ to 5.ØØ	5.ØØ to 1Ø.ØØ	1Ø.ØØ to 15.ØØ	15.ØØ to 2Ø.ØØ	Above 2Ø.ØØ	Total
1.	Andhra Pradesh	6	3	3	1	-	-	13
2.	Bihar	1	4	5	4	2	1	17
3.	Gujarat	2	3	-	-	1	1	7
4.	Haryana	3	1	1	1	-	-	6
5.	Himachal Pradesh	-	1	-	-	-	8	9
6.	Karnataka	8	3	-	-	-	-	11
7.	Madhya Pradesh	1Ø	16	8	1	-	1	36
8.	Maharashtra	9	1	-	-	-	-	1Ø
9.	Punjab	-	1	5	2	2	1	11
1Ø.	Rajasthan	1	5	3	2	-	5	16
11.	Tamil Nadu	3	-	-	-	-	-	3
12.	Uttar Pradesh	3	18	11	8	2	1	43
	Total	46	56	36	19	7	18	182

Mungher and Bhagalpur districts in Bihar; Bahraich, Mainpuri and Farrukhabad districts in Uttar Pradesh. Number of districts devoting higher proportion of GCA to maize, (more than 2Ø per cent) have increased from 12 in 195Ø-53 to 18 in 1965-68. Udaipur and Dungerpur districts of Rajasthan and

Fig. 3·4


INDIA
CONCENTRATION OF AREA UNDER MAIZE
(Triennium Averages of 1965-68)
100 0 100 200 300 400 500 Kms
Concentration Index
ABOVE 0·85
0·65 — 0·85
0·45 — 0·65
0·25 — 0·45
0·05 — 0·25
BELOW 0·05

Chamba and Bilaspur districts of Himachal Pradesh ranked very high (45.95, 4Ø.95, 39.32 and 38.99 per cent of GCA respectively) in terms of maize acreage.

Although spatial pattern of middle ranking district (5.Ø to 15.Ø per cent of GCA under maize) in 1965-68 is almost the same as that in 195Ø-53, however, some districts of Bihar and Madhya Pradesh have gained in terms of area under maize.

1Ø2 districts out of 182 districts fall in the low category in maize cultivating districts, with less than 5 per cent of total cropped area to maize. During the period 195Ø-53 to 1965-68, the proportion of area under maize to total cropped area in the country increased marginally from Ø.86 per cent to 1.Ø9 per cent. As a result of this the number of districts with less than 1 per cent of GCA to maize decreased from 57 to 49. Moreover, the number of districts in the lower categories of maize growing districts in Maharashtra and Karnataka increased during this time period. Maize cultivation has been extended to some non-maize cultivating districts. Most of the districts in the region continued to have a low proportion of total cropped area devoted to maize.

b) Concentration of Area under Maize

In higher category of concentration with index value of more than above Ø.65, the number of districts and their spatial spread is almost the same as in 195Ø-53. The

districts recording more than 2 per cent of total maize acreage of the country are also same (except for the inclusion of Bhilwara district of Rajasthan and exclusion of Bahraich district of Uttar Pradesh). These six districts account for 16.19 per cent of total area under maize in the country. However, as shown in Table 3.5 and Figure 3.4 there is upward movement in the category of high concentration consequently the numbers of districts, recorded index value of above Ø.85, increased from 32 in 195Ø-53 to 38 in 1965-68. Whereas, their relative contribution decreased from 68.56 to 53.78 per cent of country's maize acreage. This fact indicates towards the decrease of relative maize acreage in some districts of this highest category. Spatially, districts in Bihar have shown a down ward trend in maize acreage in the high concentration belt, whereas, there has been an upward trend in upper Ganga plain Himachal-Punjab,Rahasthan-Gujarat-Madhya Pradesh clusters.

The spatial pattern of middle category with concentration index value of Ø.22 to Ø.65 remained same as in 195Ø-53 except that northwestward and southeastward extension of central Madhya Pradesh low concentration belt and decrease in share of the area in Uttar Pradesh-Bihar-Madhya Pradesh cluster of north eastern India.

The pattern of low at concentration category in 1965-68, also almost the same as in 195Ø-53.

Fig. 35

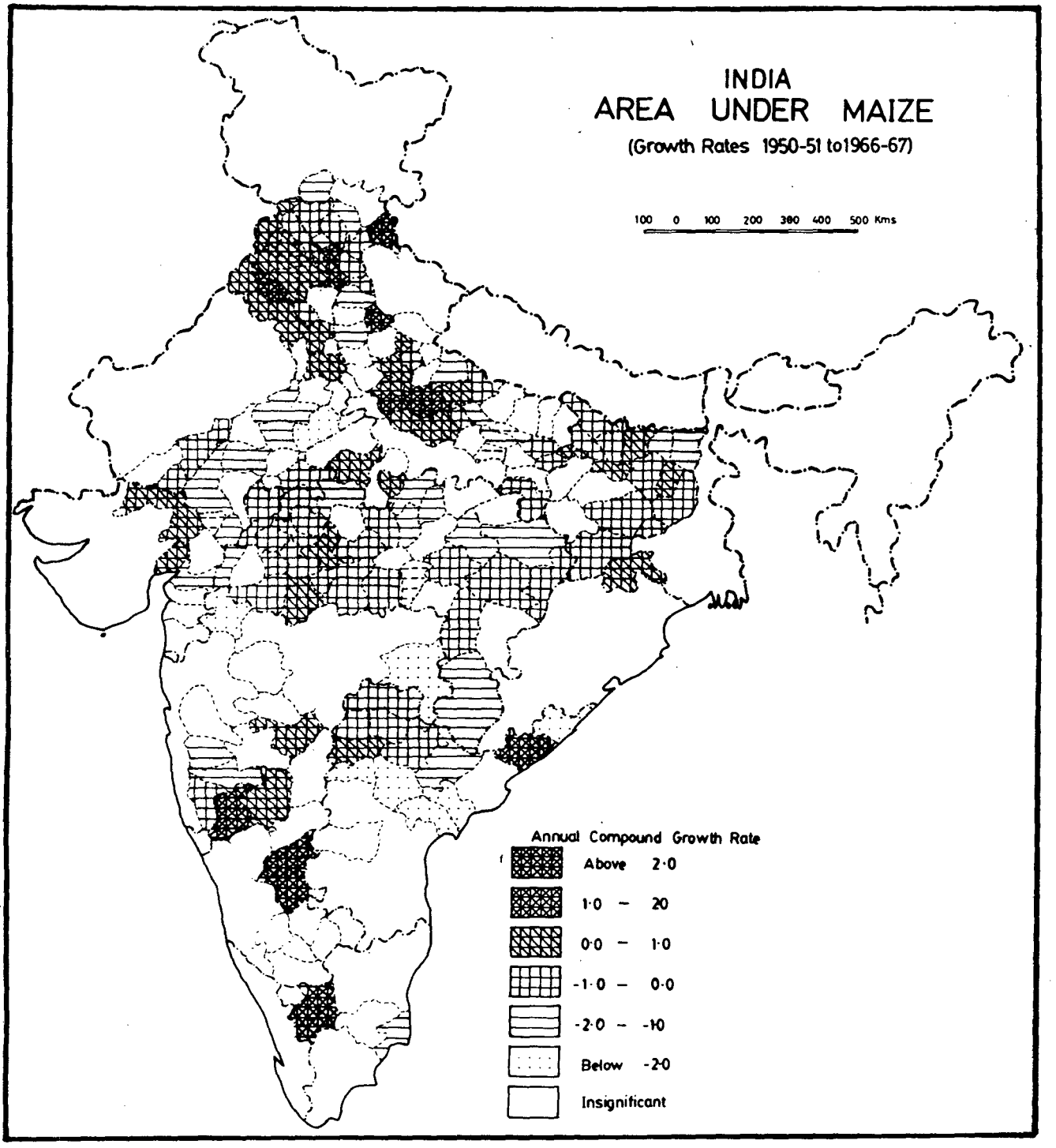

INDIA
AREA UNDER MAIZE
(Growth Rates 1950-51 to1966-67)
100 0 100 200 300 400 500 Kms
Annual Compound Growth Rate
Above 2·0
1·0 – 2·0
0·0 – 1·0
-1·0 – 0·0
-2·0 – -1·0
Below -2·0
Insignificant

Table 3.5

Frequency Distribution of Districts by Percentage Categories of Area Under Maize in a District to Total Area Under Maize of the Country
(Triennium Averages of 1965-68)

S.No.	State	Percentage Categories						
		Below Ø.Ø5	Ø.Ø5 to Ø.25	Ø.25 to Ø.45	Ø.45 to Ø.65	Ø.65 to Ø.85	Above Ø.85	Total
1.	Andhra Pradesh	6	2	1	1	1	2	13
2.	Bihar	-	3	2	-	4	8	17
3.	Gujarat	2	3	-	-	-	2	7
4.	Haryana	-	4	-	1	-	1	6
5.	Himachal Pradesh	1	1	3	3	-	1	9
6.	Karnataka	7	3	1	-	-	-	11
7.	Madhya Pradesh	1Ø	12	8	2	1	3	36
8.	Maharashtra	4	6	-	-	-	-	1Ø
9.	Punjab	-	-	2	2	2	5	11
1Ø.	Rajasthan	1	2	3	4	-	6	16
11.	Tamil Nadu	2	1	-	-	-	-	3
12.	Uttar Pradesh	1	13	1Ø	6	3	1Ø	43
	Total	34	5Ø	3Ø	19	11	38	182

(c) Growth Rate of area under Maize

Table 3.6 and Figure 3.5 show that there were 135 districts having significant rates of growth in area under maize in pre-green revolution period (195Ø-51 to 1966-67). 96

Table 3.6

Frequency Distribution of Districts by Categories of Exponential Annual Compound Growth Rates of Percentage of Area Under Maize to Gross Cropped Area (1950-51 to 1966-67)

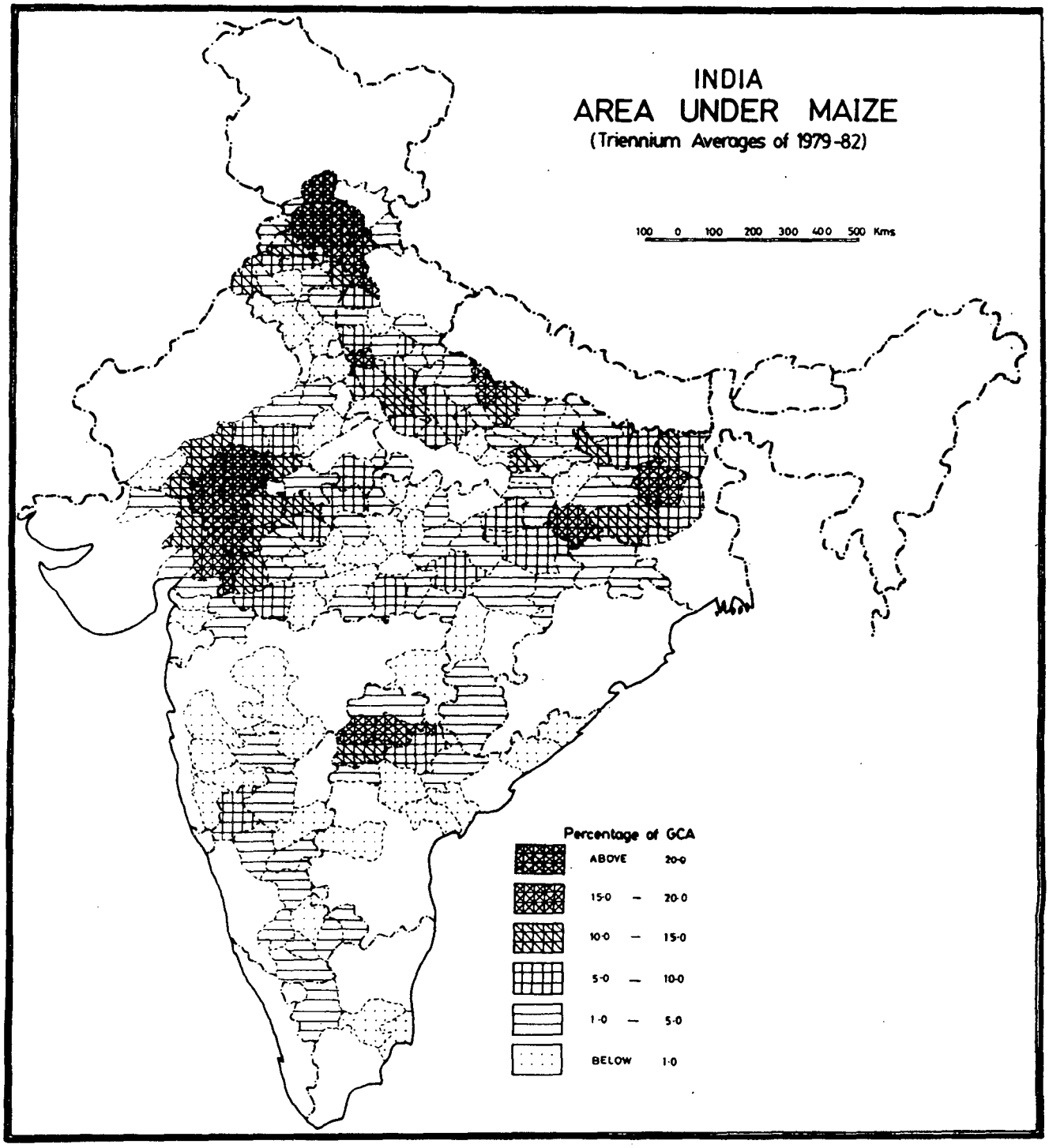
S.No.	State	Categories						
		Below -2.00	-2.00 to -1.00	-1.00 to 0.00	0.00 to 1.00	1.00 to 2.00	Above 2.00	Total
1.	Andhra Pradesh	5	-	1	4	1	2	13
2.	Bihar	-	-	-	8	4	-	12
3.	Gujarat	-	1	1	1	3	-	6
4.	Haryana	-	-	-	1	2	2	5
5.	Himachal Pradesh	-	-	-	4	1	2	9
6.	Karnataka	-	-	-	-	-	2	3
7.	Madhya Pradesh	-	1	1	21	1	-	31
8.	Maharashtra	1	-	-	1	2	-	6
9.	Punjab	-	-	-	2	1	1	9
10.	Rajasthan	1	1	6	3	6	-	12
11.	Tamil Nadu	-	-	-	-	-	1	1
12.	Uttar Pradesh	-	2	6	7	8	5	28
	Total	7	5	27	52	29	15	135

districts recorded positive growth rates. However, there were only 15 districts recording higher annual growth rate of more than 2.0 per cent. Such districts are scattered in Uttar Pradesh, Himachal Pradesh, Punjab, Andhra, Karnataka and

Tamil Nadu. Chitradurg district recorded highest positive annual growth rate (42.7 per cent) followed by Bellary district (15.7 per cent) of Karnataka. The districts with medium positive annual growth rates are mainly located in north-western India (Haryana, Punjab, Western and Central Uttar Pradesh), Andhra Pradesh and Karnataka. Madhya Pradesh with 21 districts dominates the low category of positive growth rate (Ø.Ø to 1.Ø per cent). Other districts of low category are located in southern part of Himachal Pradesh, northern and eastern Bihar and part of Telengana region.

