DYNAMICS OF CROPPING LAND USE PATTERN AND STATUS OF FOOD SCENARIO IN JAMMU AND KASHMIR- A SPATIO-TEMPORAL ANALYSIS

THESIS

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Certificate

Certified that the thesis entitled **"Dynamics of cropping land use pattern and status of food scenario in Jammu and Kashmir- A Spatio-temporal analysis"** submitted by **Mr. Showkat Ahmad Ganaie,** in partial fulfillment for the award of Ph.D Degree in Geography & Regional Development, is based on original research work carried out by him under my supervision and guidance. This thesis has not been submitted in part or in full, to any University/Institution for the award of any degree or diploma. The candidate has fulfilled all the statutory requirements for the submission of the thesis.

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Showkat Ahmad Ganaie

Dedicated

To

My Beloved Parents

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1.1 INTRODUCTION

Economic activity is the work that people do to enhance their quality of life. Economic activities include all the tasks that people do to get, refine or use natural resources. Land is one important natural resource used by man from times immemorial in a number of ways (Siddhartha, 2008). It was in Neolithic age (10000-2500 B.C.) when man used first time land for cultivation (Dinham, 2003). This practice of care of the soil or the cultivation of land is referred to as '*agriculture*' [Hussain (1970), Varsha and Datye (1976), Mounton (1981), Timmer and Szirmai (2000), Kurosaki (1999), Huffman and Evenson (2001), Misra and Rao (2003), Hayami (2003), Ainsworth and Leakey (2008)] and is by far the most important of the world economic activities. It has been a popular theme of geographic studies in India as well. It is not only because most of the people depend for food and several raw materials on it, but also because of the largest fraction of land under human occupancy is used for agricultural purposes. Therefore, the geographers are primarily concerned with man's varied impact upon the earth's surface, i.e., land husbandry or land use analysis (Zamir, 2005). Land use is the human use of land and it involves the management and modification of natural environment or wilderness into built environment such as fields, pastures, and settlements (FAO, 1997a; FAO/UNEP, 1999). Land use is a synthesis of physical, chemical and biological systems and processes on the one hand and human/societal processes and behavior on the other. The monitoring of such systems includes the diagnosis and prognosis of land use changes in a holistic manner at various levels (Singh, 1992). One of the first land use patterns that geographers studied is the pattern of crops across an agricultural landscape. Different crops represent different agricultural land uses (Bednarz, 2005). Cropping land-use is a highly dynamic process. It implies that policy discussions and development planning have to be based on a sound understanding of these dynamics. Therefore, it is imperative to make a comprehensive study of the pattern and magnitude of cropping land-use shifts for sustainability and productivity of agriculture in an area (Wani *et al*, 2009). The very purpose of cropping land use classification is to get an idea of the extent the land has been put into different uses (cereals, non-cereals, cash crops etc). Knowledge of cropping land use helps in maximization of productivity and conservation of land. Physical and human factors influence cropping land use pattern (ICAR, 1980).

Cropping pattern refers to the proportion of the area under different crops at a point of time (Siddhartha & Mukherjee, 2007). It also reveals the rotation of crops and the area under double cropping etc. in any state or country. The primary factor determining a farmer's choice of cropping pattern is the rate of rate of return; other contributing factors include agro-climatic conditions, farm programmes, conservation programmes, and environmental regulations (Duffy, 1996). In any locality, the prevalent cropping systems are the cumulative results of the past and present decisions by individuals, communities or governments and their agencies. These decisions are usually based on experiences, traditions, expected profit, personal preferences and resources, social and political pressures and so on. A change in cropping pattern implies a change in the proportion of area under different crops. Cropping pattern is a dynamic entity and it keeps on changing in any country, state or region in consonance with change in agricultural prices, Govt. policies and other related factors (Gupta & Singh, 1979). The interacting driving forces of population increase, income growth, urbanization and globalization on food production, markets and consumption have changed food and agricultural system worldwide (Braun, 2007). The cropping system is an important component of any farming system. Cropping system of any region is decided by a number of soil and climatic parameters which determine overall agro-ecological setting for nourishment and appropriateness of a crop or a set of crops for cultivation (Das, 2004). Crop diversification phenomenon intended to give wider choice in the production of a variety of crops in a given area to expand production related activities on various crops and also lessen the risk from loss of crops. Crop diversification in India is generally viewed as a shift from traditionally less remunerative crops to more remunerative crops. The relative importance of crops, crop yields and farm size leads to change in cropping pattern of an area (Hazra, 1997). The cropping pattern in different agro-climatic zones has been adopted by the farmers after long experience based on suitability of soil, profitability, availability of market, and industrial infrastructure and quantum of water available. Scientific cropping patterns can actually result in increased soil productivity by improving the physical, chemical and micro-biological properties of soils and increasing the fertility status (Adihikari *et al.*, 2005).

The introduction of new agricultural technology especially during the period of green revolution in the late sixties and early seventies resulted in wide spread change in

cropping land use pattern. There is a continuous surge for diversified agriculture in terms of crops, primarily on economic considerations. The major change in cropping pattern that have been observed in India is a substantial area shift from cereals to non-cereals. Although cereals gained a marginal increase in area in the first decade of the green revolution, its area and share declined gradually thereafter. Between 1966-1967 and 1996-1997, 3.35 percent of the gross cultivated area (G.C.A) representing approximately about 5.7 million hectares has shifted from cereals to non-cereals (Hazra, 2006). The cropping pattern is influenced by the *physical factors* such as soil, climate, *technological factors* like irrigation, improved varieties of seeds, availability of fertilizers and plant protection chemicals; *Institutional factors* like land reform, consolidation of holdings, credit facilities, price structure, procurement policies and storage facilities (Shafi, 2000). These factors are not watertight but inter-related. For instance, the adoption of crop technologies is influenced not only by resource related factors but also by institutional and infrastructural factors. Similarly, Government policies- both supportive and regulatory in nature- affect both the input and output prices. Likewise, special Government programmes also affect area allocation and crop composition. More importantly, both the economic liberalization policies as well as the globalization process are also exerting strong pressures on the area allocation decision of farmers, essentially through their impact on the relative prices of inputs and outputs. Although the factors that influence the area allocation decision of farmers are all important, they obviously differ in terms of the relative importance both across farm groups and resource regions. While factors such as food and fodder self-sufficiency, farm size, and investment constraints are important in influencing the area allocation pattern among small farmers, large farmers with an ability to circumvent resources constraints usually go more by economic considerations. Similarly, economic factors play a relatively stronger role in influencing the crop pattern in areas with a better irrigation and infrastructure potential. In such areas, commercialization and market networks co-evolve to make the farmers more dynamic and highly responsive to economic impulses (Bhalla & Singh, 2001). Examining the socio-economic and environmental consequences of crop pattern changes, the green revolution technologies have fomented among other things, an increasing tendency towards crop specialization and commercialization of agriculture. While the developments have positive effects on

land/labour productivity and net farm income, they have also endangered a number of undesirable side effects like reduced farm employment and crop imbalances. Besides crop pattern changes also lead to serious environmental consequences that take such forms as ground water depletion, soil fertility loss and water logging and salinity all of which can reduce the productive capacity and growth potential of agriculture over the long term. A classical example is the rice-wheat system in north western India replacing traditional crops like pulses, oilseeds, and cotton (Hazra, 1997).

