INTRODUCTION OF THE STUDY
1.1 INTRODUCTION

Rice (Oryza sativa) belongs to the genus oryza. There are 18 valid wild species distributed mainly in Asia, Africa and America. Among the two cultivated species – Oryza sativa and Oryza glabarrima, the former is cosmopolitan and the latter is confined to Africa. The carbonised grains obtained in India could be dated back to around 2300 B.C. Sample from Lathal (extension of the Harappan civilization) excavation in India reveals the use of paddy husks in potteries, bricks etc. Asian rice (Oryza sativa) evolved from the ancestral wild progenitor over a broad region stretching from the Gangetic plains below the Himalayan foothills across northeast India.

It is generally felt that the domestication of rice had occurred independently in different parts of the world, and India is one of the oldest regions where domestication of the crop began. There is a mention of ‘nivara’, a wild from the rice, in Vedic literature. ‘Atharva Veda’ mentions ‘vrithi’ probably meaning wild rice. The extension of rice cultivation, extensive contracts between the people and selection process both natural and artificial had led to the differentiation of variety. Two major varieties of the crop namely Indica and Japonica are recognised.
All the rice varieties of India belong to the former group, although these resemble Japonica (Kainth and Mehra, 1985).

1.2 CONDITIONS OF RICE GROWTH

Rice is the dominant crop and is mainly grown in rain-fed areas where annual rainfall is more than 125 cm., and the fields remain waterlogged during the summer monsoon rainy season. It is also raised with the help of irrigation in areas where annual rainfall is less than 125 cm. It means that the rice crop requires high temperature and high humidity, with abundance of water during its life period.

The crop is grown on a variety of soils such as silts, loams and gravels, and it can tolerate acidic as well as alkaline soils. Clayey loam is, however, extremely suitable for the cultivation of this crop. This soil can be easily puddied in the mud in which rice seedlings can be transplanted. It thrives when the soil remains wet and is under water during the growing period. Such soil requirements make it predominantly a crop of river valleys, flood plains, deltas and coastal plains. High level loams and lighter soils can be used for quick maturing varieties of rice. Black lava soil is also useful for rice cultivation.

Rice fields should, therefore, be level and have low mud walls for retaining water. In the low land area excess rainwater is allowed to
inundate the rice fields and flow slowly. Rice raised in the well-watered low land areas is known as 'low land' or 'wet rice'. In the hilly area, slopes are cut into terraces for the cultivation of rice. Here water cannot be supplied to the rice fields to the extent it can be done in the low-lying areas. The rice grown in the hilly areas is, therefore called 'dry' or 'upland rice'.

Rice is successfully raised only in those areas where average monthly temperature does not fall below 21°C. A temperature range of 21°C to 37°C is required for its optimum growth. The crop requires a higher temperature at tilling than that during early growth. The temperature requirement for blossing ranges between 26.5°C and 29.5°C. At the harvesting time, when it ripens, the temperature suitable vary from 37°C to 38°C. The humidity needs vary according to variety. For early types, the favourable range of humidity is 83 to 85 per cent and for late one, it is 67 to 68 per cent. Higher temperature and high light intensity adversely affect grains filling. Among the environmental factors affecting rice cultivation, water supply is the most important one. The rice crop requires large quantities of water. The field must be flooded under 10-12 cm. deep water at the time of sowing and during early stages of growth. Therefore, the fields must be level and have low mud walls to retain
water. This peculiar requirement of rice makes it primarily the crop of plain areas.

Besides this combination, the monsoon lands are densely populated areas with abundant supply of cheap labour. Further, it must be realised that rice cultivation is not suited to mechanical cultivation. It needs plenty of hand labour. To sum up it can be said that rice needs plenty of heat, plenty of rain, plenty of alluvium and plenty of labourers to provide plenty of food for plenty of people.

1.3 RICE CULTIVATION IN INDIA

Rice is the most important food crop in India. Nearly half of the people in the country subsist on it. India is the second largest producer of rice in the world. Area and production of rice in the country were 44361.1 thousand hectares and 84871.2 thousand tonnes respectively in 2000-01 (C.M.I.E., Dec. 2002). This is the staple food of the people living in the eastern and the southern parts of country, particularly in the areas having over 150 cm. of annual rainfall. There are about 4,000 varieties of rice grown in India. Rice covers about one-fourth of the total cropped area and provides food to about half of the Indian population.
Rice though principally a tropical crop. It is cultivated both in the tropical and sub-tropical zones of the world extending from 40°N to 45°S latitude. However, most of the rice cultivation occurs between 70°E to 140°E longitudes. Rice is predominantly a monsoon crop where alone it finds the most ideal conditions for its growth.

In India, rice cultivation extends from 8°N to 34°N latitude, and the crop is grown under widely varying conditions of rainfall, altitude and climate. There are rice grown at sea level in the river deltas, in areas even below sea level with protective embankments as in some parts of Kerala, in 5 to 6 inches of water as the deep water rice in the states of Assam and Bengal, and at altitudes of 915 to 1524 metres and even more as in Kashmir and the slopes of the Himalayas (Kamlesh Paliwal, 2000: 166).