In the pre-green revolution period, there were 39 districts with significant negative growth rates. Seven of them have high negative growth rate (below -2.Ø per cent) amongst them 5 were located in coastal and interior Andhra, one in Maharashtra and one in Rajasthan. Chandrapur district of Maharashtra recorded highest negative growth rate (-4.4 per cent) followed by Srikakulam district (-3.2 per cent) of Andhra Pradesh. Only five districts have medium decreasing trend (-1.Ø to -2.Ø per cent) that were scattered in Uttar Pradesh, Madhya Pradesh, Rajasthan and Gujarat. The districts with low negative growth rates in area under maize were mainly concentrated in two clusters (northern Madhya Pradesh, and eastern Rajasthan). Thus, all districts of irrigated tracts of the country were gaining the area during pre-green revolution period.

Fig. 3·6


INDIA
AREA UNDER MAIZE
(Triennium Averages of 1979-82)
100 0 100 200 300 400 500 Kms
Percentage of GCA
ABOVE 20·0
15·0 — 20·0
10·0 — 15·0
5·0 — 10·0
1·0 — 5·0
BELOW 1·0

ii) **1979-82**

a) Level of Area under Maize

As is evident from the Table 3.7 and Figure 3.6, the two traditional maize growing belts in Aravali-Malwa plateau region and Siwalik ranges and Munghor district of Bihar continue to have a high proportion of area under maize to total cropped area. However, the remarkable gain of maize acreage is also evident in the surrounding districts of Rajasthan-Gujarat-Madhya Pradesh belt and Telengana region of Andhra Pradesh.

The districts with 5 to 15 per cent of GCA under maize are spread over the most of the districts in Punjab, southern part of upper Ganga plain, northern and eastern Bihar and districts surrounding the belts of higher maize acreage in Aravali-Malwa region.

Most of the districts of south India (except Telangana region of Andhra and Belgaum district in Karnataka) have low maize acreage. Most parts of coastal Gujarat, Central Chottanagpur region and central Madhya Pradesh, Haryana and Terai region of Uttar Pradesh have comparatively low proportion of total cropped area under maize.

Fig-3.7

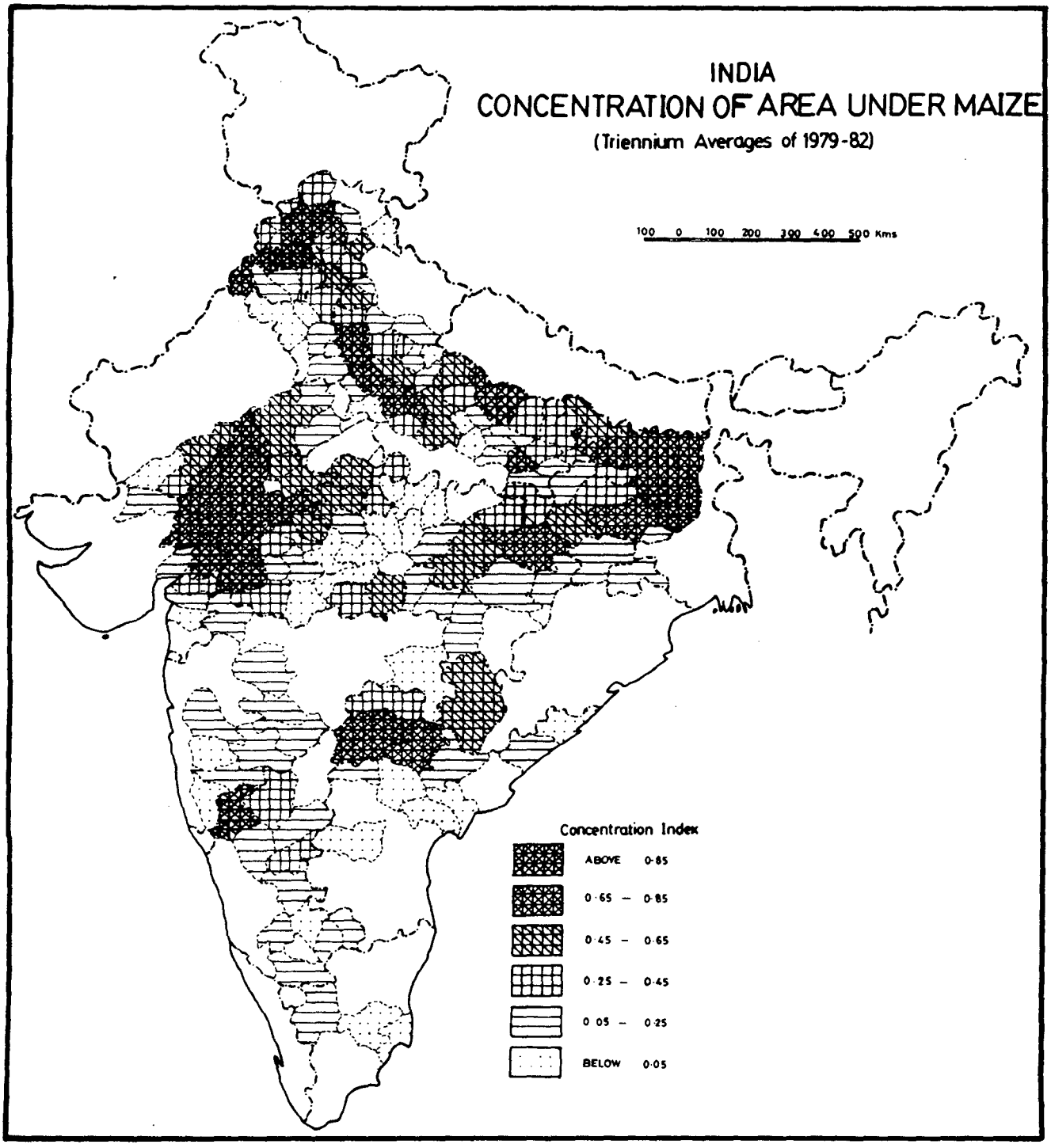

INDIA
CONCENTRATION OF AREA UNDER MAIZE
(Triennium Averages of 1979-82)
100 0 100 200 300 400 500 Kms
Concentration Index
ABOVE 0·85
0·65 – 0·85
0·45 – 0·65
0·25 – 0·45
0·05 – 0·25
BELOW 0·05

Table 3.7

Frequency Distribution of Districts by Percentage Categories of Area Under Maize to Gross Cropped Area
(Triennium Averages of 1979-82)

S.No.	State	Percentage Categories						
		Below 1.ØØ	1.ØØ to 5.ØØ	5.ØØ to 1Ø.ØØ	1Ø.ØØ to 15.ØØ	15.ØØ to 2Ø.ØØ	Above 2Ø.ØØ	Total
1.	Andhra Pradesh	5	4	1	1	2	-	13
2.	Bihar	1	5	5	3	2	1	17
3.	Gujarat	2	3	-	-	1	1	7
4.	Haryana	4	1	-	1	-	-	6
5.	Himachal Pradesh	-	1	-	-	-	8	9
6.	Karnataka	3	7	1	-	-	-	11
7.	Madhya Pradesh	9	14	9	3	-	1	36
8.	Maharashtra	8	2	-	-	-	-	1Ø
9.	Punjab	1	4	2	2	1	1	11
1Ø.	Rajasthan	2	3	2	4	-	5	16
11.	Tamil Nadu	2	1	-	-	-	-	3
12.	Uttar Pradesh	6	19	9	4	5	-	43
	Total	43	64	29	18	11	17	182

b) Concentration of Area under Maize

As is evident from the Table 3.8 and Figure 3.7 and also indicated by above noted description of spatial pattern of the level of area under maize. During this triennium, under

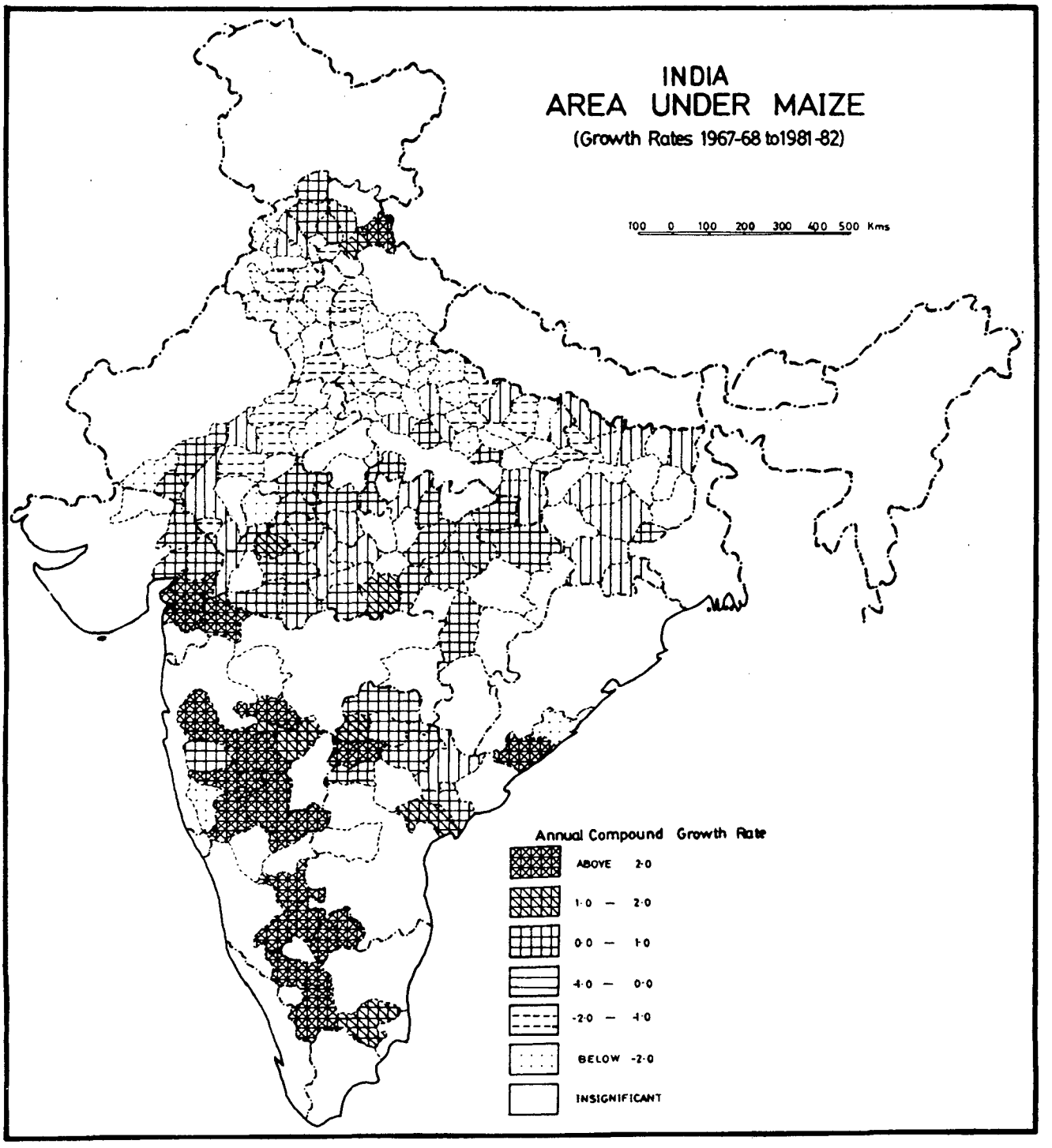
Table 3.8

Frequency Distribution of Districts by Percentage Categories of Area Under Maize in a District to Total Area Under Maize of the Country
(Triennium Averages of 1979-82)

S.No.	State	Percentage Categories						
		Below Ø.Ø5	Ø.Ø5 to Ø.25	Ø.25 to Ø.45	Ø.45 to Ø.65	Ø.65 to Ø.85	Above Ø.85	Total
1.	Andhra Pradesh	5	3	1	-	1	3	13
2.	Bihar	-	4	2	1	2	8	17
3.	Gujarat	1	3	1	-	-	2	7
4.	Haryana	2	2	1	1	-	-	6
5.	Himachal Pradesh	1	1	4	1	1	1	9
6.	Karnataka	1	7	2	-	-	1	11
7.	Madhya Pradesh	1Ø	9	4	7	3	3	36
8.	Maharashtra	3	7	-	-	-	-	1Ø
9.	Punjab	-	2	3	1	1	4	11
1Ø.	Rajasthan	1	2	1	4	1	7	16
11.	Tamil Nadu	2	1	-	-	-	-	3
12.	Uttar Pradesh	2	14	12	6	1	8	43
	Total	28	55	31	21	1Ø	37	182

the influence of green revolution there is remarkable decrease in the high concentration belt of maize acreage in the irrigated parts of north west India. However, its concentration is extended in dryland Gujarat, Madhya Pradesh,

Fig.3·8


INDIA
AREA UNDER MAIZE
(Growth Rates 1967-68 to1981-82)
100 0 100 200 300 400 500 Kms
Annual Compound Growth Rate
ABOVE 2·0
1·0 — 2·0
0·0 — 1·0
-1·0 — 0·0
-2·0 — -1·0
BELOW -2·0
INSIGNIFICANT

Rajasthan and in south India i.e., Telengana and Karnataka regions. During this period Aravali-Malwa cluster of highest category with index value above Ø.85 emerged as the main maize concentration belt of the country with 19 per cent of total acerage of the country under maize. (Udaipur district) recorded highest concentration of maize acreage in the country i.e., 3.4 per cent of area under maize in the country. All 37 district having more than .85 per cent index value recorded 54.3 per cent of total area under maize in India. Only five of them, i.e., Mungher, Panchmahals, Bhilwara, Udaipur and Bulandshahr, recorded 12.9 per cent of total area under maize in the country.