Agriculture is the main occupation for the people of Jammu & Kashmir. About 80% of the people are directly or indirectly dependent on agriculture and allied activities for their livelihood. Agriculture and its allied activities are the predominant sector of the economy of Jammu and Kashmir and this sector contributed more than 43.29 per cent of Gross Domestic Production (GDP) in 2002 (Digest of Statistics, 2001-02). The land holding pattern is an important pre determining factor of economic and social development. According to the 1995 Agriculture Census, the average land holding is 0.73 hectare. The only state in India with lesser land holding than Jammu and Kashmir is Kerala (0.33 ha). The number of agricultural land holdings went up after land reform, a positive indicator of development. Out of the total geographical area of 101437 km^2, 40.94 per cent was the gross cropped area including the net sown area and area sown more than once. The net area sown was 30.47 per cent, fallow land accounted for 4.30 per cent and area under forest formed 27.23 per cent. Land not available for cultivation was 29.29 percent (Directorate of Economics and Statistics Govt. of J & K, 2005). The main crops grown in the state are wheat, maize etc. Rice is a Kharif crop grown in the state of J&K between March-April and harvested in autumn (Lawrence, 2006). Total area under rice cultivation in the valley of Kashmir is 3,74,000 acres having a yield of 25.5 quintals per acre. Wheat is a Rabi crop sown in August and harvested in March or April. It requires a cool and moist climate in the beginning and dry at the time of harvesting. Important wheat producing areas are Kathua, Ranbirsinghpora, Samba and Reasi. In Kashmir, wheat is grown like grass. Total area under wheat cultivation in Jammu region is 31000 acres, in Kashmir 78000 acres and in Ladakh 7000 acres. Maize is sown in the month of May/July and harvested in August/September. The crop requires hot dry climate with rainfall varying from 75cm to 125 cm. It is cultivated on

Karewa lands in the valley of Kashmir on about 303000 acres of land. Other important crops in the state include tobacco, pulses, saffron and rape-seed etc (Khan, 2001).

1.2 DETERMINANTS OF CROPPING LAND USE

a) Climatic factors: Climate is one of the dominant physical factors affecting agriculture. It consists of the elements like temperature, length of growing season, sunlight, frost, fog, moisture conditions, snow, hailstorms and winds. All these elements of weather have direct and indirect influence on the cropping patterns of a region. Thus an imbalance in one or all of these elements leads to a change in cropping pattern (Hussain, 1979).

b) Land tenancy: Land tenure includes all forms of tenancy and also ownership in any form. Land tenure affects the form of agricultural operations in many ways, having far-reaching effects on the land use patterns. The cultivator plans the agricultural operations by keeping in mind his rights and possession duration on the land (Shafi, 2004).

c) Population dynamics and change in family structure: The population dynamics affect the cropping land use pattern of any area as population attributes like population growth rate, sex ratio, literacy etc. are intimately related with the agricultural system. The breakup of the traditional joint family system leads to partitioning of households. Increase in population and partitioning of households has resulted in fragmentation of holdings and rise in the demand for new dwelling units. The spread of education and the increase in communication facilities opened the rural society to outside forces. The new generation, especially the educated, is after jobs outside agriculture and give only secondary importance to cultivation, the least being to rice cultivation. One of the consequences has been the decline in the average household size due primarily to adoption of family planning. Each household, of four to five members, chose to have an independent house of its own with a small homestead around it and in the homestead a variety of new crops are raised with preference being given to cash crops and ornamental crops (Mohammad, 1981).

d) State intervention- Land acquisition: The Government acquires private land for various development activities like construction of railways, road ways, building infrastructure and military purposes etc. displacing a large number of

households mostly belonging to rural labour. Amounts paid to them by the government by way of compensation for the lands acquired, brings liquid cash in large sums thereby increase the price of dry land. The new settlements alter the existing cropping pattern. Moreover, the price fixed by the government for dry lands is higher than that for the wetlands; the owners anticipating high prices hastily convert the paddy fields into dry land (Tarrent, 1974).

e) Deforestation: The deforestation process results in the shortage of supply of green manure for paddy fields and fodder for cattle. Due to it the cost of cultivation increases as cultivators had then to depend more on external sources of supply. Increase in the cost of cultivation is said to be one of the reasons for the shift from paddy to other crops (Bednarz, 2005).

f) Strengthening of public distribution system: The establishment of strong public distribution system (PDS) ensured availability of food items in addition to free movement of these items from one region /state to another. Rice at moderate prices became available in the open market. This development worked to the disadvantage of paddy cultivation. Similarly other crops have also been changed with more viable options (Mahesh, 1999).

g) Modernization and commercialization of agriculture: The application of high yielding varieties of seeds, chemical fertilizers and pesticides has enlarged the scope of production beyond limits. These developments have led to change in cropping patterns as well because farmers tried to maximize their benefits (Maghimbi, 2007). The consumption pattern also changed with commercialization of agriculture thus led to greater dependence on the use of purchased goods. This change expanded the need for cash income in the community. Therefore, the purpose of cultivation changed from production for household consumption to production for the market. The cultivators therefore chose to cultivate those crops that yielded higher cash income in the long run (Sangwan, 1985).

h) Labour problems: The availability of labour is also a major constraint in the cropping pattern of a region. Labour represents all human services other than decision-making and capital. The availability of labour, its quantity and quality at the periods of demand have great influence on the agricultural land-use and

decision making process of the farmer. The choice of crop cultivation is changing in consonance with the total labour requirements. The higher wages existing in the non-agricultural sectors and the preference of the workers to work in sectors other than farming shifted a sizeable proportion of the rural labour away from agriculture. Increased educational facilities extended the period of schooling and delayed the entry of younger generation to the work force. The new entrants who are better educated than their elders preferred white-collar or non-manual jobs, reducing the availability of farm labour even further (Shafi, 2004).

i) Price factors: One of the major factors that influence the choice of crops and cropping pattern is the expected income from land. Labour being one of the principal inputs in crop production; it is natural that farmers shift to crops requiring a lower labour input. The fluctuations in the price of agricultural products create a state of insecurity among farmers. In order to reduce the risk, they diversify crops preferring those that are expected to give a steady income. This pattern is said to provide a reasonable level of income from land and at the same time minimize risk due to crop failures and price fluctuations (Duffy, 1996).

j) Transportation facilities: Transportation facilities also have a direct bearing on the cropping patterns of a region. Better transport linkages are advantageous because of the economies in farm labour and storage costs which they make possible. The areas inadequately served by the modern means of transportation lose a lot by either adverse weather or pests or diseases. Better transport facility makes it possible for farmers to put their less accessible land to more productive use (Bednarz, 2005).

k) Market: The accessibility of the market is a major consideration in the decision-making and selection of cropping system of the farmer. The intensity of agriculture and the production of crops are determined by the distance from the market centres (Hazra, 1997).

Apart from these socio-economic and cultural factors the government policies and international relation also influence the spatial patterns of agricultural landscape. For instance, in some of the socialist countries the rotation of crops and crop associations

are determined by the governments. Moreover, the international agreements also limit or alter the cultivation of certain crops in the different regions. Restrictions on the import of certain agricultural commodities encourage their cultivation in the country. In brief, the socio-economic factors, i,e. land tenancy, size of holdings, labour, capital, market and national and international policies all individually or collectively influence the agricultural practices, cropping intensity etc. in general and cropping pattern and its dynamism in particular (Gersmehl, 2004).