In the areas having a favourable temperature regime, paddy production is restricted by the availability of rainfall. Rice is a leading crop in India where rain is over 150 cm. a year. By and large, the rice cropland occupancy dominates the agricultural landscape where annual rainfall is at least between 125 cm. and 200 cm. Remarkably, rice cultivation is also found in arid, semiarid, and dry sub-humid continental monsoon warm-summer climate in India. The 100-cm isohyets forms the limit of rice in rain-fed areas. In areas receiving less than 100-cm. annual
rainfall, rice can be grown with the help of irrigation as done in Punjab, Haryana and Western Uttar Pradesh. About 40 per cent of rice crop in India is raised under irrigation (Khullar, 2002: 352). The crop needs a good supply of water, which is often supplied artificially with intensive irrigation system, regardless of climatic conditions. The rice bowl of Punjab and Haryana plain is one such example where the crop occupies between 17 to 32 per cent of the total cropped area.

In the north-eastern region, comprising Assam, Bengal, Orissa and South Bihar, where rainfall is high, rice is a dominant crop occupying more than 80 per cent of the cultivated area. Going further south through the plateau region of the peninsula, rainfall decreases and rice crop is grown to the extent of 30 to 40 per cent of the cultivated area, being concentrated in the coastal areas of Andhra Pradesh, Tamil Nadu and Kerala. In the northern and central India, rice is grown wherever rainfall conditions are favourable.

On the whole, in India, the geographic distribution of the rice crop is limited by its heavy demands of water. Lowland rice must have much water, both in and upon the soil during the entire period of its growth.
In India, the area devoted to rice is considerably larger than any other food-grain crops individually and, of this, a substantial proportion represents multiple double cropping of rice in paddies.

There are three rice harvests in the coastal regions of Orissa, West Bengal and Andhra Pradesh. The coastal plains and Cauvery delta of Tamil Nadu have an in-blowing monsoon that brings substantial rain between September and April, when the Indian monsoon lands are generally experiencing dry conditions. Therefore, Tamil Nadu has its main rice harvest in April instead of October/November, which are the principal harvest months in the rest of continental area of India (Singh, 1996).

Rice cropland occupancy constitutes the largest proportion, indeed nearly 25 per cent of the total cropped area, and everywhere on irrigable deltas, flood plains, coastal plains and artificially built terraces, low land rice is the main crop. In many drier, hilly parts of India upland rice is grown, though its yield per hectare is less than 50 per cent of lowland rice.

1.3.1 Area under rice cultivation:

Rice is the main crop in coastal and eastern parts of the country during summer monsoon rainy season where both high temperature and
heavy rainfall present ideal conditions for rice cultivation. In the interior of the country, the Chattisgarh plain and the Wanganga valley are also important producers of rice. Interior Maharashtra state and the Indian plateau, north of the Narmada valley, where rainfall is less than 100 cm. a year and irrigation facilities are generally absent, have less than 10 per cent of their cultivated area under rice cultivation. In the alluvial plain of West Bengal, the Mahanadi delta and the eastern part of the Assam valley, where soils are fertile and rainfall is sufficient, more than 80 per cent of the land is devoted to rice crop. In the Cauvery delta also more than 80 per cent of the land is under this crop. This high percentage of rice land in the Cauveri delta is maintained largely by the application of irrigation, which is easily available there.

In 1950-51, rice was grown on 30.8 million hectares, which amounted to 31.6 per cent of total area under foodgrains. In 2000-2001 it was grown on 44.4 million hectares, which amounted to 35 per cent of total area under foodgrains. This shows that area devoted to rice has increased in the country over the past few decades. In fact, area under rice in absolute terms has increased in almost all the states in recent years.

In India during the last two to three decades rice cultivation has rapidly spread in the non-traditional areas in the north, mainly in the
plains of Punjab and Haryana, and it is here that one comes across one of the highest yield levels. The spread of rice cropping in these areas, which are otherwise semi dry, has been facilitated by expansion of irrigation facilities, especially during the post green revolution period.

Punjab-Haryana plain is a traditionally wheat producing region but the enterprising farmers of the plain have made full use of package technology including perennial irrigation by canals and tube wells, HYV seeds and fertilizers. This has resulted in widespread change in the cropping pattern of Punjab-Haryana plain and the plain has become a very important producer of rice. This region now gives a very high yield of 2955 kg/hectare. Over a short period during the last three to four decades the spread of rice cultivation has enabled this plain to occupy an important place among the rice producing regions of India.

1.4 MAJOR STATES IN RICE CULTIVATION - RECENT SHIFT:

In India, the eastern, north-eastern and southern states are the traditional rice growing states. For a long period these states had a major share in area under rice cultivation. These states are West Bengal, Assam, Bihar, Orissa, Andhra Pradesh, Tamil Nadu and Kerala. As shall be seen in the forthcoming paragraphs, all these traditional rice growing states have witnessed a decline in the proportion area devoted to the crop.
West Bengal, a major state in rice cultivation had 71 per cent area under rice cultivation to total cropped area in 1962-65. During the next two decades area under rice remained in the neighbourhood 72 per cent, but data for the years 1990-93 and 1998-01 show a definite decline in it. In the early 1990s the area under rice was 67 per cent of the total cropped area which further declined to 62 per cent by the period 1998-01 (Appendix 1.1). Thus the percentage area under rice during the last two decades has witnessed a decreasing trend in West Bengal.

Another major state in rice cultivation is Assam. The state had reported 73 per cent of its total cultivated area under rice in 1962-65. Thereafter, there has been a gradual decline in area under rice expressed as percentage to total cropped area. For instance, during the years 1970-73 and 1980-83 the percentage area under rice was 72 per cent and 69 per cent respectively. In the years 1990-93 and 1998-01 the rice occupied nearly 66 per cent to total cropped area. Therefore, from 1962-65 to 1998-01 the percentage area under rice to total cropped area has declined in this major rice cultivating state.