As a consequence of decrease of maize acreage in north-west India one belt of medium concentration category with index value of Ø.25 to Ø.65 begins from from Mahasu district (presently Solan) of Himachal Pradesh and extending eastward parallel to Himalayas till Kanpur district in Uttar Pradesh. Other spatial variations are almost the same as in 1965-68.

(c) Growth Rate of Area under Maize

As shown in the Table 3.9 and Figure 3.8 that there were 138 districts in post-green revolution period recording significant growth rates in area under maize and half of them recorded positive growth rates. 21 districts,recording high positive growth rates, were situated in southern India except

Table 3.9

Frequency Distribution of Districts by Categories of Exponential Annual Compound Growth Rates of Percentage of Area Under Maize to Gross Cropped Area

(1950-51 to 1981-82)

S.No.	State	Categories						
		Below -2.00	-2.00 to -1.00	-1.00 to 0.00	0.00 to 1.00	1.00 to 2.00	Above 2.00	Total
1.	Andhra Pradesh	1	-	1	5	2	2	11
2.	Bihar	1	1	7	2	-	-	11
3.	Gujarat	-	-	-	3	-	3	6
4.	Haryana	3	1	-	-	-	-	4
5.	Himachal Pradesh	-	1	-	4	1	1	7
6.	Karnataka	-	-	-	-	-	8	8
7.	Madhya Pradesh	-	-	6	18	2	1	27
8.	Maharashtra	-	-	-	2	1	5	9
9.	Punjab	5	1	2	-	-	-	8
10.	Rajasthan	2	3	4	4	-	-	13
11.	Tamil Nadu	-	-	-	-	1	1	2
12.	Uttar Pradesh	10	11	8	3	-	-	32
	Total	23	18	28	41	7	21	138

that of Kinnaur district of Himachal Pradesh. The major concentration of districts in this category was in coastal Gujarat-Maharashtra and Maharastra-Karnataka-Tamil Nadu belt. Raichur and Dharwad districts of Karnataka have high annual

growth rates in area under maize (14.2 and 13.2 per cent respectively). There were only seven districts with medium positive growth rates which are scattered in central and south India. Lower positive growth rates (Ø.Ø to 1 per cent) lie in central India, south Andhra and northern Himachal Pradesh.

Almost all districts of northern India recorded negative growth rates. Higher negative growth rates have been recorded in irrigated parts of northwest India (Punjab, Haryana and north-western Uttar Pradesh). Medium negative growth rates have also been recorded in parts of Uttar Pradesh and Rajasthan. The districts with low negative growth rates were located in Bihar, Central part of Madhya Pradesh, and parts of Rajasthan, Punjab and Uttar Pradesh.

It becomes more explicit from the pattern of growth rate that there are high rates of decline in area under maize in irrigated tracts of north-west India in post-green revolution period and increase in area has been recorded in south and central India.

Thus, package technology introduced in irrigated area of north-west India has had a adverse effect on the crop acreage and seems to be major reason behind the pushing out of cropping pattern of such regions.

There were total 156 districts having significant growth rates. (Significant at 5 per cent level of significance). As indicated by Table 3.1Ø, 122 districts recorded positive growth rates. But, there were only 32

Table 3.1Ø

Frequency Distribution of Districts by Categories of Exponential Annual Compound Growth Rates of Percentage of Area Under Maize to Gross Cropped Area

(195Ø-51 to 1981-82)

S.No.	State	Categories						
		Below -2.ØØ	-2.ØØ to -1.ØØ	-1.ØØ to Ø.ØØ	Ø.ØØ to 1.ØØ	1.ØØ to 2.ØØ	Above 2.ØØ	Total
1.	Andhra Pradesh	1	1	5	3	2	1	13
2.	Bihar	-	-	3	13	-	-	16
3.	Gujarat	-	-	-	1	5	1	7
4.	Haryana	1	-	1	1	1	1	5
5.	Himachal Pradesh	-	-	1	3	2	1	7
6.	Karnataka	-	-	-	-	-	11	11
7.	Madhya Pradesh	5	1	1	11	2	14	34
8.	Maharashtra	-	-	1	2	3	3	9
9.	Punjab	-	-	4	3	4	-	11
1Ø.	Rajasthan	-	3	-	7	1	-	11
11.	Tamil Nadu	-	-	-	1	-	1	2
12.	Uttar Pradesh	-	-	6	17	7	-	3Ø
	Total	7	5	22	62	27	33	156

districts having higher positive annual growth rate (above 2.Ø per cent). All eleven districts of Karnataka accounted above 4 per cent annual exponential compound growth rates, whereas, Bangalore, Hassan and Bellary districts recorded highest positive growth rates in the country having 19.6, 14.9, 14.Ø per cent respectively. The districts with higher annual growth rates were mainly concentrated in two belts i.e., Karnataka-Maharashtra belt of southern and eastern Madhya pradesh belt of central India. The impressive growth in Karnataka and Maharashtra is also attributed to low base level during earlier period. The 27 districts of medium category of positive growth rate (1.Ø to 2.Ø per cent) were mainly located in coastal and interior Gujarat and adjacent areas of Maharashtra and Madhya Pradesh, in parts of Andhra Pradesh, Punjab and Uttar Pradesh. Whereas, the districts with lower positive growth in area (Ø.Ø to 1.Ø per cent) are mainly concentrated in four clusters viz., north-eastern cluster which started from India-Nepal boundary in Bihar and extended southward till Telengana region; eastern Rajasthan; Haryana-Punjab; and part of upper Ganga Plain in Uttar Pradesh.

However, there were only very few districts (34) where area under maize has declined significantly. Only 7 districts recorded high negative growth rate (below -2.Ø per cent). Highest rate of decline of maize acreage has been recorded in

Chattarpur, (-5.11) followed by Sehore (-5.4) district of Madhya Pradesh. Five districts with high rate of decline are located in eastern and central Madhya Pradesh, one in Haryana and one in Andhra Pradesh. There were only 5 districts with medium negative growth rates (-2.Ø to 1.Ø per cent). 22 districts recorded low rates of negative growth in area under maize, which were mainly located in eastern Punjab, north-western U.P., Tarai region of Uttar Pradesh and some districts of Andhra Pradesh.

Thus above description shows that the overall spatial pattern of growth of area under maize after independence (195Ø-51 to 1981-82) is quite close to that of post-green revolution period.

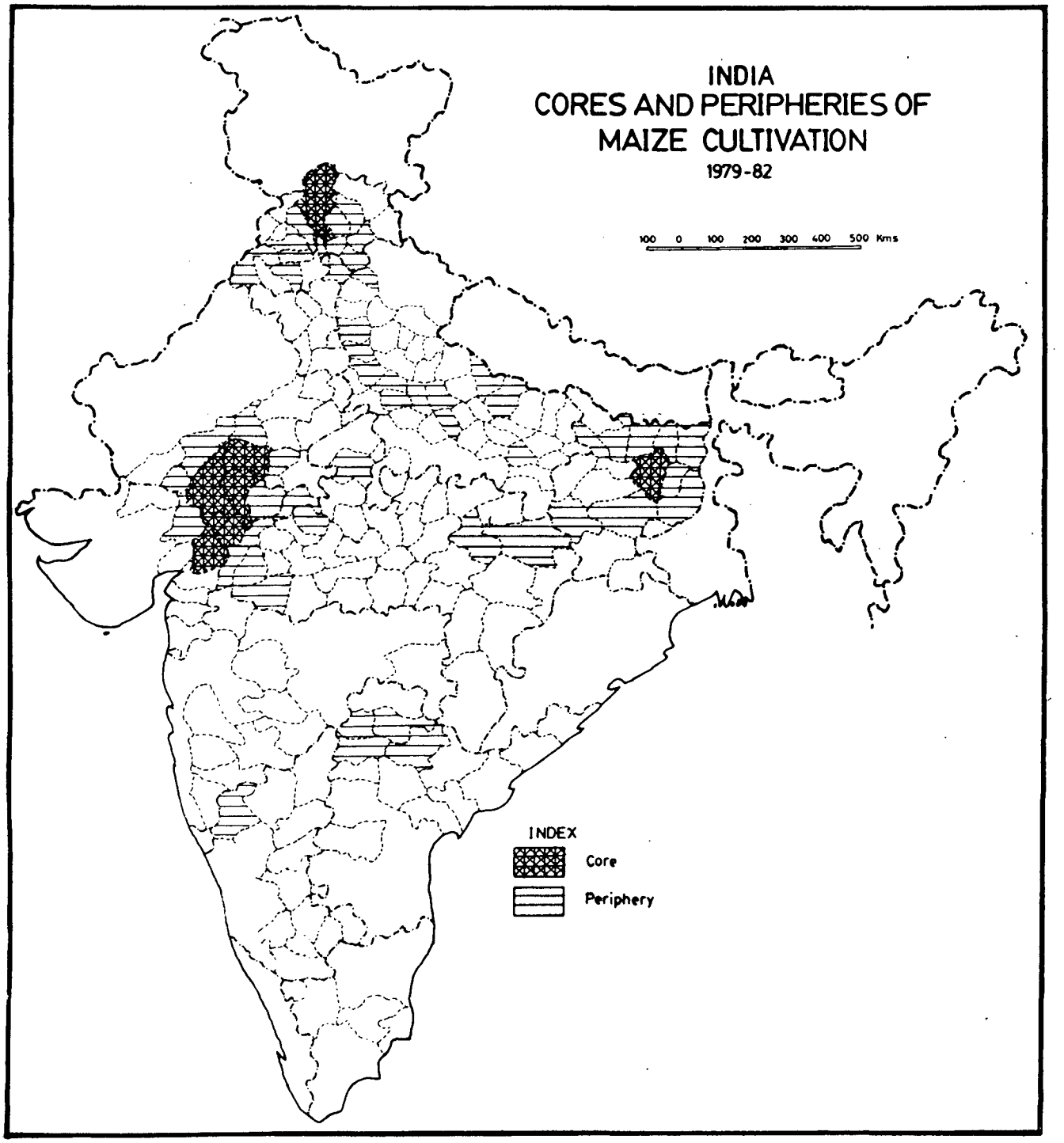
Cores and Peripheries of Maize Cultivation in 1979-82

For presenting a more comprehensive picture of spatial pattern of area under maize. The composite index takes into account both the proportion of area under maize to GCA and proportion of the area under maize in a district to total maize acreage in the country. Values of the composite index have been used to delimit cores and peripheries of maize cultivation. The composite index have been calculated through :

$$C_{ij} = \sum_{i=1}^{i=2} W_j X_{ij}$$

i = number of variables (i_1, i_2)

Fig. 3-9


INDIA
CORES AND PERIPHERIES OF
MAIZE CULTIVATION
1979-82
100 0 100 200 300 400 500 Kms
INDEX
Core
Periphery

j = number of district (j_1, j_2 ..... j_{182})

C_{ij} = Composite index of jth district

W = Weightage assigned to a variable

X_{1j} = Percentage of area under maize to gross cropped area of jth district.

X_{2j} = Percentage of area under maize in jth district to total maize acreage in the country.

Taking into account the importance of both variables equal weightage have been given. Secondly both the variables have been made scale free by dividing every figure by their respective means[2].

The values of composite index have been categorised into cores and peripheries with the help of method based on standard deviation[3].

Core = $\bar{C}_{ij}$ + 2 SD and above

Periphery = From $\bar{C}_{ij}$ to $\bar{C}_{ij}$ + 2 S.D.

As shown in Figure 3.7, there is one major core region of maize cultivation. It extends in Aravali range and adjacent area in Bhilwara, Udaipur, Chittorgarh, Dungerpur and Banswara districts in Rajasthan and Panchmahals district of Gujarat.

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2. Amitabh Kundu, Measurement of Urban Process - A Study of Regionalisation, Bombay, Popular Prakashan, 1980.

3. Moonis Raza and Aijazudin Ahmad, An Atlas of Tribal India, New Delhi, Concept Publishing Co., 1989, p. 35.

Highest value of composite index in the country is that of Udaipur district followed by Panchmahals and Bhilwara.

The second significant core area of maize acreage is Himachal region comprising Chamba, Kangra and Bilaspur districts. Bulandshahr district of Uttar Pradesh and Munger district of Bihar also form core areas of maize cultivation.

There are 53 districts in peripheral which lie in the periphery of maize cultivation in the country. Except that of peripheries of Telengana region of Andhra Pradesh, Belgaum district of Karnataka, Shivpuri district of Madhya Pradesh, Jaunpur, Gonda and Bahraich districts of Uttar Pradesh, four peripheries of maize acreage contiguously spread along core areas.

Sum up

It is evident from the above analysis that more than 60 per cent of identified maize growing districts devoted very low proportion of their GCA, to maize (below 5 per cent) at all three selected trienniums (1950-53, 1965-68 and 1979-82). The Aravali-Malwa region of Rajasthan, Gujarat and Madhya Pradesh, middle and lower Himalayan belt of Himachal Pradesh and Punjab had more than 20 per cent of their respective GCA under maize. Only very few districts (5 per cent of the total identified maize growing districts) have contributed more than 50 per cent of the total maize acreage in the country at all three points of time.

During 1950-53, proportion of area under maize was comparatively higher (more than 20 per cent) in Aravali - Malwa plateau and Siwaliks in Himachal Pradesh. Some district of Bihar and Uttar Pradesh had also come up as major maize growing areas in terms of the concentration of maize acreage. By mid sixties maize had spread to new areas in Karnataka and Maharashtra states. The regions devoting comparatively higher proportion of gross cropped area to maize (Aravali-Malwa plateau region and middle and lower Himalayan region in Himachal Pradesh) had also expanded. A moderate growth (2 per cent) in area under maize had been recorded in north west and central India during the period 1950-51 to 1966-67.

The green revolution has had an adverse effect on the maize acreage. During the post green revolution period most of the districts in north India have experienced decline, whereas, southern and central parts of the country have recorded a marginal increase (less than 1 per cent) in area under maize. The gain in the maize acreage is comparatively high in Karnataka plateau and Maharashtra after mid sixties. However, the impressive growth of maize acreage in this region is also attributed to low base during earlier period. The overall spatial pattern of growth of area under maize after independence (1950-51 to 1981-82) is also quite close to that of post green revolution period.

Chapter - IV

SPATIO-TEMPORAL PATTERN OF YIELD OF MAIZE

In the preceding Chapter, the spatio-temporal patterns of area under maize and its growth rates have been described. This Chapter has been devoted to discuss the patterns of yield levels of maize and its growth rates during the post-independence period. The yield levels have been analysed at these periods taking the trinnium averages of the data pertaining to the years 1950-53, 1965-68 and 1979-82, and the growth rates in the yield have also been described at three points of time (1950-51 to 1966-67, 1967-68 to 1988-89 and 1950-51 to 1988-89). The districts which recorded annual compound growth rates significant at 5per cent level of significance, have been considered the areas of change in yield rates.