1.3 CONSEQUENCES OF CROPPING LAND USE DYNAMICS

1.3.1 Economic Impact

i) Change in agricultural production: The shift in cropping pattern leads to enhanced production as the focus of farmer changes from home consumption to surplus production or monetary income. Farmers therefore take special care to select crops and crop varieties and tend them carefully, to obtain better yields. The overall result is an increase in agricultural production with major shifts in composition from food items to commercial items (Mohan, 2009).

ii) Changes in farm income: In the traditional pattern of farming, the income per unit of land is very low due to least use of technological interventions in the agricultural system. However, in the emerging pattern the land is put to intensive use with the result the income per unit area is higher. From the point of view of the farmers, the emerging crop pattern with predominance of cash crops has reduced risks of food and income insecurity and improved standards of living (Mahesh, 1999).

iii) Change in employment and income of rural labour: Due to change in cropping pattern, the demand for agriculture labour is increasing due to increase in area under commercial crops. This increasing demand leads to the decline in the supply of labour to traditional agricultural activities and increase in the labour wages. Thus it changes the employment scenario as well as the income generated by the rural labourers. Agricultural labourers of the older generation were able to attend to all items of farm operations including maintenance of draught animals. However, with the change in the system, labour becomes more specialized in specific activities. In consequence, segmentation of agricultural labour markets evolves. One of the reasons for the simultaneous existence of unemployment and

non-availability of labour in the farm sector lies perhaps in this process of segmentation (Immink and Alarcon, 1992).

iv) Women's participation: Women used to play an active role in the traditional agricultural system. In every agricultural labour family all the household members except the very young and the very old, used to do some kind of work to earn a living. Their roles and responsibilities have changed due to shift in the cropping pattern. In the present pattern where paddy cultivation is dwindling, the demand for female labour has diminished considerably. Mainly male workers attend to the agricultural operations in the converted lands and gardens. The change in crop pattern has thus lowered the employment opportunities of women. The number of entrants to the rural labour force from the female population has diminished with the emergence of nuclear families, and with the spread of education. The younger generation looks for white-collar work or prefers to remain at home (Dube, 1987).

v) Livestock: One of the major impacts of the change in crop pattern is the decrease in the livestock. The decrease in the area under paddy cultivation, conversion of grazing lands for raising tree crops and reduction in area under common resources (pastures near forest and ponds) have made rearing of cattle costly. The reduction of area under paddy and the replacement of animal power by mechanically and human labour has made the rearing of draught animals redundant. In earlier times, rearing of milch cows was common in most farming households and in some of the rural labour households. Owing to increase in maintenance cost, the number of milch animals has come down (Singh, 1984).

1.3.2 Social and Cultural Impact

i) Cultivator-labour relationship: The relationship between the cultivator and the labourer changed drastically because of the fact that earlier it was based not solely on economic considerations but was a relationship between two families, of the cultivator and of the labourer. With the decline in the importance of traditional crop cultivation, the attached labour system has lost its relevance. Labourers now shift from employer to employer according to their preference and convenience. This practice has pushed up the self-confidence and self-esteem of the rural labourer (Mahesh, 1999).

ii) Loss of traditional skills: The dynamism in the cropping land use system resulted in a shift from low external input system to the modern high external input system, thus leading to loss of many traditional skills of cultivation. The traditional system was complex and diverse and rural livelihood methods depended on local resources and traditional skills. The farmers adapted techniques using local resources suited to local needs. These methods ensured maximum use of internal inputs that sustained agricultural yields. In the changed scenario, these skills have vanished. Modernization transformed cultivation practices making them more dependent on external resources. Seeds, agricultural implements, fertilizers, draught power, etc are purchased from outside agriculture making local traditions and skills irrelevant. Knowledge of traditional medicines and treatments has also been lost almost entirely (Joshi, 1999).

1.3.3 Environmental Impact

i) Loss of local varieties and breeds: Due to the change in cropping pattern, the present system of agriculture is characterized by use of improved or high-yielding varieties of seeds and seedlings. The introduction of modern varieties and breeds has almost entirely displaced traditional varieties and breeds. Though their yields were not high they were pest and disease-resistant and were best suited to specific localities than the high yielding varieties (Mahesh, 1999).

ii) Receding water table and decrease in bio-diversity: The extensive cultivation of cash crops on account of cropping land use have affected the water tables adversely as extensive crop cultivation needed large quantities of water from the soil. Due the increasing impact of shift in traditional farming system, different varieties of herbs, plants and trees are lost. The value of this wild diversity is not recognized by the present generation, but this will have an ill effect on the generations to come (Agrawal, 1981).

1.4 FOOD SECURITY-CONCEPTUAL FRAMEWORK

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. It would be a mistake to confine food security to the issue

of "raw" production, because it also involves access to food and the correct use of it. Moreover, it extends beyond the simple notion of self-sufficiency. Food security is a multidisciplinary concept which includes economic, political, demographic, social (discriminatory food access), cultural (eating habits) and technical aspects. Making food security a reality therefore also implies to take into consideration the role of non-food factors. This widely accepted definition points to the four dimensions of food security, *viz*; Food availability, Food access, Utilization, and Stability (World Food Summit/ Rome Declaration, 1996).

Food availability addresses the "*supply side*" of food security and is determined by the level of food production, stock levels and net trade. However, supply is not important until people have the purchasing power to buy it. Thus, an adequate supply of food at the national or international level does not in itself guarantee household level food security. Concerns about insufficient food access have resulted in a greater policy focus on incomes, expenditure, markets and prices in achieving food security objectives The other important dimension is best utilization of the food consumed. Thus sufficient energy and nutrient intake by individuals is the result of good care and feeding practices, food preparation, and diversity of the diet and intra-household distribution of food. Combined with good biological utilization of food consumed, this determines the nutritional status of individuals. Besides these three components, the most vital component is their sustainability on a periodic basis. For food security objectives to be realized, all four dimensions must be fulfilled simultaneously (FAO, 2008). The notions inherent to food security are discussed below;

(a) Food crisis/stress: The notion of food crisis should be set apart from that of food stress. A food crisis is a specific event of limited duration. It has political overtones linked to variable appreciations of the gravity of a situation or shortage, real or artificial, and its repercussions. The notion of food stress applies whenever households fall below the vulnerability threshold, defined on the basis of food availability and people's ability to access food. Families may also have to reduce the number and quality of meals or even cut health expenditure. They may also be forced either to consume their food stocks or sell part of their means of production − thereby adversely affecting their living conditions and future food security in the long term (European Commission, 2009).

(b) Stability/structural resilience and vulnerability: *Resilience* denotes the capacity of populations to maintain a level of well-being when faced with food stress by resorting to adapted survival and risk management strategies. In contrast, *vulnerability* is defined as the risk facing households – even when they manage to maintain an acceptable standard of living in the present – of falling into poverty at any time and being unable to cope with possible future causes of food insecurity. Resilience and vulnerability depend therefore on the adaptation and reaction mechanisms implemented in response to a difficult situation. Whenever these mechanisms prove ineffective, the population enters a situation of chronic vulnerability. In regions regarded as relatively "affluent", populations may appear more vulnerable to food insecurity than populations from difficult regions accustomed to regular on-off shocks. A detailed analysis is necessary in order to identify these populations (Stamoulis and Zezza, 2003).