Bihar is also a major state in rice cultivation. However, unlike West Bengal and Assam, proportion area under rice in this state remained almost unchanged at least up to the early 1990s. In 1962-65, 49 per cent
of the total cultivated area in the state was devoted to rice. In the early 1970s and early 1980s the area was 48 per cent and 50 per cent respectively. In 1990-93 the area under rice to total cropped area increased marginally to 51 per cent, but by the end of 1990s the area under rice cultivation recorded a sharp decline and reached on all time low of 36 per cent to total cropped area. It can thus be seen that the proportion area under rice that remained almost unchanged up to early 1990s recorded a sharp decline thereafter.

Andhra Pradesh is another important state in rice cultivation. In this state no major change in area under rice cultivation is noticed over a period of roughly forty years. The state has in fact witnessed a marginal increase in percentage area under rice from 28 per cent in 1962-65 to 31 per cent in 1998-01.

Orissa has reported a substantial decline in the strength of area under rice cultivation over the period. The share of area under rice crop in total cropped area has declined by 28 percentage points between 1962-65 and 1990-93. In the year 1962-65, 74 per cent of the total cultivated area was under rice crop, which declined to 46 per cent in 1990-93. But in 1998-01, with a significant improvement, rice occupied nearly 53 per cent of total cropped area in the state. Thus, although 1990’s recorded an
increase in the proportion area under rice in the state, the crop has witnessed a definite decline in its dominance in the post-green revolution period.

Kerala is also an important state in rice cultivation. This state had reported 37 per cent area under rice cultivation in 1962-65. Thereafter, there has been a gradual decline in percentage area under rice in the state. During the years 1970-73 and 1980-83, the area under rice as percentage to total cropped area amounted to 33 per cent and 31 per cent respectively. In the years 1990-93 and 1998-01 the rice occupied only 19 per cent and 12 per cent of total cropped area respectively in this state. Therefore, from 1962-65 to 1998-01 area under rice to total cropped area has declined in this major rice cultivating state.

Other states, which also reported decline in the share of area under rice during this period, are Tamil Nadu, Jammu & Kashmir and Himachal Pradesh. In Tamil Nadu the share of rice acreage is found to have declined from 38 per cent in 1962-65 to 33 per cent in 1998-01. The corresponding figures for Jammu & Kashmir were 28 per cent and 24 per cent respectively. Similarly, Himachal Pradesh reported a decline from 12 per cent in 1962-65 to 8 per cent in 1998-01.
Therefore, it is obvious that most of the traditional rice growing states have experienced decline in the strength of area under rice cropping vis-à-vis other crops. But during the same period, area under rice cultivation in non-traditional states like Haryana and Punjab is reported to have increased sharply.

Haryana a non-traditional state in rice cultivation had only 4 per cent area under rice cultivation to total cropped area in 1962-65. In the year 1970-73 this share went up to 6 per cent. The subsequent decades witnessed further rise in the area under rice cultivation. Thus, in the early years of 1980s and 1990s the area under rice was 10 per cent and 11 per cent respectively. Data for the years 1998-01 show still another increase in it. During this period area under rice was 17 per cent to total cropped area in the state.

Another non-traditional state with regard to rice cultivation is Punjab. This state has also witnessed a sharp increase in proportion area devoted to rice crop. In 1962-65, the state had reported only 6 per cent of its cultivated area under rice cultivation. In the year 1970-73 the area under rice increased to 9 per cent. Thereafter, there has been a sharp increase in area under rice in the state expressed as percentage to total cropped area. For instance during the years 1980-83 and 1990-93 rice was
grown on 21 per cent and 27 per cent of the total cropped area respectively. In the year 1998-01 the rice occupied 32 per cent to total cropped area. Therefore, from 1962-65 to 1998-01, the percentage area under rice to total cropped area has increased sharply in this non-traditional rice growing state.

As a result of this spatio-temporal change in the relative strength of area under rice cultivation during the post-green revolution period, the relative share of different states in the total area under rice in the country has under a marked change. While, on the one land in the traditionally rice growing states, the share has undergone a monotonous decline, on the other, the non-traditional states have witnessed an almost uninterrupted increase.

From 1970-71 to 2000-01 the share of traditional states like Bihar, Orissa, West Bengal, Tamil Nadu and Kerala in the total area under rice in the country has decreased. In 1970-71 the data reveal that Bihar accounted for 14 per cent of the total area under rice in India. This is found to have declined to 11.6 per cent in 2000-01 (Appendix 1.2). Orissa has recorded a decline from 12 per cent in 1970-71 to 10 per cent in 2000-01. Similarly West Bengal, Tamil Nadu and Kerala have also experienced decline during the period 1970-71 to 2000-01. During the
period, the share of these three states viz. West Bengal, Tamil Nadu, and Kerala, in the total area under rice cultivation in the country has decreased from 13.2 per cent to 12.3 per cent in case of West Bengal, 7.2 per cent to 4.8 per cent in case of Tamil Nadu and 2.3 per cent to 0.8 per cent is case of Kerala.

Some other traditional states like Assam and Andhra Pradesh, however, have experienced a marginal increase in the share. For instance, between 1970-71 and 2000-01, the share of these two states in the total area under rice cultivation in the country has increased from 5.2 per cent to 6 per cent in case of Assam and 9.4 per cent to 9.6 per cent in case of Andhra Pradesh.