Statewise Pattern of Yield Level

As is evident from Table 4.1, the statewise spatial pattern of yield is more dynamic over time than that of area analysed in last Chapter. In 1950-53, Punjab recorded highest yield in the country (1008 kg./hac). Punjab, Uttar Pradesh, Jammu and Kashmir, Tamil Nadu, Karnataka and Delhi respectively recorded higher yield level than country's average (657 Kg./hac.), while, Maharashtra, Rajasthan, Gujarat, Orissa and Madhya Pradesh recorded yield level less than 500 Kg/hac. and remained below the national average.

Table 4.1
Statewise Triennium Average Yield of Maize in India

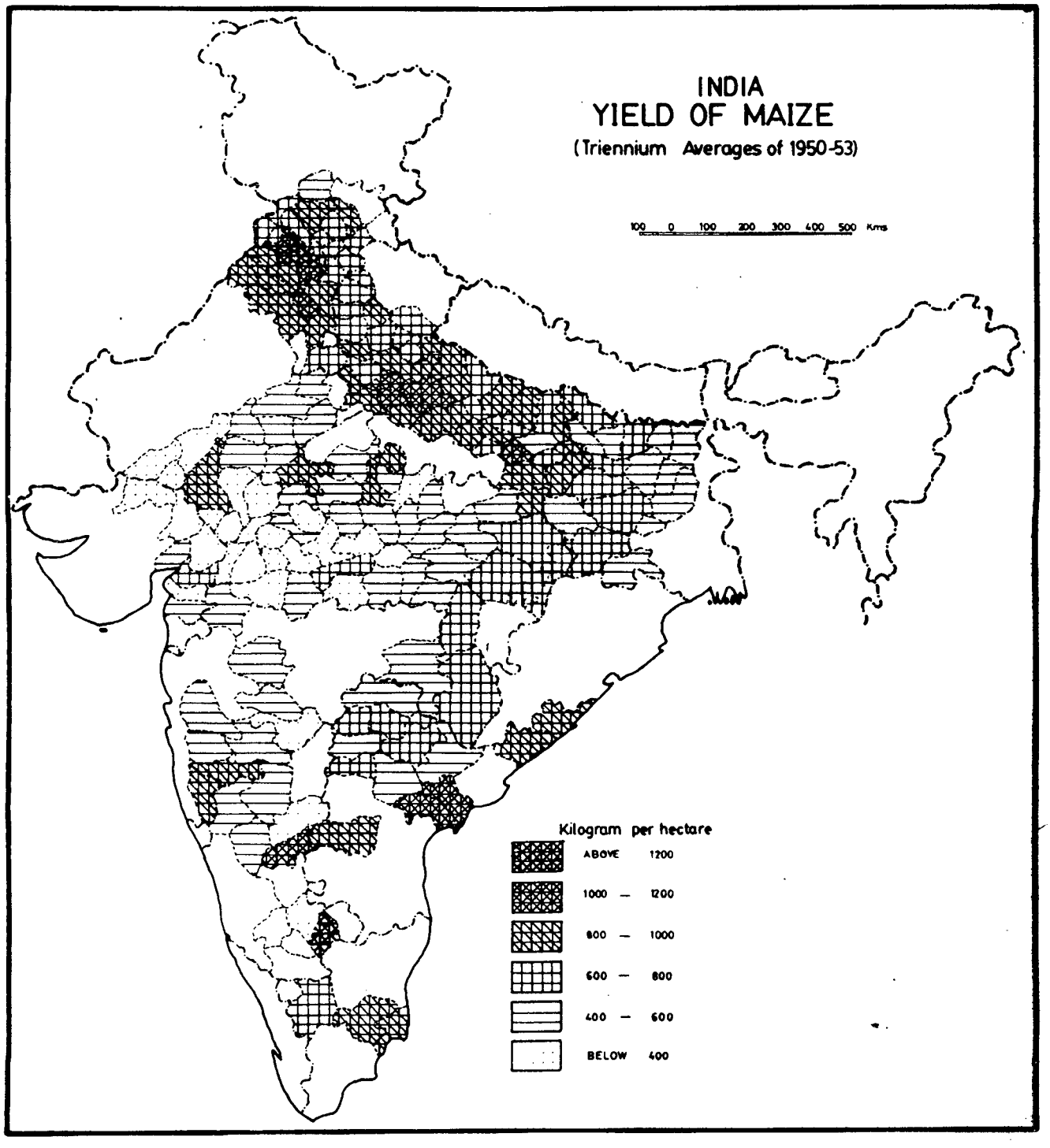
State/Union territory	Average of 1950-53	Average of 1965-69	Average of 1979-82
Punjab	1008	1556	1716
Uttar Pradesh	859	557	791
Jammu and Kashmir	813	772	1602
Tamil Nadu	714	1000	1536
Karnataka	700	1319	2629
Delhi	670	-	1000
West Bengal	650	853	1111
Assam	625	542	576
Andhra Pradesh	613	915	1859
Bihar	604	1095	946
Himachal Pradesh	578	1517	1675
Haryana	-	1247	933
Maharastra	467	1024	1706
Rajasthan	407	1024	784
Gujarat	401	914	1015
Orissa	393	811	912
Madhya Pradesh	380	956	873
Manipur	-	-	745
Mizoram	-	-	1167
Arunachal Pradesh	-	-	1123
Meghalaya	-	-	902
Nagaland	-	-	706
India	657	1031	1100

In 1965-68, the statewise pattern of yield changed and only Punjab, Himachal Pradesh, Karnataka, Bihar and Maharashtra recorded yield level higher than national average (1Ø31 Kg/hac.). Karnataka improved its ranks among states recording high yield from fifth in 195Ø-53 and third in 1965-68, Bihar, Himachal Pradesh and Maharashtra recorded for yield level below the national average. Punjab continued to record highest yield (1556 Kg.) during this time period. Assam, Jammu and Kashmir, Orissa, West Bengal and Uttar Pradesh respectively recorded low yield levels (below 9ØØ Kg.). Two of them i.e. Uttar Pradesh and Jammu and Kashmir occupied second and third place amongst the high yield states in the country during 195Ø-53. Hence, the yield levels have comparatively improved in southern states. This fact became more clear in 1979-82, when Karnataka, Andhra Pradesh, Maharashtra and Tamil Nadu held first, second, fourth and seventh place in yield level. All states of north India except four i.e., Punjab, Himachal Pradesh, Jammu and Kashmir and West Bengal recorded lower yield levels than the national average in 1979-82 (11ØØ Kg./hac.). Therefore, as shown by preceding discussion, there has comparatively been higher growth in yield levels in every maize growing state of southern India than the states of northern India which recorded either decreasing, stagnant or very low growth in yield from 195Ø-53 onwards.

Districtwise Patterns of Maize Yield

Above noted statewise pattern of yield brings out only

Fig. 4-1


INDIA
YIELD OF MAIZE
(Triennium Averages of 1950-53)
100 0 100 200 300 400 500 Kms
Kilogram per hectare
ABOVE 1200
1000 — 1200
800 — 1000
600 — 800
400 — 600
BELOW 400

broad regional variations. The agricultural processes and patterns are largely influenced by environmental, economic and institutional factors. Therefore, the regional dimension of yield variations can be better evaluated when areal units are smaller and more homogeneous than the states. Taking this fact into account, districtwise analysis of yield has been conducted here. Moreover, in order to minimise weather induced annual fluctuations in yield, triennium averages for yield level analysis and three yearly moving averages for growth rates have been taken. The districts have been divided into three categories, viz., low, medium and high both for levels of yield and as well as for growth rates. For presenting more minute variations in levels of yields and growth of yield rates each category has been divided into two groups. In this way, the patterns of levels of yield and growth rates have been analysed dividing the statistical information into six groups.

(i) 1950-53

As presented in Table 4.2 and Figure 4.1, in the triennium of 1950-53, 15 districts recorded high yield level (above 1000 Kg.). Bangalore district which recorded the yield of 5000 Kg./hac. has the highest yield followed by Kapurthala and Jalandhar districts with yields of 1586 and 1507 Kg/hac. respectively. In fact, maize which accounted for .0001 per cent area to GCA, was a marginal crop to Bangalore district during this period. The districts with high yield levels are distributed

Table 4.2

Frequency Distribution of Districts by Categories of Maize Yield in kilogram Per Hectare
(Triennium average 1950-53)

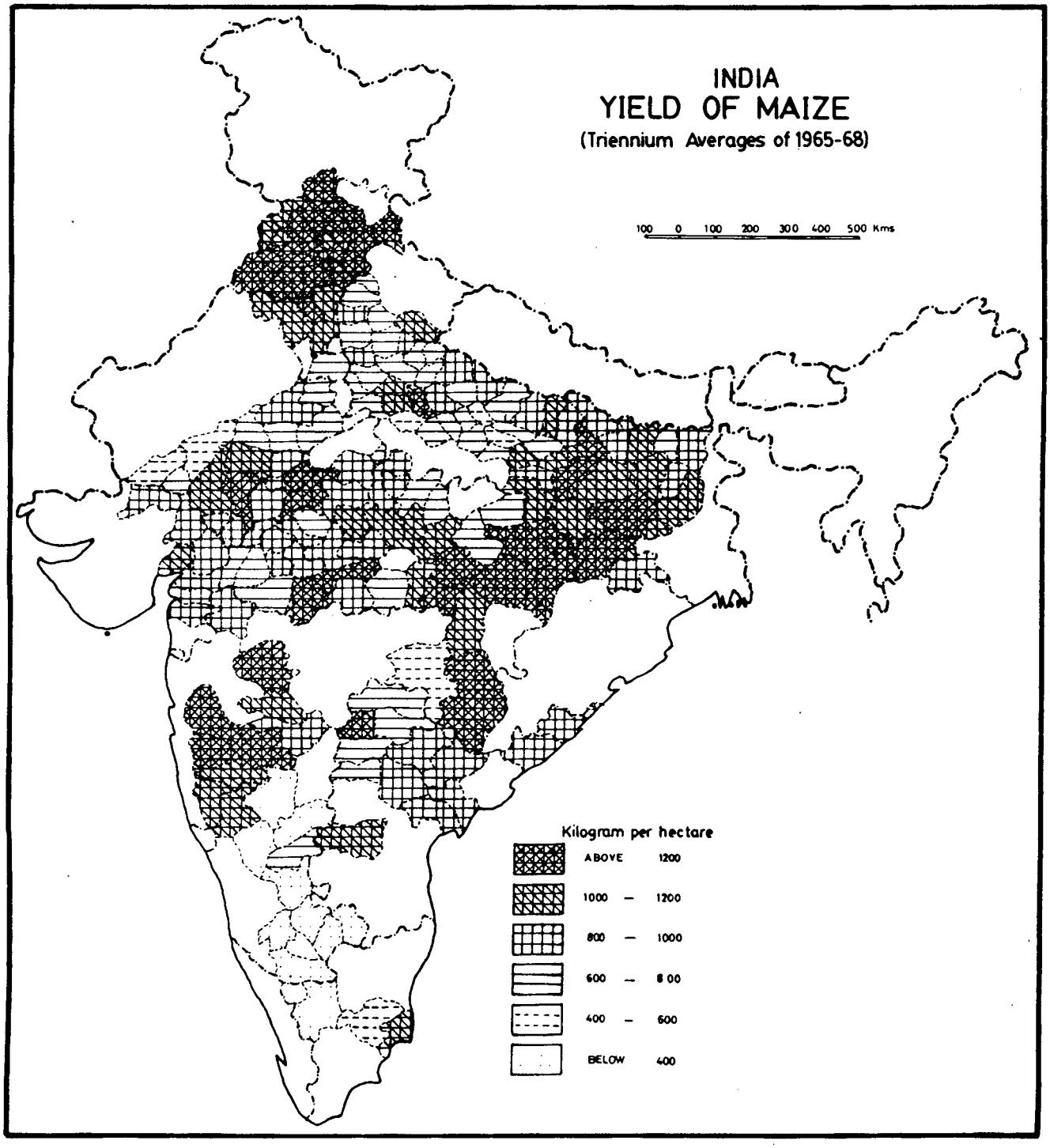
S.No.	State	Categories						
		Below 400	400 to 600	600 to 800	800 to 1000	1000 to 1200	Above 1200	Total
1.	Andhra Pradesh	-	4	4	3	2	-	13
2.	Bihar	-	10	6	1	-	-	17
3.	Gujarat	4	2	1	-	-	-	7
4.	Haryana	-	-	2	3	1	-	6
5.	Himachal Pradesh	-	1	5	2	-	-	8
6.	Karnataka	2	2	-	1	1	1	7
7.	Madhya Pradesh	13	16	7	-	-	-	36
8.	Maharashtra	1	8	-	1	-	-	10
9.	Punjab	-	-	4	4	1	2	11
10.	Rajasthan	6	7	1	2	-	-	16
11.	Tamil Nadu	-	-	1	-	2	-	3
12.	Uttar Pradesh	-	1	15	22	5	-	43
	Total	26	51	46	39	12	3	177

in middle part of Haryana-Punjab plain, in middle part of Uttar pradesh, coastal Andhra and Tamil Nadu and parts of Karnataka plateau. Most of this area has been located in the irrigated tract of the country.

85 districts recorded medium yield level during 1950-53. Uttar Pradesh alone accounted for about 50 per cent of the total districts in this category. The main contiguous belt of medium yield which included 76 districts, extended between Kangra district of Himachal Pradesh, along the Sutlej-Ganga plain to Hazaribagh district of Bihar. It further spread southward upto Telangana region of Andhra Pradesh. Except that of some part of Chottanagpur region, the areas with medium level are distributed in irrigated river basins.

The districts having low level of yield (below 600 Kg.) are concentrated in unirrigated dryland areas of central, north-western and southern parts of the country. 29 out of its 36 districts of Madhya Pradesh identified as maize growing districts, recorded low yield levels. Almost all districts of Gujarat, Rajasthan, Maharashtra, Central Karnataka, eastern Bihar and parts of Andhra Pradesh also recorded low level of yield. The fact that districts in unirrigated dryland regions had low yield level during 1950-53, becomes explicit when pattern of the districts having yield below 400 Kg./hac. is evaluated. Out of a total of 26 districts with this yield level 23 are located in north-western Gujarat, south-eastern Rajasthan and south-western Madhya Pradesh. This area of lowest yield is the region having high percentage of area under maize as identified in last chapter.