(c) Various forms of malnutrition: Malnutrition is the result of a poor or inadequate diet which does not provide the necessary nutritional intake, in both quality and quantity. *Chronic malnutrition* is revealed by stunting, which is measured in terms of the ratio of size to age. It occurs whenever the diet of children is chronically inadequate or when children regularly fall ill. Chronic malnutrition can have irreversible effects on a child's future development, heightens the vulnerability of populations and weakens their capacity to cope with episodes of food stress. *Acute malnutrition* arises when a child's weight is too low for his or her size (wasting) and significantly increases the mortality risk. It occurs whenever children lose weight as a result of severe nutritional deficiencies in the short term. A high rate of acute malnutrition reflects a food consumption shock (e.g. poor harvest, war, drought, epidemic) and/or the appearance of a disease (Dilley and Boudreau, 2001).

1.5 CHANGING CROPPING LAND USE AND FOOD SECURITY-A RELATIONSHIP

The general trend in cropping land use has been a shift from cereals to non-cereals implies low production of food crops. This process has a direct impact on the basic component of food security, i,e, deficiency in food supply. The supply demand gap in

terms of staple food in various regions has been widened by the changing cropping land use. The dynamics of cropping land use has led to crop diversification and crop diversification among small holder farmers is incompatible with maintaining or improving household food security when cash crops are included in the new crop mix (Lunven.1982; Fleuret and Flueret, 1980; Dewey, 1979; Lappe and Collins, 1977; Hernandez et.al, 1974; Gross and underwood, 1971). The main concern is that food availability of smallholder farm households will be affected by the displacement of food crops by cash crops (Marteen and Alarcon, 1992). Cereal grains continue to play a dominant role in feeding people. Of the nearly two billion acres of cropland in the world, about 72 percent is used to produce grain. Grains provide 55 percent of all food energy produced. Grains are typically divided into food grains for people (wheat, rice and rye) and feed grains for livestock and poultry (oats, barley, sorghum etc.). Any imbalance in the area devoted to food grains would definitely affect the food security (Snodgrass and Wallace, 1982). In India the food problem arises from demand supply gap and of the various causes leading to this gap, the cropping land use change is most important (Singh and Sadhu, 1986). In context of Jammu and Kashmir, the supply demand gap has widened on account of change in cropping land use pattern. It was stated that by assuming 622 gms of food grains consumption per capita per day to be standard norm, then two lakh tons of food grains would have to be imported to meet the growing demand of food in the state (Ali, 1992). A few decades back Kashmir was a producer state with potential for self sufficiency and export. However, changing cropping land use pattern, stagnant agricultural production and misplaced policy priorities have transformed the state as a whole and Kashmir in particular into a major importer of food items with tremendous dependence on other states (Rehman, 2008).

1.6 STUDY AREA

The state of Jammu and Kashmir constitutes northern most extremity of India and is situated between 32^{o} 17′ to 37^{o} 05′ N latitude and 73^{o} 26′ to 80^{o} 30′ E longitude (Fig.1.1). It falls in the great northwestern complex of the Himalayan Ranges with marked relief variation, snow-capped summits, antecedent drainage, complex geological structure and rich flora and fauna (Raina, 2002). The state is 640 km in length from north to south and 480 km from east to west. It consists of the territories of

Jammu, Kashmir, Ladakh and Gilgit and is divided among three Asian sovereign states of India, Pakistan and China. The total area of the State is 222,236 km^2 comprising 6.93 per cent of the total area of the Indian territory including 78,114 km^2 under the occupation of Pakistan and 42,685 km^2 under China (Qazi, 2005).

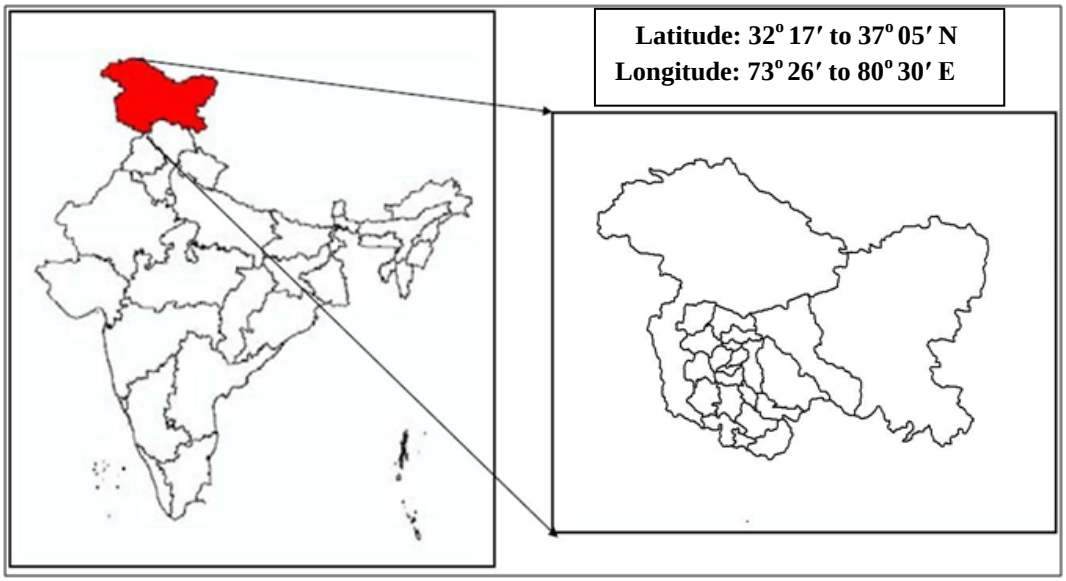


Fig. 1.1

1.7 OBJECTIVES OF THE STUDY

The present study shall focus to accomplish the following objectives:

(a) To prepare a micro agro-climatic zone map of Jammu and Kashmir.
(b) To examine the spatio-temporal dynamics of food crop productivity in different agro-climatic zones of Jammu and Kashmir.
(c) To analyze the change in food crop production and per capita food demand vis-a-vis the trends in demographic growth and the availability of agricultural land use.
(d) To identify the food deficit regions and the levels thereof.
(e) To suggest suitable strategy to make the land use of the region more productive and sustainable.

1.8 SIGNIFICANCE OF THE STUDY

The pattern of land use of any geographical area at a particular time is determined by the physical, economic and institutional framework taken together or it is simply the

outcome of action and interaction of various factors related to the cropping land use. The cropping pattern change can have both positive as well as negative impact. The very purpose of the present study is to analyze the impact of changing cropping pattern in the state on the food scenario/budget. The study of spatial patterns and temporal changes of cropland is important to understand the underlying factors and the functional effects of the agricultural landscape. Crop dynamic mapping is essential to know the overall agro-spatial diversity of the area. A close study of the present cropping land use patterns and the trends during recent years is imperative to suggest for planned shifts in the land use patterns (Rahman and Saha, 2009).

Moreover, knowledge of cropping land use helps in maximization of productivity and conservation of Land .The awareness of cropping land use pattern is preliminary to check food security in any area and to present some recommendations and suggestions to enhance and balance the food availability in relation to growing population. The study of cropping land use helps in analyzing whether the crop diversification is viable or not in any given area.

The significance of the present study lies in the fact that in last couple of decades, Jammu and Kashmir has witnessed a large scale change in its cropping land use pattern. The change is a result of various factors like economic considerations, lack of irrigation facilities, easy availability of food items and climatic variability etc. Moreover the objectives mentioned above have not been addressed in a detailed and comprehensive manner in the earlier studies and hence a novel attempt is made here to address these issues.