On the whole, these traditional rice-growing states accounted for 63.3 per cent of area under rice cultivation in the country in 1970-71 which came down to 55.1 per cent in 2000-01.

Remarkably, during the same period the share of non-traditional state like Punjab, Haryana and Uttar Pradesh is found to have increased sharply. For instance, Punjab accounted for barely 1 per cent of the area devoted to rice in the country in 1970-71. But within a period of 30 years this share is found to have increased to 6 per cent in 2000-01.
during the same period Haryana reported an increase in the share from 0.7 per cent to 2.4 per cent.

In Uttar Pradesh the area under rice increased from 12.1 per cent to 13.9 per cent between 1970-71 to 2000-01.

These three states viz. Punjab, Haryana and Uttar Pradesh taken together accounted for 22.3 per cent of the total area under rice cultivation in the country in 2000-01 as against only 13.8 per cent in 1970-71. The total rice cropped area in these states has grown at the rate of 88 per cent during this period.

1.5 CAUSES AND CONSEQUENCES OF SHIFT IN RICE CULTIVATION

The basic cause underlying this shift in rice cultivation in favour of northern region is a well-developed irrigation network. The irrigation facilities have reached in large areas of western Uttar Pradesh, Punjab and Haryana during last few decades. With the help of a significant development in irrigation facilities, these states have emerged as important rice growing states in India.

In Punjab and Haryana plain, intensive and cheap availability of irrigation facilities and presence of clayey soil have given a fillip to rice cultivation, making these states the rice bowls in the north-western part of India where the climate is otherwise dry, and paddy may be treated as a
non-traditional alien crop to the new environment. These may be taken as areas of moderate rice concentration showing a definite transition from the millet oriented agriculture dependent on inadequate and unreliable rain to a more devoted rice region than that of Orissa, West Bengal and Assam where soils are rich and the rainfall is heavy and more reliable.

The improved strains and methods of rice cultivation in reclaimed low lying water logged area are responsible for Haryana’s emergence as an important paddy region in north-western India. Further in some of districts in Punjab yield levels are very high due to fertile clay-pans in the flood plains, intensive care of the small rice area, assured and timely tubewell irrigation and enterprising farmers.

This spread of rice cropping in India has led to a remarkable increase in its production. At the same time it has caused some serious environmental consequences. In area where rice cropping is mainly dependent upon tubewell irrigation, an intensive use of underground water has caused depletion of water table. As against this, areas where rice cropping thrives mainly on canal irrigation and where under ground water is saline and, thus, not fit for irrigation, rice cultivation has resulted in the growing menace of water logging and salinization.
1.6 LITERATURE REVIEW

There are various approaches in any study in agricultural geography. They are the commodity approach, regional approach, environmental approach and systematic approach (Singh 1984: 22). The present study is based on commodity approach. In this approach a researcher focuses attention on the detailed spatial analysis of a particular commodity. A review of studies conducted in the field of geography in India reveals that commodity approach is not very popular, as the literature available on this subject is very scanty.

Tripathy (1996) has examined the performance of area, production and yield of rice in Orissa during the period 1970-71 to 1989-90. The study indicated that the output of rice during this period (post-green revolution period) grew at an annual rate of 1.43 per cent. This was contributed solely by per hectare yield.

Area under rice experienced a declaration due to diversion of area to pulses and oilseeds. High yield variety seeds, fertilizer and irrigation facilities led to higher yield of rice. During the seventies in most of the districts of Orissa regional disparities existed in the growth rates of area, production and yield and during eighties rice showed improvement in per hectare yield.
Kalita and Baruah (1992) attempted to explore the annual growth rate in acreage, production and productivity of rice along with the fluctuation on the basis of decades as well as over all time period in Assam. Time series data of different types of rice (summer, autumn and winter) has been taken from 1951-52 to 1988-89. The three types of rice occupied 1.51 per cent, 18.83 per cent and 53.36 per cent respectively of the total gross cropped area in the state. In the case of summer rice only sizeable growth rate in area and production has been estimated. In the case of autumn and winter rice crop the growth rate in area and production were in between 1 and 2 per cent, and to the case of productivity, however, the growth rate for autumn rice was negative and for winter and summer rice was negligible. Under summer rice the scope of increasing area existed to a considerable extent and under autumn rice to a limited extent, the technology and the uncontrollable factors of production has been inhibiting the growth process of the crop in the state. Hence, development of irrigation network with proper planning and technology were the prime needs for increasing rice productivity in the state.

It is important to note that apart from geographers, several agricultural economists have contributed to the literature on the spatial di-
mension of a particular crop or commodity. Any review on literature, therefore, must take them into account.