Fig. 4·2


INDIA
YIELD OF MAIZE
(Triennium Averages of 1965-68)
100 0 100 200 300 400 500 Kms
Kilogram per hectare
ABOVE 1200
1000 — 1200
800 — 1000
600 — 800
400 — 600
BELOW 400

(ii) 1965-68

a) Yield Pattern : The yield levels of maize for the country increased from 657 Kg./hac. in 1950-53 to 1031 Kg./hac in 1965-68. Consequently, there has been a substantial increase in number of districts in high yield level. There were 101 districts having yields level below national average in 1965-68 in comparison to 83 districts in 1950-53. Therefore, variations in yields level increased during this time. 75 districts recorded yield higher than 1000 Kg. per hectare in the triennium of 1965-68 in comparision to 15 in 1950-53. Firozpur, Jalandhar and Chamba districts recorded high yield with 2138, 2117, 2059 Kg./hac. respectively. Majority of the districts having high yield levels were located in four clusters. i) Himachal Pradesh - Punjab - Haryana belt of north-west irrigated tract, ii) eastern Uttar Pradesh-Bihar-Madhya Pradesh belt of east, iii) Maharashtra belt of Deccan lava plateau and iv) south-eastern part of Rajasthan. Thus, it is clear that during this period, high yield has been registered in some unirrigated areas also.

89 districts recorded the medium level yield (from 600 to 1000 Kg.). These districts included 31 districts of Uttar Pradesh, northern districts of Bihar, districts of eastern Rajasthan and Gujarat, 22 districts of eastern Madhya Pradesh and almost all district of Andhra Pradesh.

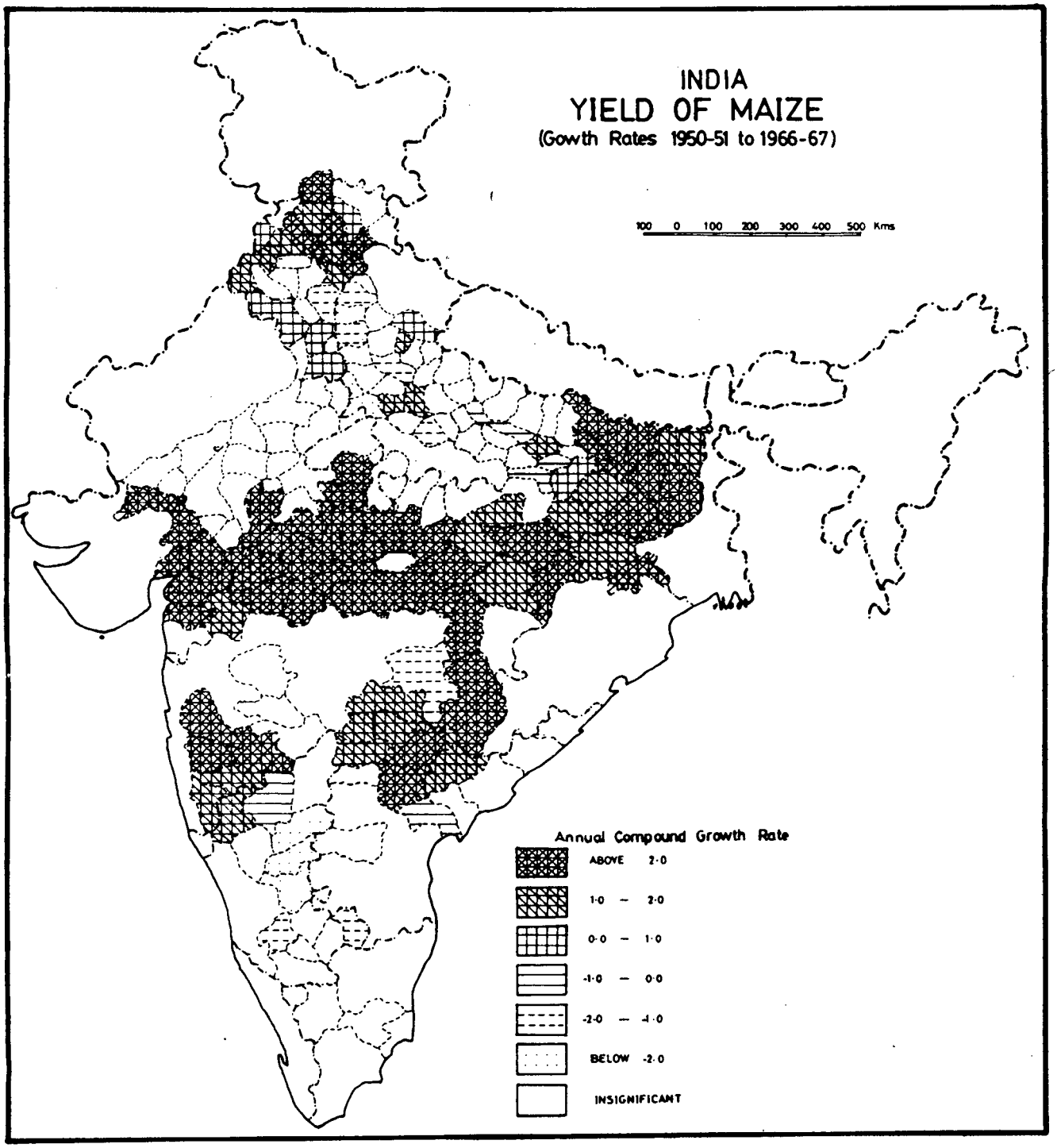
Table 4.3

Frequency Distribution of Districts by Categories of Maize Yield in kilogram Per Hectare
(Triennium average 1965-68)

S.No.	State	Categories						
		Below 400	400 to 600	600 to 800	800 to 1000	1000 to 1200	Above 1200	Total
1.	Andhra Pradesh	-	-	4	7	1	1	13
2.	Bihar	-	-	1	5	7	4	17
3.	Gujarat	-	-	-	6	1	-	7
4.	Haryana	-	-	1	-	2	3	6
5.	Himachal Pradesh	-	-	-	-	1	8	9
6.	Karnataka	9	-	1	1	-	-	11
7.	Madhya Pradesh	-	-	8	13	6	9	36
8.	Maharashtra	-	1	-	2	3	4	10
9.	Punjab	-	-	-	-	2	9	11
10.	Rajasthan	-	2	5	4	2	3	16
11.	Tamil Nadu	1	1	-	-	1	-	3
12.	Uttar Pradesh	-	4	20	11	8	-	43
	Total	10	8	40	49	34	41	182

The 18 districts having low yield level (below 600 Kg/kac.) were mainly distributed in dryland tract of Karnataka plateau and districts of Rajasthan. Four districts in central Uttar Pradesh also recorded yield below 600 Kg./hac.

Fig-4.3


INDIA
YIELD OF MAIZE
(Gowth Rates 1950-51 to 1966-67)
100 0 100 200 300 400 500 Kms
Annual Compound Growth Rate
ABOVE 2·0
1·0 — 2·0
0·0 — 1·0
-1·0 — 0·0
-2·0 — -1·0
BELOW -2·0
INSIGNIFICANT

b) Growth Rate of Yield : Table 4.4 and figure 4.3 indicate that 109 districts recorded growth rates in yield significant at 5per cent level of significance during 1950-51 to 1966-67. As it is also shown in the description of yield level, majority of the districts recorded positive growth rates (above 2.00) and were located in two large clusters of Madhya Pradesh-Gujarat and north-eastern Bihar; and in three small belts of Himachal Pradesh-Punjab in north-west Maharashtra and Andhra Pradesh in South India. Mandsaur, Dhar and Jhabua districts of Madhya Pradesh recorded high positive annual growth rates of 8.9, 5.6 and 5.1 per cent respectively. Medium positive annual growth has been recorded in parts of Chotanagpur region, part of Telengana region in Andhra Pradesh and part of Siwalik ranges in Himachal Pradesh, Haryana and Punjab.

Negative growth rates have been recorded by 19 districts while 6 districts registered high negative growth rates (above -2.0 per cent). These are located in Karnataka plateau and north-western Uttar Pradesh. Highest negative annual growth rates have been recorded in Banglaore and Hasan districts of Karnataka of -5.3 per cent and -4.5 per cent respectively. Medium negative annual growth rate (-1.0 to -2.0 per cent) has been registered in five districts of Uttar Pradesh and one each in Haryana, Punjab and Maharashtra. Six districts have recorded growth rate ranging from 0.0 to -1.0 per cent. Four of them located in eastern Uttar

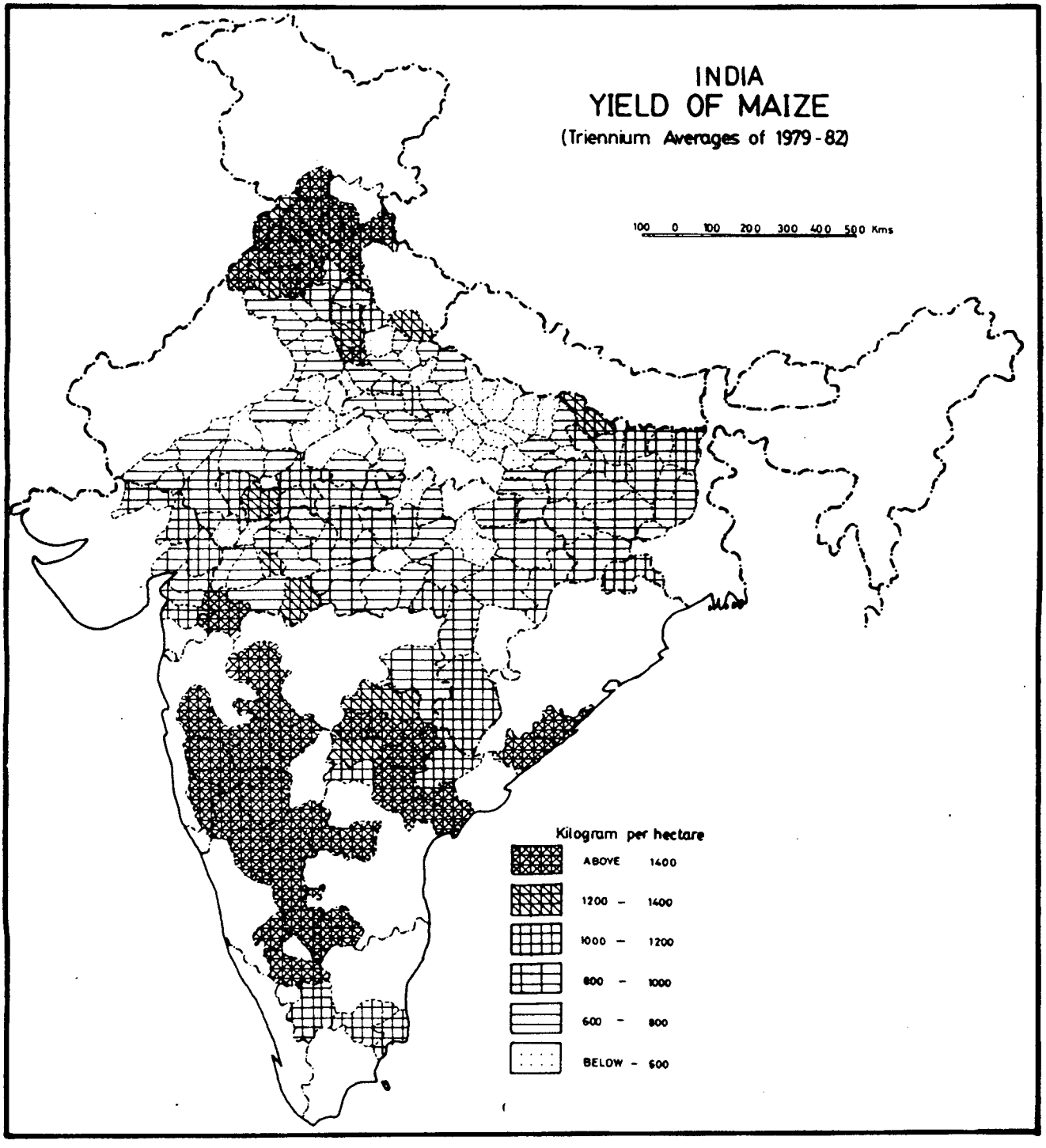
Table 4.4

Frequency Distribution of Districts by Categories ofExponential Annual Compound Growth Rate of Maize Yield (1950-51 to 1966-67)

S.No.	State	Categories						
		Below -2.00	-2.00 to -1.00	-1.00 to 0.00	0.00 to 1.00	1.00 to 2.00	Above 2.00	Total
1.	Andhra Pradesh	-	-	1	-	5	2	8
2.	Bihar	-	-	-	-	5	11	16
3.	Gujarat	-	-	-	-	-	7	7
4.	Haryana	-	1	-	3	1	-	5
5.	Himachal Pradesh	-	-	-	1	2	5	8
6.	Karnataka	4	-	1	-	-	-	5
7.	Madhya Pradesh	-	-	-	-	3	29	32
8.	Maharashtra	-	1	-	1	2	3	7
9.	Punjab	-	1	-	1	3	1	6
10.	Rajasthan	-	-	-	-	-	-	-
11.	Tamil Nadu	-	-	-	-	-	-	-
12.	Uttar Pradesh	-	4	4	1	4	-	15
	Total	6	7	6	7	25	58	109

Pradesh and one each in Karnataka and coastal Andhra Pradesh. As above discussion shows, growth of yield in almost all maize growing districts of Uttar Pradesh and Karnataka either stagnated or decreased.

Fig. 4·4


INDIA
YIELD OF MAIZE
(Triennium Averages of 1979-82)
100 0 100 200 300 400 500 Kms
Kilogram per hectare
ABOVE 1400
1200 – 1400
1000 – 1200
800 – 1000
600 – 800
BELOW – 600

iii) 1979-82

Table 4.5 and Fig. 4.4 show that there has been remarkable increase in yield level in almost all districts of south India, while the maize growing areas in Bihar and Chottanagpur region in Mahdya Pradesh have witnessed decline in yield level pattern after mid sixties. Yield level also decreased in eastern Uttar Pradesh, Haryana and north-eastern Rajasthan. A total of 59 districts have rendered high yield level (above 12ØØ Kg/hac.) during the triennium. All eleven identified maize growing districts of Karnataka recorded yield more than 2ØØØ Kg per hectare. Highest yield was recorded in Chitradurg (3437 Kg.) followed by Raichur district (3251 Kg.) of Karnataka. Two main clusters of high yield levels have emerged during this time period. They are i) Deccan trap which did not exist in 1965-68 and 195Ø-53 and ii) Himachal Pradesh - Punjab belt.