In order to gain a background knowledge of the problem, to identify appropriate methodology, research design, methods of measuring concepts and techniques of analysis or to be able to formulate the problem precisely, it seems logical to present a brief review of the available literature relating, directly or indirectly, to the field of problem under study.

2.1 CROPPING LAND USE DYNAMICS - CONCEPT AND ISSUES

Cropping pattern refers to the proportion of the area under different crops at a point of time (Siddhartha & Mukherjee, 2007). It also reveals the rotation of crops and the area under double cropping etc. in any state or country. A change in cropping pattern implies a change in the proportion of area under different crops .Cropping pattern is a dynamic entity and it keeps on changing in any country, state or region in consonance with change in Agricultural prices, Govt. policies and other related factors (Gupta & Singh, 1979). Lot of studies have been carried out on the dynamics of cropping pattern both on International and national level to ascertain the underlying causes of changing cropping pattern and its impact on the food budget and to present the optimal cropping pattern of the various regions.

David de Garis de Lisle (1982) in his paper highlights the effects of distance on cropping patterns internal to the farm. The findings from the Manitoba study indicate that distance has to be viewed as one of the several factors that affect cropping pattern internal to the farm; among others is the physical, environmental and social and technological change.

Marteen and Alarcon (1992) point out in their work that the crop diversification among small holder farmers is incompatible with maintaining or improving household food security when cash crops are included in the new crop mix (Lunven.1982; Fleuret and Flueret, 1980; Dewey, 1979; Lappe and Collins, 1977; Hernandez *et al.*, 1974; Gross and Underwood, 1971). The main concern is that food availability of smallholder farm

households will be affected by the displacement of food crops by cash crops. A consistent body of evidence from different settings indicates that the income effects from agricultural transformation in the subsistence sector are positive and can reduce income inequality among diversified small holders (Bouis and Haddad, 1990; Kennedy, 1998; Kennedy and Cogill, 1987; Von Braun, De Haun & Blanken, 1991; Von Braun, Peutz and Webb, 1989; Immick and Alarcon, 1992). However, in spite of higher income returns to household resources (land and labour) from cash crops compared with basic staple crops, a number of risks for small holder farmers are associated with increased commercialization. These include: Income loss from crop failure, market price variability over time, weak inefficient marketing institutions, higher input requirements and thus greater need for credit and extension services, both of which are typically lacking for farmers with little hand.

Abou, Mandour and Tahani (1995) mentioned that Egyptian Agriculture depends heavily on the Nile water for irrigation which leads to changing cropping pattern to include the less water consuming crops and growing such varieties that can benefit from low quality water. The change in Egyptian cropping pattern from 1970-1991 indicate that cereal crops and fodder retained their position, vegetables moved to a higher position and fiber crops moved to a lower position on the scale of importance.

El-Awar, Darwish and Nimah (2001) point out that a linear programming mathematical model was developed to determine optimum water allocation. The main objective of this optimization model was to choose the optimal cropping pattern that satisfies the existing climatic, Agronomic, Economic and Land and water availability constraints for a selected pilot study area in Ghazza in the South Bekaa region of Lebanon.

Majid Al Nabir (2009) in his research work mention that optimization of the cropping pattern under limited water supply and existing environmental and socio- economic constraints are necessary to make efficient use of land and water in central Jordan valley.

Hossain (2009) Senior scientific officer at Regional Wheat Research Centre (RWRC) of Bangladesh Agriculture Research Institute (BARI) points out in his research work that cultivation of rice, wheat and other crops under bed-planting system can double the

yield in northern districts of Bangladesh and suggests that short duration crops should be grown with rice-based cropping pattern.

Amanor-Boadu (2010) in his research paper points out that the HIV/AIDS pandemic and changing climate patterns in southern Africa are expected to alter cropping patterns in the region. In this research, an attempt has been made to measure and compare the effects of HIV/AIDS and drought on cropping patterns using econometric models and time series data. The research focused on Zambia as a case study and used data taken from 1961 - 2007. The study's results indicated that while the effect of HIV/AIDS was statistically significant in explaining changes in cropland allocations for both cassava and maize, the effect of drought was only significant in explaining changes in cassava's cropland allocations. They showed that although the absolute effect of drought on cropping pattern changes was higher in both crops, HIV/AIDS presented a stronger explanatory power. Based on these results, it is recommended that the pursuit of drought-tolerant technologies must continue in countries depending on rain-fed agriculture technologies for their food supply. However, because of the labor supply risk posed by HIV/AIDS to agricultural production, it is important that governments develop partnerships with non-governmental organizations, corporations and foreign governments to help control its spread, reduce the prevalence rate and secure effective therapeutic solutions for infected rural populations.

Ewers *et al.* (2009) observed a tendency for cropland areas in developing countries to remain unchanged even as yield increased, suggesting that cropland shifts may be influenced by factors other than yield improvements.

In India, the inter-district variations and regional characteristics of the cropping patterns have been examined first by the Indian Council of Agricultural Research (ICAR, 1964) and Professor Bhat and Learmonth (1968) for the late fifties and later on by Professor Bhalla and Alagh (1979) for showing the regional patterns of the growth of food grains production for the late sixties. It may be generalized from these studies that the regional variations in the cropping patterns and changes therein are the results of physical factors like soils, rainfall, temperature, and length of seasons etc. rather than the application of modern technology.

Bagchi (1972) in her paper has ascertained the impact of population pressure on agriculture from 1961 to 1971. The study reveals that the pressure of population has not only helped the growth of production of crops, but has also led to the changing cropping pattern.

Sen and Bhattacharya (1976) highlighted the role of physical and socio-economic forces which come into play and induce metamorphosis in land use in Bhagirathi-Jalangi interfluves. The study further revealed that the interaction of both physical and socio-economic factors have brought about a change in the landscape. The use of technology has considerably changed the cropping land use pattern. Technological change in Agriculture consists of adoption of farming techniques developed through research to bring out diversification and increase in production and greater economic return to farmers. The use of fertilizers, improved irrigation facilities, new agricultural implements and contour bunding for the conservation of moisture and soil are some of the examples of such techniques. The nature and process of diffusion of these innovations together with other ideals and materials have been studied by geographers for several decades (Griliches, 1957; Tiedemann & Van Doren, 1964; Moore, 1966; Mayfield, 1967; Morril and Pitts, 1967; Ramachandran, 1973 and Mohammad, 1976).

Singh and Sadhu (1986) mentioned that two types of factors are influencing cropping pattern at a particular period of time,viz, Changeable factors(Economic, Social, Govt. policies and personal factors) and natural factors (Soil and climatic conditions). Experts like Dr. N.A. Majumdar have tested the empirical data and proved the fact that Indian farmers have been motivated by economic factors. Dr. Majumdar has concluded that there is a close relationship between price movements and cropping pattern.

Mohammad, N. (1992) opines that in northern part of the union territory of Delhi the total cropped area and area under cereals and vegetables has increased while it has decreased in the case of millet and cash crops.

Singh (1992) mentions that agricultural system in India undergone drastic changes from the mid-1960’s through the introduction and application of various newly developed techniques in agro sciences such as crop and water management practices. Emphasis has been given to the integrated system approach in crop production.