De (1999) has examined the nature and extent of inter-district variations in the growth in the yield of rice in West Bengal during 1970-71 to 1994-95. He has also examined the causes underlying these variations. The study reveals that yield of rice in West Bengal has increased manifold during the period under study. This was mainly due to the development in irrigation network and increasing use of fertilizers. District wise pattern of yield growth not only varied but was divergent. Initially many districts were highly dependent on rainfall and so growth in yield was uncertain. Moreover, the districts having a quite easy access to irrigation sources have experienced fairly high rates of growth in yield. It was possible for them to utilise HYV seeds and fertilizers more intensively. In the erstwhile developed districts a slight deceleration in the growth rate was observed after mid eighties because of depletion of ground water sources of irrigation. Another breakthrough in technologies is required for further expansion of irrigation in these districts. Though the erstwhile backward districts experienced higher growth rate in the later year, still there exists inter-district disparity in the level and rate of growth.
Singh and Kalra (2002) have examined the various issues related to the huge expansion of rice cultivation in Punjab since the 1970s, and its environmental and ecological implications, such as falling yields and water tables and stagnant production. The study reveals that rice in Punjab, starting with an insignificant area under cultivation, has assumed significance beyond proportions. It has added tremendously to food security. At the same time it has been associated with serious problems of sustainability due to overexploitation of natural resources, particularly ground water, creating ecological and environmental problems. According to them, yield of rice has stagnated, at the level of 3510 kg per hectare achieved in 1989-90. In some areas yield has shown a declining trend also. Area under rice has increased to more than 60 per cent of net area sown in this state with four districts (out of twelve) having more than three-fourth area under rice.

Deosthali and Nikam (2004) have examined the disparities in area and yield in the three main rice-growing regions in Maharashtra, namely, the coastal, the upland and the inland areas. In this study the authors have examined the growth trends of rice cultivated in kharif season by fitting a semi-log trend equation to the area and yield series of 86 talukas for the period 1967-68 to 1993-94. The analysis reveals that production and area
of rice in Maharashtra have increased by about 48 per cent and 12 per cent respectively; indicating increase in production, mainly yield-led, due to the development and spread of H.Y.V. led technology.

In the coastal region, expansion and yield growth in north Konkan is in the low rainfall – moisture retentive black soils, and in south Konkan in the high rainfall – laterite soils. However, in the entire coastal region high vertical growth is seen with low concentration of area under rice in the total cropped area.

The upland region, where rice areas correspond to deep black soils of river valleys in the high rainfall zone reported a growth trend that is area led as well as yield-led. And in the inland region, spread in area and rise in yields are observed in the deep black-low rainfall agro-environment of Wardha-Wainganga and Pranhita valleys.

Sharma and Joshi (1995) have examined the performance of rice cultivation and factors affecting it in the coastal regions of India. According to them most of the areas in the coastal regions of India is mono-cropped and rice is the main crop during the kharif season. In areas where irrigation facility is available, a second crop of rice is also taken during the rabi season whereas in non-traditional states like Punjab and Haryana rice is grown during kharif season only. The study suggests that
during the period 1970-71 to 1988-89, the growth rate of yield exceeded 3 per cent in only 26 per cent of the districts during *kharif* and about 18 per cent during *rabi* season. The growth rate of area under rice is negative in a majority of the districts during *kharif* season. Consequently, the production performance of rice in the *kharif* season in the coastal districts is not very impressive except in coastal Andhra Pradesh. On the other hand, in non-traditional rice growing regions all the districts are reported to have witnessed an increase in area, production and yield of rice. This was largely due to a relatively higher profitability and low yield uncertainly as compared to other competing crops, expansion of irrigation facilities, high yielding varieties of seeds and price incentives.

The results of this study indicate that in the Coastal region, a rapid increase in rice yield is needed as there is no scope for bringing more area under rice due to the problem of coastal salinity, lack of irrigation facilities and poor coverage of HYVs in some coastal areas.

Bezbaruah (1998) has examined the trend in the production of rice in different seasons in Assam using the district level data for the period 1974-75 to 1994-95. He suggested that the rate of growth in both production and area under rice are modest in comparison to some neighbouring states. It is also revealed that the state has experienced a
shift towards summer and winter rice, which are less prone to flood damage. This has been possible due to expansion of irrigation particularly lift irrigation during the 1980s.

Dey (1977) in his study has examined statistically with a trend analysis of rice in West Bengal and Andhra Pradesh and wheat in Punjab (including Haryana) and Uttar Pradesh. The study suggests that for wheat in Punjab and Uttar Pradesh, there has been a break in the trends of growth of production and per-hectare yield around 1966-67, but no such break can be located in the case of rice in West Bengal and Andhra Pradesh. As a matter of fact, the rate of growth of rice production in Andhra Pradesh seems to have been diminishing systematically.

According to Naidu, Swami and Rao (1994) data analysis from 1980-81 to 1989-90 indicated high productivity of rice per unit of area in Srikakulam district of Andhra Pradesh and increase in area under groundnut in all the three districts of study area viz. Srikakulam, Vizianagaram and Visakhapatnam. It is also concluded that ragi and bajra based cropped system is slowly fading away and in its place the more remunerative commercial crops like groundnut and sugarcane are cropping in. Though the sesamum and mesta are other important crops for better production and productivity.
Goswami and Bora (1974) presented a comparative account of Jute and autumn paddy cultivation in the Nowgong district of Assam where the diversification of crop is the highest in the district and intensity is also very high compared to the other districts of the state. Paddy, both winter and autumn, occupies about 66 per cent of the total cropped area of the district followed by jute, rape and mustered. Amongst the crops grown in the district of Nowgong, Jute and autumn paddy are two predominant crops. These two crops have occupied more than one fourth of the total cropped area of the district during 1970-71. The other important crops are winter paddy, rapeseed and mustered, pulses etc.

Researchers have also devoted their attention to the study of other crops in different regions of India. Bhatnagar and Nandal (1994) have examined the growth in area, production and yield of wheat in Haryana for a period of 25 years during 1966-67 to 1990-91. The study reveals that during this period growth rate of wheat are found highly significant. Interaction between area and yield has played a significant role in increasing the production of wheat. Further, the production has increased to a larger extent by adoption of H.Y.V. of wheat, good irrigation network, good fertilizer consumption, adoption of modern mechanization and good crop price. Thus wheat being a relatively much less risky crop
as compared to other rabi crops provided impetus to the formers to increase the area under wheat.