48 districts out of a total of 61 with medium level of yield (from 8ØØ to 12ØØ Kg.) lie in two contiguous belts. One belt begins from extreme northern districts of Bihar extending southward upto Khammam district of Andhra Pradesh, and the other from eastern Madhya Pradesh, parts of Rajasthan upto the coastal districts of Gujarat. Last belt is basically the area of dryland. The remaining districts of this category are located in Tamil Nadu, Haryana and Uttar Pradesh.

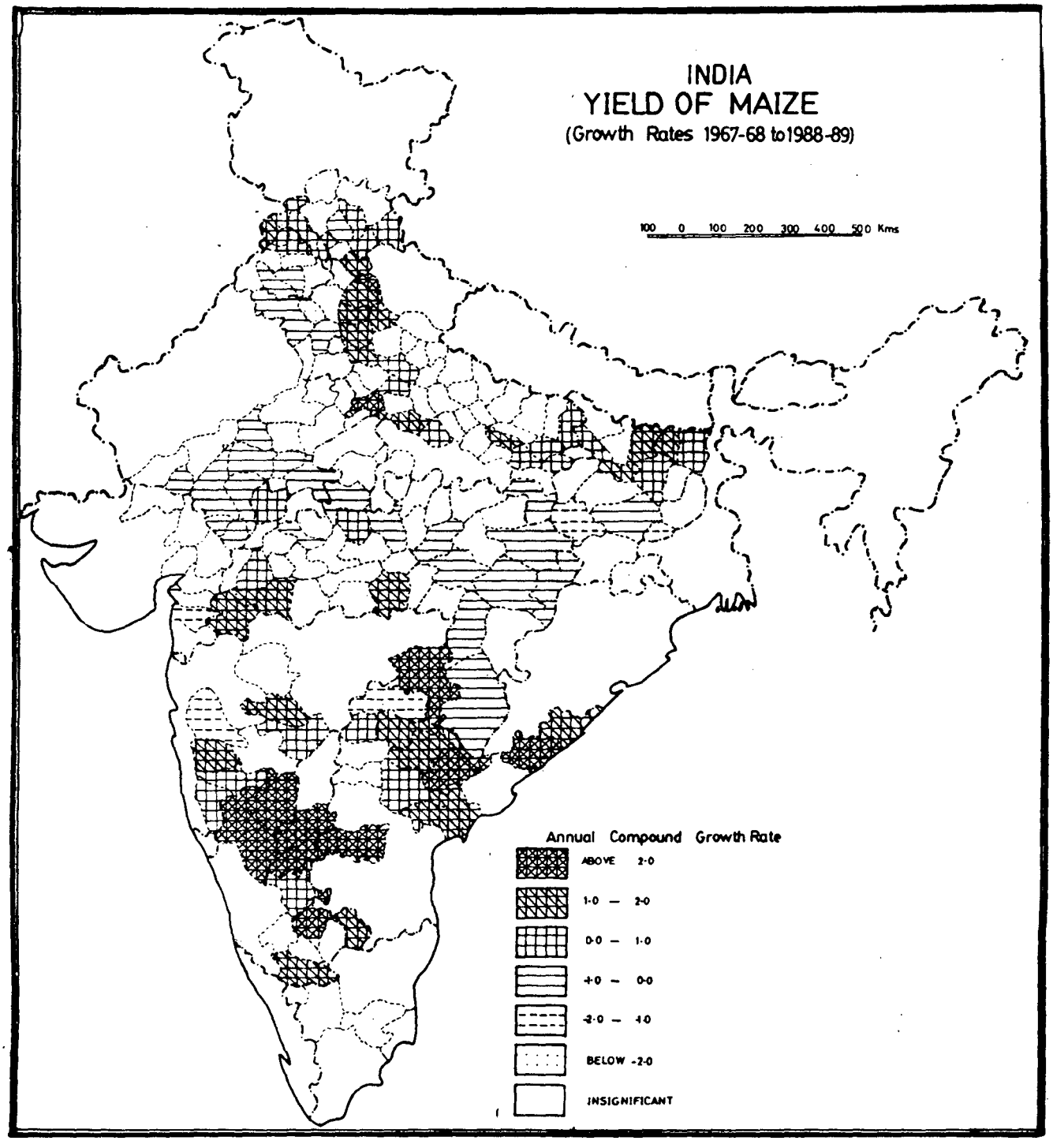
Table 4.5

Frequency Distribution of Districts by Categories of Maize Yield in kilogram Per Hectare
(Triennium average 1979-82)

S.No.	State	Categories						
		Below 600	600 to 800	800 to 1000	1000 to 1200	1200 to 1400	Above 1400	Total
1.	Andhra Pradesh	-	-	-	2	2	9	13
2.	Bihar	-	1	11	4	1	-	17
3.	Gujarat	-	-	4	3	-	-	7
4.	Haryana	-	4	1	1	-	-	6
5.	Himachal Pradesh	-	-	-	-	1	8	9
6.	Karnataka	-	-	-	-	-	11	11
7.	Madhya Pradesh	4	10	16	3	3	-	36
8.	Maharashtra	-	-	1	-	-	9	10
9.	Punjab	-	-	-	-	2	9	11
10.	Rajasthan	5	6	3	2	-	-	16
11.	Tamil Nadu	-	-	-	3	-	-	3
12.	Uttar Pradesh	17	15	4	3	3	1	43
	Total	57	36	40	21	12	47	182

The areas with low level of yield (below 800 Kg.) are mainly concentrated in Uttar Pradesh (32 districts). There is one major contiguous cluster of districts having low yield extending from Hissar district of Haryana eastward and then

Fig-4.5


INDIA
YIELD OF MAIZE
(Growth Rates 1967-68 to 1988-89)
100 0 100 200 300 400 500 Kms
Annual Compound Growth Rate
ABOVE 2·0
1·0 — 2·0
0·0 — 1·0
+0 — 0·0
-2·0 — 4·0
BELOW -2·0
INSIGNIFICANT

fragmenting into two portions, one extending south-westward in Rajasthan upto Pali and Jalore districts, while the other spreads throughout the length and breadth of Uttar Pradesh except that of some districts of western part of the states. In this way Uttar Pradesh, part of Rajasthan and Hrayana, to record decrease continued to downward movement in level of yield, whereas almost all maize growing areas of south India recorded upward movement in the yield level from 1965-68 onwards.

b) Growth Rates of Yield

As Table 4.6 and Fig. 4.5 indicate that the growth rate is about 50 per cent of the identified maize growing districts has been found to be insignificant in the period after the introduction of package technology in the selected parts of the country, i.e., from 1967-68 to 1988-89. Consequently, only 96 districts recorded growth rates significant at 5 per cent level of significance. Positive growth rate has been registered by 65 districts. High positive growth rates (above 2 Per cent) have been recorded by 11 districts. Nine of them lie in south India and two in Uttar Pradesh. Bellary and Dharwad districts of Karnataka recorded highest positive growth rates of 8.3 and 6.7 per cent respectively. From comparison between Table 4.4 and 4.6, and Fig. 4.3 and 4.5, it is evident that there has been remarkable difference in the spatial patterns of higher positive growth rates of yield in pre and post-green revolution period.

Table 4.6

Frequency Distribution of Districts by Categories of Exponential Annual Compound Growth Rate of Maize Yield (1967-68 to 1988-89)

S.No.	State	Categories						
		Below -2.ØØ	-2.ØØ to -1.ØØ	-1.ØØ to Ø.ØØ	Ø.ØØ to 1.ØØ	1.ØØ to 2.ØØ	Above 2.ØØ	Total
1.	Andhra Pradesh	-	1	-	2	5	3	11
2.	Bihar	-	2	2	3	3	-	1Ø
3.	Gujarat	-	1	-	-	-	-	1
4.	Haryana	1	-	2	-	-	-	3
5.	Himachal Pradesh	-	-	-	4	1	-	6
6.	Karnataka	-	-	-	1	2	5	8
7.	Madhya Pradesh	-	-	1Ø	3	2	-	15
8.	Maharashtra	-	1	-	3	3	1	8
9.	Punjab	-	-	1	6	1	-	8
1Ø.	Rajasthan	-	-	9	-	-	-	9
11.	Tamil Nadu	-	-	-	-	-	-	-
12.	Uttar Pradesh	-	-	-	8	7	2	17
	Total	1	5	25	3Ø	24	11	96

There were about 5Ø per cent of the districts having significant values accounting for higher positive growth rates in pre-green revolution period while in post-green revolution period this proportion of districts with higher positive growth rates decrease to 11 per cent. Medium positive annual growth rate (1.Ø

to 2.Ø per cent) had been recorded in 24 districts and most of them are located in western Uttar Pradesh and coastal Andhra Pradesh. This pattern of medium level of growth rate in yield was almost the same as in pre-green revolution period. Districts with medium positive annual growth rate were also scattered in Bihar, Punjab, Maharashtra and Madhya Pradesh. Districts with low positive growth rates (Ø.Ø to 1.Ø per cent) are located in irrigated tracts of Punjab, Himachal Pradesh, Uttar Pradesh, Bihar and Madhya Pradesh.

A total of 31 districts recorded negative annual growth rates, 25 of them had low negative growth rates (Ø.Ø to -1.Ø per cent). These districts of low negative growth rates are mainly concentrated in eastern parts of Madhya Pradesh and Bihar, eastern Rajasthan and western Haryana and Punjab. Two districts of Bihar and one each of Gujarat and Maharashtra recorded growth rate between -1.ØØ and -2.ØØ per cent. Jind districts of Haryana recorded higher negative annual growth rate (-2.7 per cent). Above analysis shows that there are remarkable variations in the patterns of growth rate of yield in pre- and post-green revolution time. Consequently, when whole time period since independence (195Ø-51 and 1988-89) has been taken into account the spatial pattern of growth rates again changed. As is evident from Table 4.7, there were 139 districts with significant growth rates. Majority of the districts (116) like that of pre and

Table 4.7

Frequency Distribution of Districts by Categories of Exponential Annual Compound Growth Rate of Maize Yield (1950-51 to 1988-89)

S.No.	State	Categories						
		Below -2.00	-2.00 to -1.00	-1.00 to 0.00	0.00 to 1.00	1.00 to 2.00	Above 2.00	Total
1.	Andhra Pradesh	-	-	-	3	8	-	11
2.	Bihar	-	-	-	13	2	-	15
3.	Gujarat	-	-	-	5	-	-	5
4.	Haryana	-	1	3	2	-	-	6
5.	Himachal Pradesh	-	-	-	3	6	-	9
6.	Karnataka	-	-	-	-	1	9	10
7.	Madhya Pradesh	-	-	-	22	8	-	30
8.	Maharashtra	-	-	-	-	9	1	10
9.	Punjab	-	-	-	11	-	-	11
10.	Rajasthan	-	-	8	2	-	-	10
11.	Tamil Nadu	-	-	-	3	-	-	3
12.	Uttar Pradesh	-	-	9	10	-	-	19
	Total	-	1	20	72	34	10	137

post-green revolution period recorded positive growth rate. High positive annual growth rates (above 2 per cent) have been recorded by nine districts of Karnataka and one district of Maharashtra. High annual growth rate has been recorded in Tumkur (4.3 per cent), Raichur (4.2 per cent) and Dharwad (3.1 per cent)

districts of Karnataka. The districts having annual growth rates between 1 and 2 per cent were mainly located in Maharashtra, Andhra Pradesh, Madhya Pradesh and Himachal Pradesh. However, majority of the districts recorded low growth rate in yield during this period and are mainly spread in Madhya Pradesh, Bihar, Uttar Pradesh and Punjab. There were only very few districts (21) which recorded negative growth rates in yield from 1950-51 to 1988-89 and 20 of them had low negative growth rates (0.0 to -1.0 per cent). These are located in Uttar Pradesh, Rajasthan and Haryana. Jind district is the only district which recorded more than -1.0 per cent annual growth rate of yield during post-independence period.

Sum up :

The above discussion underline that the pattern of yield level of maize has been dynamic over space. No such belt(s) emerged like the area under maize which recorded high or low level of yield through out the period under study. In 1950-53, there were very few (15) districts which recorded high yield (above 1000 Kg./hac) and mainly located in irrigated tracts of the country. Substantial number of districts recording low level of yield (below 600 Kg/hac) which are located in unirrigated dryland areas of central, north-western and southern part of the country. But in 1965-68, a sizeable number of districts registered high yield and their location make it clear that high yield of maize has basically recorded in irrigated areas of

north-western and eastern part of the country. During the pre-green revolution period (1950-51 to 1966-67) majority of the districts recorded growth rate of yield above 2 per cent and their main concentration is in central and eastern India. Whereas, negative growth rates mainly recorded in Karnataka and Uttar Pradesh.

In 1979-82 the spatial pattern of yield again changed and eastern belt of high yield totally disappeared and north-west belt shrank. On the other hand, a new belt of high yield emerged in South India. The yield level in Uttar Pradesh - more particularly eastern and central part, recorded decreasing level of yield from 1950-53 onwards. The growth rates in yield from 1967-68 to 1988-89 are insignificant in 50 per cent of identified maize growing districts and only eleven districts that are located in south India recorded annual growth rate above 2.0 per cent. Almost all districts of north India, except some districts in north-western Uttar Pradesh, contrary to the general pattern of growth rate of yield of foodgrains during this period, recorded either very low positive or negative growth rates in yield of maize. In the whole post-independence period, pattern of growth rate in yield remained almost same as in post-green revolution period except the difference of degree in rates of growth. Like that of post green revolution period, districts of south India recorded high and medium positive growth rates. Districts of south India recorded both high yield level and high growth rate of yield.

Chapter - V

DETERMINANTS OF AREA AND YIELD OF MAIZE

In the previous two chapters, the spatio-temporal patterns of area and yield of maize have been analysed. It has been brought out that there are remarkable variations in spatial and temporal patterns of both area and yield of maize. However, these variations have been caused by differentiations in physical and non-physical determinants. The most prominents amongst them are Environmental factors like physiography, climate, soil and hydrological factors and non physical factors viz., technological, social, economic and political factors[1]. Some of the basic agro-climatic conditions causing variations in area and yield levels of maize have been discussed in chapter 1. However, in this chapter, an attempt has been made to explain the spatial variations in the patterns of area and yield levels of maize with the help of cross-sectional statistical exercise. The selected variables of the exercise are :

(a) Dependent Variables

Y_1 = Percentage of area under maize to gross cropped area

Y_2 = Yield of maize in kilogram per hectare.

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1. Jasbir Singh and S.S. Dhillon, Agricultural Geography, New Delhi, Tata McGraw Hill, 1984, pp. 43-167.