Gopalkrishnan, Sakthival and Sunil (1997) in their work mention that between 1967 and 1997, the crop land area has declined from 25.4% to 22.1%, but the plantation area increased from 17.6% to 25% of the total area to generate more and more income.

Hazra (1997) mentions in his work that crop shift takes place due to Govt. policies and thrust on some crops over a given time. For example, creation of the technology mission on oilseeds (TMO) to give thrust on oilseeds production as a national need for the country's requirement for less dependency on imports. Market infrastructure development and certain other price related supports also induce crop shift and thus affect cropping pattern.

Nina (1998) opines that the rate of growth of net sown area had decelerated over time and particularly since mid-eighties a declining trend is noticed in Haryana state of India, because of diversion towards urbanization, thus affecting cropping pattern.

Sharad *et al.* (2001) argued that cropping pattern changed considerably in Dharampur tribal Block of South Gujarat, because of combined effect of orchard development, land shaping and utilization of available water etc. Growing of some crops for the market is observed in areas having appropriate water facilities. Cultivation of perennial crop is also increasing. These include Coconut, guava, lime, ber etc. an overall change in the cropping pattern is observed on 51% of the total area. The visible impact of cropping pattern change is crop diversity.

Ramanathan *et al.* (2002) mention that there are some evidences which highlight that change in cropping pattern of Tamil Nadu took place due to price fluctuation, insufficient availability of ground water, labor non- availability etc. but that shift or change gets reverted back to the original cropping pattern after the problem is over. The Tamil Nadu Agricultural University has worked out the alternate cropping pattern for Tamil Nadu to meet the challenge of continued unforeseen agricultural drought from 2000-03 to make the agriculture sustainable in Tamil Nadu.

Swagata and Saha (2003) mention that the crop and other land use/land cover pattern of a region is an outcome both natural and socio-economic factors and their utilization by man in time and space. Land is becoming a scarce commodity due to immense agricultural and demographic pressure. Hence, information on land use/land cover and possibilities for their optimal use is essential for the selection, planning and

implementation of land use schemes to meet the increasing demands for basic human needs and welfare. Increasing human interventions and unfavorable bio-climatic environment has led to transformation of large tracts of land into wastelands. They also argued that area under wheat and rice in Punchkula district, Haryana increased substantially while as area under mustard, sunflower decreased. The steady increase in rice and wheat is because of increase in the procurement price for wheat and rice.

Minakshi *et al.* (2005) pointed out that there has been a great change in the cropping pattern of the Ludhiana district, Punjab from 1970 to 2005. Crops such as groundnut, gram and cotton have nearly disappeared and wheat and rice dominate the region. The factors responsible for sequential change in cropping pattern were reclamation of the sand dunes, development of irrigation facilities, improved technology and availability of essential input. The wheat crop dominates both in area and production, but groundnut, gram and cotton occupying a significant area in 1970 had almost disappeared in 2001 and they were replaced by rice. The area under wheat had increased by 1.12 times while that of rice by 59.25 times during the 30 years and at the same time the area under gram and groundnut decreased by 20.25 and 332 times respectively. After establishment of sugar factories there is significant increase in area under sugarcane localized near these factories.

Dayankar and Parvez (2005) pointed out that although sorghum was a major cereal during 1950's and occupied more than 18 million hectares area yet it has come down to 11.6 million hectares as a result of continuous decline over the last three decades (NRCS, 1998). A host of competing crops like rice, oilseeds, pulses, groundnut, cotton etc. have gained area at the expense of Sorghum (Hall, 2000).

Shafi (2006) mentioned that cropping pattern in India has undergone an evolutionary process, from subsistence to commercial farming. He also mentions that land use and cropping pattern having a close bearing on (a) Rainfall, (b) Irrigation and Command Area Development, (c) Soils and moisture conservation, (d) Crops, animal husbandry, seeds, fertilizers and manures, plant protection chemicals, and (e) Farm power and associated implements and machinery. While considering land use and cropping pattern, an integrated and broad view of the above mentioned factors have to be taken.

Mahesh (2007) argued that the change in cropping pattern cannot be analyzed in isolation from changes taking place in the farming system determined by factors such as land ownership, access to resources, labour relations, livelihood strategies, farming practices, traditions and culture. The main causes of change may be grouped into (i) Population Growth and change in family structure (ii) State intervention through land reforms, acquisition of land, deforestation, public distribution system etc. (iv) Labor market conditions, and (v) Price factors. According to Mahesh the impact of these changes are (i) Economic-changes in production, farm income, employment, women's participation etc. (ii) Social and cultural (Cultivator-labour relation, negative attitude to agriculture, loss of traditional skills, etc.) and (iii) Environmental- loss of local varieties of seeds and breeds and trees receding water table, decrease in biodiversity etc.

Subrata (2007) mentioned that the cropping pattern in most of the districts of West Bengal has noticeably changed in favor of high value non-food crops.

Bera (2008) highlights that the change in cropping pattern in West Bengal occurred due to increase in per capita income, rapid urbanization and opening up of the Indian economy to meet the growing need of green vegetables, fruits and nuts in the domestic as well as international markets.

Rahman and Saha (2009) in their paper mention that the study of the spatial patterns and temporal changes of the crop land is important to understand the underlying factors and the functional effects of the agricultural landscape. On the other hand, crop dynamic mapping is essential to know the overall agro-spatial diversity of the area.

Inderpal and Sarbjit (2009) mention that depleting water table, stagnant income of farmers, low productivity level are amongst few serious problems being faced by Indian farmers. Apart from this, the marketing facilities are mainly available for wheat and rice to the farmers though for certain other crops like cotton and sugarcane the facilities are also available. Many researchers like Swaminanthan (2001), Shina (2002) and Johl committee (2002) laid more stress on diversification in the cropping pattern from wheat and rice to other cash crops to ease the situation.

Mohan (2009) in his work mentions that cropping patterns in India underwent several changes with the advent of modern agricultural technology, especially during the period of the Green Revolution in the late sixties and early seventies. There is a continuous

surge for diversified agriculture in terms of crops, primarily on economic considerations. The crop pattern changes, however, are the outcome of the interactive effect of many factors which are related to resources available, technological know-how, household factors, price related issues and infrastructural and institutional factors. These factors are not watertight but inter related. For instance, the adoption of crop technologies is influenced not only by resource related factors but also by institutional and infrastructure factors. Similarly, government policies – both supportive and regulatory in nature affect both the input and output prices. Likewise, special government programmers also affect allocation and crop composition more importantly; both the economic liberalization policies as well as globalization process are also exerting strong pressures on the area allocation decision of farmers, essentially through their impact on the relative prices of inputs and outputs. Economic factors play a relatively stronger role in influencing the cropping pattern in areas with better irrigation and infrastructure potential. In such areas, commercialization and market networks co- evolve to make the farmers more dynamic and highly responsive to economic impulses.

Todakari, *et al.* (2010) maintained that the soil and other natural, environmental factors, along with the socio-economic factors affect the cropping pattern in the Sholapur district Maharashtra. This is evident from the fact that sugarcane has attained a significant proportion of land (8.30% of net sown area) because of economic reasons.

The cropping pattern of the state/region is different from the other state/ region because of the variation in topography, soils, climate etc. (Tiwari, 1988). The cropping pattern in Kashmir valley is different from that at the national scene owing to the topography and climatic conditions. Agriculture is the main stay of the economy of the state of J&K and directly or indirectly it supports 80 percent of population (Digest of statistics, 2001-2002). The agriculture sector has undergone wide-ranging changes in terms of ownership of land cropping pattern, cultivation practices etc.