Bandyopadhyay (1989) has examined the growth pattern and instability in the production of the main cereal crop in West Bengal and Punjab-Haryana plain during the post-green revolution period as compared with the experience of the pre-green revolution period. The study is based on district level data and pertains to the periods 1950-51 to 1966-67 and 1967-68 to 1984-85. The study reveals that there had been an outward shift of the production frontier during the post green revolution period. But this parametric shift in the production frontier was not accompanied by an increase in the rate of growth of production. In most of the districts and, thus in Punjab-Haryana as a whole, the average linear growth rate of the production of wheat did not rise in the post green revolution period compared with the pre-green revolution period, which means there was no significant rotational shift of the trend line. However, there were definite signs of diminishing year to year fluctuations in the production of wheat in Punjab-Haryana plain particularly for the districts of Punjab.

In contrast, in West Bengal there was a fall in the rate of growth of production of rice in a number of districts, particularly in the three
northern districts of the state. Except for three of four districts, the remaining district of West Bengal, however, registered only marginal increase in the rate of growth of production during the post green revolution period compared to the pre-green revolution period. What was much more disturbing was the widening year to year fluctuations in the production of rice in the districts of West Bengal during the post green revolution period.

Haridoss (2003) in his study, has analysed the inter-district variations in foodgrains production in Tamil Nadu. The study revolves round the following objectives: (a) to measure the growth rate of development indicators of foodgrains production in different districts; (b) to analyse the performance variation in foodgrains production of different districts; (c) to identity the model district; (d) to identify the inter regional variations by assigned ranks to the districts on the bases of absolute values of the development indicators, and (e) to analyse the inter-districts variations based on computed potential and actual realization targets.

The study reveals that in foodgrains production Pudukkotai alone had reached more than potential target apart from Thanjavur district. In the case of area under foodgrains, the districts of Cuddalore, Villupuram, Thiruvannamalai, Salem and Dharmapuri have actually
realised more than the computed targets. It is also evident that no district has achieved potential target in the utilization of fertilizer except the districts of Erode, Coimbatore, Villuppuram, Thanjavur, Tirunelveli and Tiruchirapalli. Cropping intensity was found to have exceeded the target values in the districts of Dharampuri, Salem and Thiruvarur. Regarding the foodgrains productivity the districts which have exceeded the targets are Nagapattanam, Madurai and Thiruvarur.

Therefore, in the foodgrains production in the state, Thanjavur is a model district. District Kanya Kumari was lagging behind in the pattern and measure of development of foodgrains production in Tamil Nadu.

Jeemol Unni (1983) in his study has examined the shifts in cropping pattern in Kerala over 1960-61 to 1978-79. It appears that garden land (particularly coconut) have been gaining at the expenses of wet-land crops (particularly paddy). There are two commonly observed ways in which paddy lands are converted into coconut gardens. Coconut saplings are planted on the bounds of the paddy fields. This also helps to strengthen the bonds. In the second method, the land is raised in mounds within the paddy fields, at regular intervals from each other, and coconut saplings are planted on them. On the topographical features of Kerala and its impact on the cropping pattern, it was observed that rice was grown under varied topographical conditions.
Tomar, Singh and Kharinta (1992) in their study have analysed the impact of green revolution (since its stabilisation in early seventies in Haryana) on growth in area, production and productivity and variability and risk in area, production and productivity of important crops in two sub-divisions of the state. The study is based on two time series data for the period 1973-74 to 1988-89. Kurukshetra and Mahendargarh districts were purposively selected from irrigated and semi-irrigated regions as these districts were having maximum and minimum percentage of their total area under irrigation. The authors concluded that during the green revolution period a major shift in the area under principal crops has taken place particularly in the irrigated region of Haryana. In irrigated region among kharif season crops, rice was replacing millets in spite of substantial improvement in their productivity. It was due to higher risk in millets and the rice was comparatively a stable crop.

In semi-irrigated region of the state, the situation with respect to barley and gram crops was almost the same as that of the irrigated region as these crops were being replaced by wheat, rapeseed and mustard. However, in semi-irrigated region there was almost a stagnation in jowar and bajra crops which were the only major crops of the kharif season of that region.
Thus, the study suggests that in the irrigated region, the growth in area of few crops like wheat, rice and rapeseed and mustard was leading the agriculture to specialisation and therefore, the benefits of diversification were disappearing. Whereas in the semi-irrigated region, the growth in area under wheat crop limits the use of irrigation water to other crops as it is grown under assured irrigated conditions and consumed most of the available irrigation water of the region.

Srivastava, Sen and Reddy (2003) have analysed the growth in area, production and productivity of pulses in eastern Uttar Pradesh. Compound growth rates were estimated by fitting the exponential function to the district wise data pertaining to the period 1975-76 to 1999-2000. It was found that the production of arhar has declined at a compound rate of 0.3 per cent per annum in the study area. This was mainly due to decline in productivity level. Decline in gram production was also found to be of the order of 6.56 per cent per annum, which, however, was due to the decline in the area. The productivity level in this case appears to have remained unchanged. The production of total pulses has also recorded a negative growth at the rate of 0.84 per cent per year as a result of decline in the area of pulses in eastern Uttar Pradesh. No important trend in the productivity of pulses was observed during the
study period. The study highlights the need of bringing more area under pulses as well as improvement in the productivity in order to make the country self sufficient in pulse production.