(b) Independent Variables

X_1 = Farm harvest price of maize of previous year (Rupees per quintal)

X_2 = Seasonal (June - Sept.) rainfall in centimeters.

X_3 = Percentage of irrigated maize acreage in a district to total area under maize in the district.

Considering the fact that the importance of a determinant changes from time to time, the statistical exercise has been conducted at three points of time, taking the middle years of three trienniumsfor the analysis. Thus the agricultural years for which analysis of determinants of area and yield of maize has been done are 1951-52, 1966-67 and 1980-81.

The hypothesis that the farmers, particularly of developing countries, do not respond to price variations has been refuted[2]. It has been argued that the profit maximisation is not limited to industries only. It is also applicable to agriculture, however, to a lesser degree[3]. Price has been found significantly effective in Indian agriculture in allocation of area not only to cash crop but also to foodgrains[4]. The importance of price in

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2. T.W. Schultz, Economic Crisis in World Agriculture, Ann Arbor, University of Michigan Press, 1965.

3. Dharam Narain, Studies on Indian Agriculture, edited by K.N. Raj et. all, Delhi, Oxford University Press, 1988, p. 3.

4. (a) Dharam Narain, The Impact of Price Movements on Areas under Selected Crops in India (1900-39), Cambridge, Cambridge University Press, 1955. and,
(b) Raj Krishana "Farm Supply Response in India-Pakistan : A case study of Punjab Region", The Economic Journal, LXXIII, Sept. 1963.

influencing the area under a particular crop and providing incentives in raising its yield level is comparatively low in dryland and subsistance agricultural economy. Price may not provide much incentives in such a situation and environmental factors and economic compulsions of farmers remain on the forefront.

The influence of climatic factors is well established in Indian agriculture. Rainfall is most prominant factor in determining the allocation of area under a crop and level of its yield. Rainfall parameters such as onset and withdrawl of monsoon, seasonal rainfall, rainfall variability and prolongation of wet and dry spells are very important in this respect. However, only seasonal (Kharif) rainfall has been included for analysis in the present study.

Irrigation is a basic technological input used in Indian agriculture. Variations in the use of this input caused the variations in the cropping pattern and yield level of different agricultural commodities. Therefore, in this study this basic technological input has been included in statistical exercise. In the present study, percentage of total irrigated area under maize to total area under maize has been taken as variable.

Moreover, in some studies bothin the case of dependent and independent variables the triennium averages have been used. But averages marginalise the significance of some variables.

Taking in account this fact, the data of only one year have been used.

Determinant of Area under Maize

For bringing out the degree and direction of association between dependent variable (Y_1) and independent variables coefficient of correlation values have been computed. As shown in Table 5.1, that farm harvest prices of lagged year (X_1) and area under maize (Y_1) are not related in 1950-51 and 1966-67. It brings out that price was a negligible factor in maize cultivation until mid-sixties when green revolution was launched. However, recently (1980-81) farmers have positively responded to price variation while allocating area for maize cultivation. The correlation coefficient (r) between price and area under maize for the period 1980-81 is low (0.18) but significant at 1 per cent level of significance.

The district-wise variation in the magnitude of seasonal rainfall (X_2) is negatively correlated with area under maize. While, in 1966-67 their correlation is positive. The values of correlation coefficient in both the cases is quite low (-0.17 and 0.14 respectively) but significant at 5 per cent level of significance. Seasonal rainfall does not show any relation with area under maize in 1980-81. The occurrence of countrywide severe drought in 1966-67 seems to have altered the relationship between seasonal rainfall and area under maize. Cultivation of maize in

Table 5.1

Correlation Matrices

	Y_1	X_1	X_2	X_3
1951-52				
Y_1	1.000			
X_1	.011	1.000		
X_2	-.166	.236	1.000	
X_3	-.077	-.181	-.392	1.000
1966-67				
Y_1	1.000			
X_1	.002	1.000		
X_2	.139*	-.124	1.000	
X_3	-.140*	.262	-.227	1.000
1980-81				
Y_1	1.000			
X_1	.183**	1.000		
X_2	-.062	.042	1.000	
X_3	-.148**	-.245	-.511	1.000

** significant at 1 per cent level of significance
* significant at 5 per cent level of significance

low rainfall areas in the country was severely restricted because of very scanty rainfall during Kharif season. Hence, our hunch that where there is high rainfall, there will be low area under maize proved true in 1950-51, but rejected in period of 1966-67.

The proportion of irrigated area under maize (X_3) and percentage of area under maize to GCA have been found to be negatively correlated in 1966-67 and 1980-81, however, the value of the coefficient of correlation (r) is very low at both time periods (-0.14 and -0.15 respectively), but it is significant at 5 per cent and 1 per cent level of significance respectively. Irrigated area under maize and maize acreage do not show any correlation in 1950-51. Therefore, our hypothesis that where there is higher irrigation facilities, share of maize area in total cropped area will be low accepted in 1966-67 and 1980-81.

Step-wise Regression

The purpose of the present study is both making some prediction and understanding causal relationship. For this purpose, stepwise regression coefficients of each variable have been found out. But, step-wise regression in comparision to other regression procedure do not produce the best equation if there is collinearity[5]. But as shown by Table 5.1 that correlation coefficient (r) values are very low. So, there is no sizeable collinearity among selected variables. Moreover, in step-wise regression procedure, there are many ways of 'order of entry' of variable. However, one of the best and widely used is that variables are entered in their order of importance in

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5. R.J. Johnston, Multivariate Statistical Analysis in Geography, Harlow, Longman Scientific and Technical, 1986, p. 87.

reducing the variance of dependent variable, with the most important first, and this ordering is indicated by partial correlation coefficient[6]. This procedure of step-wise regression has been applied in 'order of entry' of a variable, in this study.

In 1951-52, as shown in Table 5.2, all three independent variables explain only 5.28 per cent of total variance in area under maize. Seasonal rainfall (X_2) enters at the first step as most important variable. It explains 2.74 per cent of total variance whereas, regression coefficient (-.Ø4) is significant at 4 per cent level of significance. Irrigated maize area (X_3) enters at second step and increase the explanatory values from

Table 5.2

Step-wise Regression 1951-52

	Variable	R	R^2x100	increase in R^2 x 100	R^2	F	Regression coefficient	S.E. of Regression Coefficient	t	Intercept
Step 1	X_2	0.166	2.744	-	.0262	5.078*	-.042	.019	-2.253**	8.154
Step 2	X_2	0.227	5.140	2.396	.04888	4.849*	-.058	.020	-2.927**	10.678
	X_3						-.041	.0192	-2.126*	
Step 3	X_2	0.230	5.275	0.135	.037	3.384	-.060	.020	-.239	9.551
	X_3						-.0399	.019	-.164	
	X_1						.017	.033	.038	

** significant at 1 per cent level of significance
* significant at 5 per cent level of significance

6. Ibid p. 85.

2.74 to 5.14 per cent. Hence, this variable is also as important as rainfall (X_2). Both regression coefficients are significant. Maize harvest price (X_1) in 1951-52 is in significant and explain very low variance (Ø.13 per cent of total variance).

Whereas, in 1966-67, as shown in Table 5.3, all independent variables explain only 3.41 per cent of the total variance in maize area. However, the regression coefficients and regression equations at all steps are insignificant.

As Table 5.4 brings out that in 198Ø-81, all three independent variables together explain 6.59 per cent of total spatial variation in area under maize. The prices (X_1) enters at the first step of regression. It explains 3.33 per cent of the total variance and causation degree is .Ø997 with one degree of area under maize, which is highest in all variables at all three periods of time. Irrigated maize area (X_3) is second important explanatory variable, however it increases the explanatory power of regression equation by only 1.13 per cent. The seasonal rainfall, which enters in the last step, increases the explanatory value by 2.13 per cent. All three regression equations are significant but regression coefficient of irrigated also under maize is insignificant.

Above analysis depicts that these three explanatory variables explain only 6-7 per cent of total spatial variation in

Table 5.3

Step-wise Regression 1966-67

	Variable	R	R^2x100	increase in R^2 x 100	R^2	F	Regression coefficient	S.E. of Regression Coefficient	t	Intercept
Step 1	X_2	.140	1.974	-	.014	3.624	-.040	.021	-1.904	8.072
Step 2	X_2	.178	3.178	1.204	.021	2.938	-.032	.021	-1.522	5.696
	X_3						.032	.021	14926	
Step 3	X_2	.185	3.418	0.232	.018	2.895	-.036	.022	-1.633	4.061
	X_3						.033	.022	1.532	
	X_1						.027	.0.41	.653	

‡‡ significant at 1 per cent level of significance
‡ significant at 5 per cent level of significance

Table 5.4

Step-wise Regression 1980-81

	Variable	R	R^2x100	increase in R^2 x 100	R^2	F	Regression coefficient	S.E. of Regression Coefficient	t	Intercept
Step 1	X_2	.183	3.33	-	.028	6.269*	.0997	.040	2.492**	-4.113
Step 2	X_2	.211	4.46	1.13	.034	4.179*	.085	.041	2.067*	-1.716
	X_3						-.032	.022	-1.453	
Step 3	X_2	.257	6.59	2.13	.058	4.185*	.077	.041	1.873	3.353
	X_3						-.058	.025	-2.295**	
	X_1						-.043	.021	-2.014	

‡‡ significant at 1 per cent level of significance
‡ significant at 5 per cent level of significance

area under maize. This underlines the fact that some other physical, socio-economic and institutional factors which could not be precisely identified and included in the framework of analysis of this study for some reasons play important role in determination of area under maize.

Determinants of the Yield

Correlation Matrix

Table 5.5 shows that farm harvest price of maize (X_1) and its yield do not have any association for the period 1950-51 and 1966-67. However, it has negative correlation with yield level for the period 1980-81. The correlation coefficient (r) value (-0.30) is significant at 1 per cent level of significance. therefore, the hunch that where the price of maize is high, people use more input to raise yield, consequently the yield of maize will comparatively be higher there, is rejected in the study.

The spatial variations in seasonal rainfall (X_2) do not show any relationship with maize yield in 1950-51 and 1966-67. However, it has negative and significant correlation (-0.38) for the period 1980-81. Therefore, the hypothesis that where there is high rainfall, there will be low yield is accepted only for the year 1980-81.

Table 5.5

Correlation Matrices

	Y_1	X_1	X_2	X_3
1951-52				
Y_1	1.000			
X_1	-.077	1.000		
X_2	.005	.236	1.000	
X_3	.249	-.181	-.392	1.000
1966-67				
Y_1	1.000			
X_1	-.062	1.000		
X_2	.108	-.124	1.000	
X_3	-.174**	.262	-.227	1.000
1980-81				
Y_1	1.000			
X_1	-.3000**	1.000		
X_2	-.377**	.042	1.000	
X_3	.420**	-.245	-.511	1.000

** significant at 1 per cent level of significance
* significant at 5 per cent level of significance

Irrigated maize area (X_3) is positively and significantly correlated with maize yield at all selected points of time. Infact the value of r has increased with passage of time. This means that the research question pertaining to positive relationship between the two variables is accepted.

Step-wise Regression

As Table 5.6 brings out, in 1950-51, all three independent variables explain only 7.75 per cent of total variance in maize yield. The irrigated maize area (X_3) enters at the first step and explains 6.23 per cent of the total spatial variation in yield. The regression coefficient and equation are significant at 1 per cent and 5 per cent levels of significant respectively. Whereas, seasonal rainfall (X_2) increases the explanatory value (R^2 x 100) by 1.24 per cent. However, regression equation is significant at 5 per cent level of significance but regression coefficient of X_2 (1.87) is insignificant. Price is also an insignificant variable in 1950-51.

In 1966-67 as shown in Table 5.7, irrigated area (X_3) emerges as a significant variable in explaining yield. It explain 3.04 per cent of the total spatial variation in the level of yield. Except this, remaining two variables are insignificant. Hence, these variables (X_1 and X_2) do have insignificant explanation for the year 1966-67.

In 1980-81, as Table 5.8 shows three independent variables explain comparatively higher proportion of the total variance in spatial pattern of yield. The explained variance is 26.18 per cent of the total variance in the yield. Irrigated maize area (X_3) explains 17.65 per cent of the total variance and enters at the first step. Whereas, maize price (X_1) enters at the

Table 5.6

Step-wise Regression 1951-52

	Variable	R	R^2x100	increase in R^2 x 100	R^2	F	Regression coefficient	S.E. of Regression Coefficient	t	Intercept
Step 1	X_3	.250	6.225	-	.057	11.948*	3.719	1.079	3.457**	544.488
Step 2	X_3	.273	7.465	1.240	.064	7.228*	4.427	1.165	3.800**	418.348
	X_2						1.871	1.2082	1.549	
Step 3	X_3	.278	7.746	0.281	.062	4.982**	4.341	1.172	3.703**	456.894
	X_2						2.036	1.238	1.655	
	X_1						-1.459	1.982	-.736	

** significant at 1 per cent level of significance
* significant at 5 per cent level of significance

Table 5.7

Step-wise Regression 1966-67

	Variable	R	R^2x100	increase in R^2 x 100	R^2	F	Regression coefficient	S.E. of Regression Coefficient	t	Intercept
Step 1	X_3	.174	3.04	-	.025	5.645*	17.429	7.336	2.376*	795.600
Step 2	X_3	.207	4.28	1.24	.032	3.999	28.445	7.574	2.700**	2064.669
	X_1						-21.678	14.259	-1.520	
Step 3	X_3	.221	4.89	0.61	.033	3.052	18.763	7.731	2.427*	2725.506
	X_1						-22.734	14.287	-1.591	
	X_2						-8.058	7.588	-1.073	

** significant at 1 per cent level of significance
* significant at 5 per cent level of significance

Table 5.8

Step-wise Regression 1980-81

	Variable	R	R^2x100	increase in R^2 x 100	R^2	F	Regression coefficient	S.E. of Regression Coefficient	t	Intercept
Step 1	X_3	.420	17.65	-	.172	38.588**	8.710	1.402	6.212**	918.192
Step 2	X_3	.467	21.77	4.12	.289	24.988**	7.647	1.414	5.410**	1857.953
	X_1						-8.149	2.655	-3.070**	
Step 3	X_3	.512	26.18	4.41	.249	21.844**	4.936	1.688	3.869**	2378.389
	X_1						-8.998	2.599	-3.462**	
	X_2						-4.485	1.351	-3.261**	

** significant at 1 per cent level of significance
* significant at 5 per cent level of significance

second step and increases the R^2 x 100 value by 4.12 per cent. Seasonal rainfall enters at the third step of the regression analysis and along with irrigated area under maize and price explains 26.18 per cent of the total variance in its yield. All three regression equations and regression coefficients of three independent variable at all steps are significant at 1 per cent level of significance.