Gupta & Amarijit (1979) mentioned that the cropping pattern in the Kashmir Valley is changing on account of rapidly increasing population, spread of commercial farming concept and adoption of new technology and HYV seeds. The increasing population

demands more food, commercial farming demand surplus and adoption of new technology is the solution for it.

Nisar (1985) mentioned that although cropping pattern in the Kashmir Valley is rice biased yet its proportion has registered a marginal decline and the area under fruits and vegetables has increased considerably. The crop pattern over the period of time has emerged commercial oriented as is evident from three percent annual increase in area sown more than once.

Shahid E Murtaza (2007) has mentioned in his work that cropping pattern of the valley floor of Kashmir is dominated by rice while as on the karewas and rim lands, maize is the dominant crop. Further he mentions that crop concentration and diversification is very high in the valley floor and goes on decreasing towards karewas and rimlands.

Shuja-ul-Rehman (2008) mentioned in his work that the availability of locally produced food is on a serious decline. The production of food grains as well as vegetables has shown a steady decline because of the change in land use patterns. Paddy land is increasingly finding unchecked use for residential constructions, small industrial units, brick kilns, motor vehicle workshops and railway line construction. He also mentioned that lack of irrigation facilities led many a farmer to shift from paddy cultivation to fruit growing.

Tak (2008) pointed out that the conversion of irrigated lands towards horticulture fruit crops in rice fields resulted in the low production of cereal crops and necessitated the import of food crops especially rice-the main staple food crop and wheat and vegetable from Punjab and other neighboring states, thus making the state especially Kashmir valley deficient and dependent for the most important food crop. He further mentions that the land of *Abi-awal* areas of Rawalpora, Hyderpora and other areas in Srinagar district and elsewhere have been converted into residential and industrial and other commercial colonies by property dealers and the land mafia people who are hand in glow with the concerned department. If no action in the near future is taken against this misuse of land, time shall come when the state will depend 100 percent on imported food and vegetables especially Kashmiri's will face starvation in case of road blockade. There is urgent need to take cognizance of this type of misuse of land and stop the same

prior the state is left without food and vegetable production (*Greater Kashmir, June 4, 2008*).

Bhat and Shabir (2008) examined in their study that owing to variations in climate, soil and nature of irrigation, agricultural operations and system of cultivation naturally vary from region to region and almost all the regions in the state of J&K have perceived change in cropping pattern because there is no law on minimum land ceiling for areas used for crop production. The state has not been enforcing a strict ban on use of irrigated land for non-agricultural purposes. Moreover there is lack of facility for insurance cover for major crops and marketing facilities are also inadequate.

Wani, Baba and Yusuf (2009) argued that significant decline has been observed in the total reported area, which necessitates a proper land use survey through remote sensing. A declining trend has also been observed in the area under forests. The unfavorable increasing trends in the area put to non-agricultural use are likely to have serious implications on ecological balance. Inter-sectoral land budgeting analysis has revealed that shifts in the area are occurring from desirable ecological towards undesirable ecological sector.

The Director Agriculture Kashmir attributed the decline in net sown area and irrigated area to Urbanization, coming up of Railway/Road projects and construction of complexes (*Indian Express Mar12, 2009*). No steps have been taken by government to increase it. The cropping pattern of Kashmir valley also changed as the farmers have switched over from Agriculture to Horticulture. It has been necessitated by the melting of glaciers which in turn has hit the availability of water for irrigation purposes. (*The Hindu, Vol. 132, No. 211*).

Javeed-ul-Aziz (2010) examined the economic history of Kashmir valley with reference to agriculture and mentioned that the cultivated land per agricultural person (physiological density) increased in district Anantnag on account of conversion of some land uses (Pastures, Forests etc.) into cultivable land, while as in district Srinagar, it decreased because of the process of urbanisation.

2.2 FOOD SECURITY – CONCEPT AND ISSUES

"Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (World Food Summit, 1996). This widely accepted definition points to the four dimensions of food security, viz; Food availability, Food access, Utilization, and Stability. Numerous research studies have been carried out on food security. The interacting driving forces of population increase, income growth, urbanization and globalization on food production, markets and consumption have changed food and agricultural systems worldwide (Braun, 2007). Climate change and its increased variability compound the effects of these changes and have serious consequences for food production and food security (Parry *et al.*, 2004).

The Govt. of India appointed Food Grains Enquiry Committee (1957) to examine the food grain policy for India. Recognizing that India would continue to face food problem in some years to come, the case for liberal imports of food grains was made. It was concluded that the solutions to the problem would lie between complete free trade and full control.

Ahmad (1969) maintained in his study that the slow pace of advancement of the primary sector in the developing economies, apart from other factors, can essentially be attributed to inadequacy and scarcity of farm-credit. Occurrence of such a situation is because of low or no surplus production.

Singh and Gupta (1979) argued in their study that productivity has a direct relationship with the size of land holding. They mentioned that the yield per acre of land increases up to a limited increase in the size of holding and then after wards the increase in holding size leads to a decrease in productivity.

Khan (1981) highlighted in his study that land reforms have nearly emancipated the peasantry from the bondages of institutional depressors and therefore, have injected the elements of dynamic growth in the agrarian setting of J&K state.

Ali (1992) suggested that supply-demand gap for food grains could be met by more capital investment on the farm. He evaluated the food grains availability and their demand in J&K state. He found that the local gap between demand and supply of food

grains continue to be of the order of 2.5 lakh tons a year. He reported that the state needed 48 thousand tons of food grains to meet the demand supply gap (NCEAR estimation). As against this the net imports in the state in 1963-64 amounted to 88 thousand tones. The study brought out that per capita availability of food grains had declined from 663 gms/day in 1960-61 to 525.12 gms/day in 1976-77. It was stated that by assuming 622 gms of food grains consumption per capita per day to be standard norm, then two lakh tones of food grains would have to be imported to meet the growing demand of food in the state.

Shafi (1995) highlighted in his research work that there is little evidence of any major change in the composition of cereals consumed in Jammu and Kashmir; however, relatively more quantity of cereals is consumed in the rural areas as compared to the urban areas. The researcher also found that with increased income and expenditure, more of rice is preferred to wheat or any other cereal which thrusts on the negative impacts of changing cropping pattern. The author also mentioned that import of food grains steadily increased from 3.90 lakh quintals in 1960-61 to nearly 25 lakh quintals by 1991-92.

Shafi (1999) examined food management in J&K state. He pointed out that the annual growth rate of food grains in the state was estimated to be 2.57% per annum in 1990-91. He further pointed out that there has not been any single year in which demand for food grains would have been met out of the local supplies. He made the conclusion that the state suffers from food grains deficiency. He finally gave two suggestions to increase food grains production in particular and agricultural production in general. First, by increasing the land under cultivation and second by increasing the productivity per unit of land. He also believed that a major portion of waste and fallow land can be very well converted into cultivable area.

Wani (2000) in his research work found that there is enough scope for agricultural development in Jammu and Kashmir, but it requires adequate financial facilities. Though state Co-operative helped the farmers by providing the financial facilities but these were not up to the desired level.