Barmon (1997) has examined the production behaviour of pulses in Assam during the period 1967-68 to 1989-90. The area, production and productivity of almost all the pulses in Assam have increased during the study period. For example area and production of gram have increased by 76 and 122 per cent. Similarly, the acreage under other pulses and total pulses has increased by the extent of 24000 and 28200 hectares respectively. But during the same period the yield rate of pulses continued to be low in the state as compared to all India level.

Badhwar (2001) has examined the spatio-temporal trend in area, production and yield levels of pulses in Haryana. The study has been carried out with reference of three trienniums, i.e. 1966-69, 1980-83, and 1994-97. The triennium averages were used to minimise the fluctuations in area, production and yield of pulses induced by variable monsoon characteristics. The study reveals that proportion area under pulses in the state has undergone a drastic decline during the post green revolution period.
Further, the study shows that during 1966-69, there was not a wide gap in acreage of pulses in the eastern and western parts of Haryana. However, this gap increased by early eighties and nineties. During the nineties the cultivation of pulses in the state was concentrated mainly in the western parts. The production of pulses is characterised by fluctuations and over all declines since the initiation of green revolution. During the period studied (1966-69 to 1994-97) production of pulses had increased at a very slow rate, i.e. 1.97 per cent per annum in Haryana.

In the year, 1966-69 the yield of pulses was 764 kg/ per hectare, but it decreased to 474 kg/ per hectare in 1980-83. However, in 1994-97, it jumped to 978 kg / per hectare. During 1966-69 eastern districts of the state had high yield level of pulses. In the year 1980-83 the yield level declined in almost all the districts of the state. But in 1994-97, the yield increased sharply in the state. In this year, district Sonipat recorded the highest yield of pulses to the state.

Gupta and Saraswat (1997) studied the growth rate in area, production and productivity of rapeseed and mustard for a period of 21 years during 1972-73 to 1992-93. According to them growth rate was positive and highly significant in all the four zones of western Rajasthan and in whole of Rajasthan. The growth rate of production was
considerably higher than in comparison to growth rates for area and yield. Area played a significant role in increasing the production of these crops. The production and yield of rapeseed and mustard has increased to a higher extent by adoption of fertilizers, H.Y.Vs, good irrigation network, pesticides, the support price offer by the concerned agencies and adoption of agro-technologies in addition.

Tripathy and Srinivasa (1993) in their study analysed the cultivation of groundnut in Orissa in terms of growth in area, yield and production over a period of twenty years from 1970-71 to 1989-90. They attributed a significant increase in groundnut production in the state to a remarkable expansion in its area. According to the study, all the districts except Koraput recorded a significant increase in area and output of groundnut.

Ashraf (1994) in his study tried to trace the history of Maize cultivation in India. On the basis of evidences collected from varied sources, he suggested that maize is very much an indigenous crop to India and not an exogenous crop introduced in India by the Europeans as is generally emphasized. Maize is a prominent coarse grain, which uses relatively less inputs, provides staple food for poor and has high industrial value.
Kumar and Qureshi (1996) have examined the spatio-temporal dynamics of area under maize in India during the post independence period. They have found that the crop occupies a very insignificant place in terms of its share in, gross cropped area in a majority of districts. In the pre-green revolution period the maize growing districts in the irrigated tracts in north-western part experienced growth in area under the crop. The growing importance of more remunerative crops in the post green revolution period, however, resulted in the shrink in area under maize in this region. Nevertheless, the drought prone areas of Central and South India experienced growth in acreage.

Sandhu’s Work (1977) on the geography of sugarcane cultivation in eastern Haryana can be considered as a pioneering work using commodity approach in research in agricultural geography. Sandhu examined the social and natural conditions of area under sugar cane production. This research was undertaken with a view to locating more areas that could be brought under sugarcane cultivation in the state.

Researchers have also devoted their attention to the study in degradation of land and water resources in different regions of India. Gummagalmath, Basavaraj and Patil (2003) have observed that proportion of degraded land is alarming (44.40 per cent) in Thunga
Bhadra Project area in Karnataka. The various land degradation processes like soils salinity and water logging are largely responsible for the land degradation processes in the study area. Faulty irrigation, lack of proper irrigation and cultivation of 'irrigation-intensive' crops (rice in both the seasons) have resulted in land degradation. There seems to be some sort of inevitability about salinity and water logging problem due to development of large-scale irrigation projects and it is also true with the TBP command area.

The study reveals that paddy, cotton, bajra, maize and sunflower were the major crops grown under normal and moderately saline affected soils. The share of paddy in total cropped area, was 53.87 per cent on water logged soils, 45.37 per cent on moderately saline soils, 41.28 per cent on normal soils and 30.06 per cent on severally saline soils. Paddy was the only crop grown on severally saline affected soils.

Paddy occupied the largest area in the total cropped area in all kinds of soils in view of its high tolerance to salts and water logging conditions. Above all the continued cultivation of paddy in both seasons has led to the occurrence of salinity and water logging.