Hence, the explanatory power of all selected variables in explaining the yield of maize is low. It means that other physical and non-physical determinants of maize yield, which could not be included in the present exercise study play significant role in determination of spatial pattern of yield.

The explanatory power of the equation of regression analyses is lowest (4.89 per cent) for the time period of 1966-67 and highest (26.18 per cent) in 1980-81. Irrigated area under maize as per cent to total area under maize emerges as a significant variables in explaining the spatial variations of maize yield at all the selected periods of time.

Sum up

It is evident from the preceding discussion that the three selected independent variables, as determinants of area under maize and its yield, explain very low proportion of spatial variation in area under maize and its yield level. This brings out the fact that other physical, socio-economic and institutional factors which could not be precisely identified and included in the framework of analysis of this study, play significant role. Secondly, there has been comparatively higher proportion of variance in maize yield than area under maize in the selected time periods. Thirdly, the three determinants have lowest impact on spatial variation in both area under maize and its yield in 1966-67 and highest in 1980-81 amongst three periods of time. Fourthly, in case of maize yield, irrigated maize area emerges as the most important variable explaining variation at all three periods of time and its explanatory power is comparatively higher than the second factor entering the exercise. In case of area under maize, the explanatory power of variables and even the direction changed from time to time.

Chapter VI

CONCLUSION

The question of the spread of maize cultivation in India has always remained historically controversial. At present it is a cereal raised by poor and marginal farmers particularly in drylands. This coarse grain has not experienced much breakthrough in seed technology. Rather, it has been pushed out of the cropping pattern in irrigated land. Consequently, the production of this crop has stagnated after independence.

The present study is an attempt to examine the introduction and diffusion of maize cultivation in India in the historical past. Attempt has also been made to analyse the spatio-temporal pattern of area and yield levels of this crop during post-independence period. The objectives of the present study are - i) to understand the approximate time and place of origin or introduction of this crop on Indian territory, ii) to trace out the process and pattern of diffusion of maize in India till independence and afterwards, iii) to bring out the spatio-temporal variations in area and yield of the crop and their growth rates during post independence period and iv) to analyse the impact of some factors i.e., seasonal rainfall, irrigation and price of maize, on acreage and yield level during post independence period.

It is evident from the discussion that maize is believed to be an American plant. It is agreed upon by large number of historians and scientists that it was introduced on Indian territory by portuguese traders sometime in sixteenth century and somewhere near their colonies in Konkan or nearby area. This crop diffused very quickly and widely accepted by Indian peasants. The historical evidences indicate, that maize became an important crop in some territories (eastern Rajasthan and surrounding area) in seventeenth century. By the end of nineteenth century this crop had diffused all over India. But, most area under the crop was confined to north India (Greater Punjab, United Province and Greater Bengal). Maize was not more than a garden corp in south India. The area under the crop and its yield remained stagnant in the country during 1891-92 to 1946-47.

During post-independence period also the regional variations in proportion of area devoted to maize cultivation was noticeable. The regional variations in the crop acreage is caused due to agro-climatic, socio-economic and technological factors. It is evident from the fact that more than 60 per cent of identified maize growing districts devoted very low proportion of their GCA, to maize (below 5 per cent) at all three selected trienniums (1950-53, 1965-68 and 1979-82). The Aravali-Malwa region of Rajasthan, Gujarat and Madhya Pradesh, middle and lower Himalayan belt of Himachal Pradesh and Punjab had more than 20 per cent of their respective GCA under maize. Only very few

districts (5 per cent of the total identified maize growing districts) have contributed more than 50 per cent of the total maize acreage in the country at all three selected points of time. Majority of the districts included in the study have recorded very minor change in area under maize (growth rate varying between -1.0 to 1.0 per cent) during all three selected periods of time, viz., 1950-51 to 1966-67, 1967-68 to 1981-82 and 1951-51 to 1981-82.

During 1950-53, proportion of area under maize was comparatively higher (more than 20 per cent) in Aravali - Malwa plateau and Siwaliks in Himachal Pradesh. Most parts of central and south India had very low maize acreage (less than 5 per cent). By mid sixties maize had spread to new areas in Karnataka and Maharashtra states. The regions devoting comparatively higher proportion of gross cropped area to maize (Aravali-Malwa plateau region and middle and lower Himalayan region in Himachal Pradesh) had also expanded. Some district of Bihar and Uttar Pradesh had also come up as major maize growing areas in terms of the concentration of maize acreage. This crop also spread to irrigated tracts of north India. A moderate growth (2 per cent) in area under maize had been recorded in north west and central India during the period 1950-51 to 1966-67.

The green revolution has had an adverse effect on the maize acreage. The package technology has encouraged the cultivation of remunerative crops and marginalised the coarse

grains including maize. During the post green revolution period most of the districts in north India have experienced decline, whereas, southern and central parts of the country have recorded a marginal increase (less than 1 per cent) in area under maize. The gain in the maize acreage is comparatively high in Karnataka plateau and Maharashtra after mid sixties. However, the impressive growth of maize acreage in this region is also attributed to low base during earlier period. The overall spatial pattern of growth of area under maize after independence (1950-51 to 1981-82) is also quite close to that of post green revolution period.

Eleven, out of 182 maize growing districts of the country have been identified as core districts growing maize. Largest cluster of such districts is located in southeastern Rajasthan (5 districts) and adjoining district of Panchmahals in Gujarat. Chamba, Bilaspur and Kangra districts of Himachal Pradesh form another core of maize cultivation. Mungher in Bihar and Bulandshahr in Uttar Pradesh are other districts forming the core of maize cultivation.

As compared to area, the yield levels of maize exhibit less spatial variation. However, temporal pattern of yield has been quite dynamic over space since independence. In 1950-53, only fifteen districts had high yield levels (more than 1000 kg./ha.), which were mainly confined to the irrigated parts of northwestern India, coastal Andhra Pradesh and Tamil Nadu. A

large number of districts recording low yield level (less than 600 kg./ha.) were located in dryland areas of central, western and southern parts of the country. But during the triennium of 1965-68 a sizeable number of districts (75) recorded high yield (more than 1000 kg./ha.). These districts are mainly located in north western and eastern part of the country. A moderately high growth rate (above 2 per cent) in the yield has been registered in 58 districts during 1950-51 to 1966-67. Only 15 districts have recorded significant decline in the yield level. Most of such districts are located in Uttar Pradesh and Karnataka.

The spatial pattern of yield level had witnessed changes since mid-sixties. Most of the districts in the eastern parts of the country which had high yield level in mid sixties disappeared during 1979-82. The number of districts having yield levels more than 1000 kg. per ha., increased to 90 in 1979-82. About 50 per cent of the maize growing districts had stagnation in yield level during the post green revolution period (1967-68 to 1988-89). Only eleven districts, located in the southern states, have recorded a annual growth rate of more than 2 per cent. Contrary to the positive trends in the yield level of most of the other crops, particularly in irrigated areas, the yield levels of maize have stagnated in northern India during post green revolution period. In fact, the growth rate of maize yield, during the post independence era, has been dismal. The major reasons for this an lack of technological breakthrough in maize seed and confinement

of maize cultivation to comparatively dried and marginal land in the country.

Like other crops, the level of area under maize and its yield level is also determined by various physical and non-physical factors. To understand the impact of these determinants on the area under maize and its yield during post independence period, farm harvest price of maize, irrigated area under the crop and seasonal rainfall have been taken as explanatory variables at three points of time (195Ø-51, 1966-67 and 198Ø-81). The analysis revealed that area under maize and prices have no association during 195Ø-51 and 1966-67 and negative correlation during 198Ø-81. Prices explained comparatively very low proportion of total variation in the area under the crop. The yield and price are also negatively correlated during 198Ø-81 and have no association at other two reference periods. Hence, the importance of price in influencing the area under maize and providing incentives in raising its yield is insignificant till mid sixties and negative in 198Ø-81. Seasonal rainfall has also either negative or no correlation with area under this foodgrain and its yield. However, irrigated area under maize has inversely influenced area under the crop during 1966-67 and 198Ø-81. The correlation coefficients and proportion of total variance in area under maize explained by irrigated area under maize increased from mid sixties onwards. Thus, as a consequence of increase in irrigation facilities in irrigated tracts of the country after

introduction of package technology, in mid sixties this crop has been pushed out from the cropping pattern of such regions. The yield and irrigated area under maize, on the other hand, were positively correlated at all three reference periods. Irrigated area under maize came out comparatively more important factor causing variation in the total varation explained by all the three independent variables during 1950-51, 1966-67 and 1980-81 respectively. Hence, irrigation facilities provide incentives in raising the yield.

It is revealed that the selected explanatory variables explain very low proportion of total spatial variation in area under maize and its yield level. The explained variation is between 3 to 7 per cent in case of area under maize and 5 to 27 per cent of total variance in case of yield. The low explanatory power of the selected variables indicates that some factors, particularly climatic and physical, which play a very crucial role in determining the area and yield of maize have not been included in the framework of this study. Terrain, slope of land and rainfall variability seems to be some important factors having a very significant influence on the area and yield of maize. Among the non-physical factors influencing area and yield of this crop, relative profitability of competing crops seems to play a very important role. These aspects need further investigation and analysis.

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Appendix 1

District Codes

Code	District	Code	District
	ANDHRA PRADESH	206.	Muzaffarpur
101.	Srikakulam	207.	Darbhanga
102.	Vishakhapatnam	208.	Munger
105.	Krishana	209.	Bhagalpur
106.	Guntur	210.	Saharsa
112.	Kurnool	211.	Purnea
114.	Hyderabad	212.	Santhal Pargana
115.	Medak	213.	Palamau
116.	Nizamabad	214.	Hazari bagh
117.	Adilabad	215.	Ranchi
118.	Karimnagar	216.	Dhanbad
119.	Warangal	217.	Singhbhum
120.	Khammam		GUJARAT
121.	Nalgonda	306.	Banas Kantha
	BIHAR	307.	Sabar Kantha
201.	Patna	310.	Kheda
202	Gaya	311.	Panchmahals
203.	Sahabad	312.	Baroda
204.	Saran	313.	Bharuch
205.	Champaran	314.	Surat

Contd.....

Appendix 1 (contd.)

Code	District	Code	District
	HARYANA	6Ø5.	Bijapur
4Ø1.	Ambala	6Ø6.	Chitra durga
4Ø2.	Karnal	6Ø7.	Dharwad
4Ø3.	Jind	6Ø9.	Hassan
4Ø4.	Rohtak	61Ø.	Kolar
4Ø5.	Gurgaon	611.	Mysore
4Ø6.	Hissar	612.	Raichur
	HIMACHAL PRADESH	614.	Tumkur
5Ø1.	Chamba		MADHYA PRADESH
5Ø2.	Kangra	7Ø2.	Datia
5Ø3.	Bilaspur	7Ø3.	Shivpuri
5Ø4.	Mandi	7Ø4.	Guna
5Ø5.	Kullu	7Ø5.	Tikamgarh
5Ø6.	Shimla	7Ø6.	Chhatarpur
5Ø7.	Mahasu	7Ø7.	Panna
5Ø8.	Sirmaur	7Ø8.	Sagar
5Ø9.	Kinnaur	7Ø9.	Damoh
	KARNATAKA	712.	Shahdol
6Ø1.	Bangalore	713.	Sidhi
6Ø2.	Belgaum	714.	Mandsaur
6Ø3.	Bellary	715.	Ratlam

Contd.....

Appendix 1 (contd.)

Code	District
716.	Ujjain
717.	Shajapur
718.	Dewas
719.	Jhabua
720.	Dhar
721.	Indore
722.	West Nimar (Khargoan)
723.	East Nimar (Khandwa)
724.	Rajgarh
725.	Vidisha
726.	Sehore
727.	Raisen
728.	Betul
729.	Hoshangabad
730.	Jabalpur
732.	Mandla
733.	Chindwara
734.	Seoni
735.	Balaghat
736.	SurguJa
737.	Bilaspur
738.	Raigarh
739.	Durg
741.	Bastar

Code	District
	MAHARASHTRA
802.	Dule
805.	Pune
806.	Satara
807.	Sangli
808.	Solapur
809.	Kolhapur
810.	Aurangabad
812.	Bir
813.	Osmanabad
815.	Chandrapur
	PUNJAB
1001.	Gurdaspur
1002.	Amritsar
1003.	Firozpur
1004.	Ludhiana
1005.	Jalandhar
1006.	Kapurthala
1007.	Hoshiarpur
1008.	Rupnagar
1009.	Patiala
1010.	Sangrur
1011.	Bhatinda

Contd.....

Appendix 1 (contd.)

Code	District	Code	District
	RAJASTHAN		UTTAR PRADESH
11Ø2.	Alwar		
11Ø3.	Sawai Madhopur	13Ø1.	Dehradun
11Ø4.	Jaipur	13Ø2.	Nainital
11Ø5.	Ajmer	13Ø3.	Saharanpur
11Ø6.	Tonk	13Ø4.	Muzaffarnagar
11Ø8.	Pali	13Ø5.	Bijnor
11Ø9.	Jalore	13Ø6.	Meerut
111Ø.	Sirohi	13Ø7.	Bulandshahr
1111.	Bhilwara	13Ø8.	Moradabad
1112.	Udaipur	13Ø9.	Rampur
1113.	Chittorgarh	131Ø.	Budaun
1114.	Dungerpur	1311.	Bareilly
1115.	Banswara	1312.	Pilibhit
1116.	Bundi	1313.	Shahjahanpur
1117.	Kota	1314.	Aligarh
1118.	Jhalawar	1315.	Mathura
		1316.	Agra
	TAMIL NADU	1317.	Etah
12Ø4.	Coimbatore	1318.	Mainpuri
12Ø6.	Tiruchirapalli	1319.	Farrukhabad
12Ø7.	Thanjavur	132Ø.	Etawah

Contd.....

Appendix 1 (contd.)

Code	District	Code	District
1321.	Kanpur	1334.	Faizabad
1324.	Jhansi	1335.	Sultanpur
1325.	Kheri	1336.	Pratapgarh
1326.	Sitapur	1337.	Basti
1327.	Hardoi	1338.	Gorakhpur
1328.	Unnao	1339.	Deoria
1329.	Lucknow	134Ø.	Azamgarh
133Ø.	Rae-Bareli	1341.	Jaunpur
1331.	Baharaich	1342.	Ballia
1332.	Gonda	1343.	Ghazipur
1333.	Barabanki	1344.	Varanasi
		1345.	Mirzapur

(1798)