Sidhu and Dhillon (1997) have examined the degradation of land and water resources in Punjab and technologies for sustainable use. The
study reveals that intensive agriculture for increasing agricultural productivity and production in this state has led to growing degradation of land and water resources over time. The underground water table is going down every year due to the over exploitation. In the areas where ground water is brackish, the water table is rising due to inadequate drainage facilities. Agricultural productivity in the sub-mountain region is low due to soil erosion and lack of assured irrigation. Therefore, agriculture of Punjab has reached a stage where conservation and efficient utilization of its land and water resources has become absolutely necessary. Appropriate technologies in crop production sector need to be adopted, which will not only prevent any further degradation of land and water resources but will also help in revitalising them for their long-term sustainable use. These strategies must be economically efficient.

From the above review of literature, it can be seen that although several studies have been conducted by scholars on rice cultivation in different areas of the country, no attention has been paid to the spread of rice cultivation in the non-traditional rice growing areas particularly in the north and north-western states of the country. The introduction and subsequent spread of an alien crop in an area which otherwise is not favourable or suitable brings about a noticeable change in the economic
prosperity and ecological conditions. In the present study, therefore an attempt has been made to examine the spread of rice cultivation in the Punjab and Haryana plains during the last four decades. An attempt has also been made to examine the ecological consequences of the growth and spread of rice cultivation in the area.

1.7 PRESENT STUDY

The present study deals with the spatial and temporal change in rice cultivation in Punjab-Haryana plains. The study covers a period of four decades from early 1960s to early years of the present century, so that pre and post green revolution scenario can be captured. The study is based primarily on district level data obtained from varied secondary sources. Data have also been collected from primary survey conducted by the researcher of a selected village. An attempt has also been made in the study to examine ecological consequences of intensive rice cultivation in terms of growing menace of depletion of underground water as well as water logging and salinization.

1.8 DATA BASE

The study is based on the data collected from primary as well as different secondary sources as published in various government reports, bulletin and Journals. Statistics on agriculture have been taken from the
Statistical Abstract of Punjab, Haryana and India. A survey of village Juan in district Sonipat of Haryana has been conducted by the researcher to collect the primary data. Some of the aspects on which district level and village level (Sample based) data have been collected from the primary and secondary sources are:

1. Total geographic area.
2. Total cropped area.
3. Total area under cereal crops.
4. Total area under rice cultivation.
5. District wise total cropped area from early 1960’s to early 2000’s.
6. District wise area under cereal crops from early 1960’s to early 2000’s
7. District wise area under rice cultivation from early 1960’s to early 2000’s
8. Water depleted, water logged, saline and alkaline area of different years.
9. Area, production and productivity of rice and cereal crops of village Juan (An sample village) and ecological problems. viz. water depletion and water logging due to intensive rice cultivation for two time periods.
Indian agriculture is marked with abrupt fluctuations from year to year. In order to minimise the impact of annual fluctuation, three-year averages corresponding to 1960-63, 1970-73, 1980-83, 1990-93 and 1999-02 have been taken into account.

1.9 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.

In the study appropriate statistical methods, viz. percentage, average, mean, standard deviation, coefficient of variation ratio, index of concentration etc. have been applied to analyse the various aspects related to the objectives of the present study. To illustrate the analysed results appropriate cartographic techniques have been applied.

In order to workout the various pursuits of analytical framework of rice cultivation development, such as rising water depletion, water logging, various related popular measures have been used.
1.10 OBJECTIVES OF THE STUDY

The present study is an attempt to examine the spatial and temporal change in rice cultivation in Punjab-Haryana plain. The main objectives of the study can be outlined as follows:

1. To present an account of rice cultivation in India and spatial shift in it.
2. To examine the spatial pattern of rice cultivation during pre and post green revolution period in the study area.
3. To examine the inter-district shift in area under rice cultivation during the period, in the study area.
4. To identify the shift and spread of ‘cores’ of rice concentration in Punjab-Haryana plain.
5. To examine the increasing ecological problems, viz. water depletion, water logging and salinization in the plain due to intensive rice cultivation.

1.11 PLAN OF THE STUDY

The present study is aimed at portraying the growth and spread of rice cultivation in Punjab-Haryana plain during the last four decades. District level data has been used. The study is spread over eight chapters.
Chapter I is introductory in nature. It presents a brief account of the history of rice cultivation in India and includes an account of the major areas of rice cultivation in India and recent shift in area under rice cultivation. A brief outline of the objectives, source and nature of data used, methodology-adopted etc. have also been presented in this chapter.

Chapter II deals with geographical background of Punjab-Haryana plain. It examines such aspects as relief, drainage, climate, soils, land-use, agriculture, agricultural pattern, change in cropping pattern, effect of green revolution, modern inputs in agriculture and other socio-economic and demographic characterisation of the plain.

In Chapter III presents an account of the macro scenario of rice cultivation in Punjab-Haryana plain in terms of area, production and yield, using the state level data covering a period of four decades.

Chapter IV discusses the spatio-temporal change in area under rice cultivation using district level data over the period.

Chapter V identifies the ‘cores’ or areas of rice concentration in the study area and aerial shift in it during the period under study.

Chapter VI deals with the problems of depletion of ground water resources, water logging as well as soil salinity/alkalinity in Punjab –
Haryana plain. Here an attempt has been made to relate these problems with growing intensity of rice cropping in the plain.

In Chapter VII presents an account of rice cultivation in village Juan, district Sonipat (Haryana) in terms of area, production and productivity, using data collected through primary survey by the researcher covering two time period has been presented. Here an attempt has also been made to relate intensive rice cultivation of the village with ecological problems, viz. water depletion, water logging etc.

Finally chapter VIII is devoted to summary and main findings of the study.