Saseendran *et al.* (2000) showed that for every one degree rise in temperature the decline in rice yield would be about 6 percent. Decrease in yield of crops as temperature

increases in different parts of India - For example a 2°C increase in mean air temperature, rice yields could decrease by about 0.75 ton/hectare in the high yield areas and by about 0.06 ton/hectare in the low yield coastal regions. Various climate change scenarios need to be evaluated for these regions and the specific adoption strategies be evolved. Simulation models may help a long way in linking other bio-physical and socio-economic drivers of agri-production with climate change. Crops have to cope with increased variability of weather, extreme events, and changing climate patterns throughout the growing season. Agriculture may learn to adapt to climate change but climate variability needs to be combated. The frequency of occurrence of extreme climate conditions dictates the response of agriculture to climate variability/change.

Bhandari and Dubey (2001) in a study argued that the poverty line be recalculated on the basis of calorie requirements and in fact rising food prices may have caused poorer households to adopt less nutritious diets. In addition, the condition of people in relatively drought-prone regions and some backward states is a major area of concern.

A recent publication, *Food Insecurity Atlas of Urban India* (2002), brought out by the M.S. Swaminathan Research Foundation (MSSRF) and the World Food Programme (WFP) indicates that more than 38 percent of children under the age of three in India's cities and towns are underweight and more than 35 percent of children in urban areas are stunted (shorter than they should be for their age). The report states that the poor in India's burgeoning urban areas do not get the requisite amount of calories or nutrients specified by accepted Indian Council of Medical Research (ICMR) norms. The problem of hunger in India is definitely not one of scarce food production. At the start of December 2002, India had a surplus of 53.56 million tons of food grains. So with many other aspects of poverty, the problem of food insecurity is often one of governance. Nobel Laureate Amartya Sen pointed out that, unlike famines, chronic undernourishment receives little political attention.

Wani *et al.* (2002) reported an increase in area under vegetables in Kashmir valley from 1981 to 2000 by 72.9% and had also mentioned that the production in the corresponding period increased by about 121.6%. They also found that productivity level of vegetables in the state (14.7mt/hectare) is almost equal to that of national level

(14.9 metric tons/hectare) which is a good sign for the vegetable cultivation on large scale.

Rashida (2004) examined demand for food grains in J&K state. As per the study it is observed that productivity of food grains showed negligible progress in the state in general and Kashmir valley in particular. The study found that all the principal crops could not maintain increase in their output and indeed started showing downward tendency. Thus, with some initial success the hybrid varieties failed to bring about a change in production scenario of cereals.

Rao and Gulati (2005) mentioned in their study that rice production in J&K state declined because the crop is more susceptible to diseases and pests than wheat and maize. Moreover, real investment in irrigation by the public sector declined during the 1980's at the rate of 1.73% per annum.

Nigeen (2005) mentioned in her work that in Kashmir valley, area under rice has decreased in the districts of Anantnag, Pulwama, Srinagar and Kupwara from 1991-92 to 2002-03. The area under rice has remained more or less constant in Budgam and Baramulla districts. However, the productivity of rice has decreased in all the districts. Area under maize has increased in all the districts except Srinagar, but the production shows declining trend and area under wheat showed increasing trend in Leh and Anantnag and its production also is increasing. The researcher also found that the technological change occurred in J&K agriculture in 1965-66. But despite the technological and institutional changes, production and productivity do not present satisfactory results. Nigeen (2005) mentioned in her work that differences in the return on different kinds of agricultural investments, account for the changes in the cropping pattern in the state of J&K.

Chakraborty, Debashis (2005) mentioned that while poverty in India is falling, concerns over food security are increasing. According to recent surveys, most states have witnessed a declining poverty ratio but increased calorie deprivation. Swaminathan (2000) argues that on average 44 percent of households are deficient in calorie intake while malnutrition among women and children is higher.

Butt, *et al.* (2005) focused on economic and food security implications of projected climate change on Malian agriculture sector especially the effects on crops, forages, and

livestock and the resultant effects on sectoral economics and risk of hunger in Mali. Results show that under climate change, crop yield changes are in the range of minus 17 percent to plus 6 percent at national level. Simultaneously, forage yields fall by 5 to 36 percent and livestock animal weights are reduced by 14 to 16 percent. The resultant economic loss ranges between $70 and $142 million, with producers gaining, but consumers losing. The percentage of population found to be at risk of hunger rises from a current estimate of 34 percent to an after climate change level of 64 to 72 percent. A number of policy and land management strategies can be employed to mitigate the effects of climate change. In particular, the development of heat resistant cultivars, the adoption of existing improved cultivars, migration of cropping pattern, and expansion of cropland can reduce climate change impacts by lowering the risk of hunger to as low as 28 percent.

Rehana (2008) mentioned in her work that vegetable farming is one of the most important sources of farm income and in J&K the productivity increased from 12.15 ton/ hectare in 1990 to 19.05 ton/ hectare in 2005 which indicates that there is an ample scope for increasing vegetable production in the state.

Suryanarayana and Silva (2008) in their work mentioned that with the United Nations Millennium Declaration adopting eight major development goals on 8 September 2000, the question of reduction in poverty and food insecurity has received major policy focus in several developing countries the world over. India has not exhibited similar policy concern on achieving these goals because of the general sense of comfort from the success in reducing poverty and food insecurity as revealed by estimates of consumption-based poverty measures and surplus stocks of food grains, which are even exported in recent years (Government of India, 2004).

Murtaza, Tasawwur and Firoz (2008) maintain that the Valley of Kashmir suffers from an acute food deficit problem as a result of declining grain production and increasing population. The valley over the years has become a food deficit area from a food surplus area not because of population growth alone but also because of declining food production. In the area of improving food production, the suggestions offered by the authors include cultivation of left out fallow lands, undertaking irrigation projects, reclamation of sizeable water-logged areas, identification of crops for the valley that

can withstand the winters, use of bio-fertilizers and green manure, bringing marginal lands under horticulture, banning the diversion of land under crops to orchards etc.

Panda and Ganesh (2008) attempted to assess the impact of trade liberalization on growth, poverty, and food security in India with the help of a national level computable general equilibrium (CGE) model. They highlighted that GDP growth and income or poverty reduction that might occur by trade liberalization need not necessarily result in an improvement in the food security / nutritional status of the poor. Evidence from simulations of (partial) trade reforms reflecting a possible Doha-like scenario show that the bottom 30 percent of the population in both rural and urban areas suffers a decline in calorie and protein intake, in contrast to the rest of the population, even as all households increase their intake of fats. Thus, the outcome on food security / status with regard to individual nutrients depends crucially on the movements in the relative prices of different commodities along with the change in income levels. These results show that trade policy analysis should consider indicators of food security in addition to overall growth and poverty traditionally considered in such studies.

United Nations World Food Programme (UNWFP) (2008) in their project *"Baseline Survey of National Program for Food Security and Agricultural Productivity Enhancement in Pakistan"* highlighted the impact of high food prices on rural and urban socio-economic conditions and livelihoods in Pakistan. The Price Study shows that *"Households cope differently with price shocks, however most widespread are changes in the quality and quantity of food consumed".* The survey shows that 40% of interviewed households in both urban and rural areas shifted consumption to less preferred food, including shifting from rice to cheaper wheat. In rural areas, adults reduce their food share for the benefit of their children. The number of meals eaten per day has changed. According to survey findings, more than 10 percent of adults and children are eating fewer meals per day than six months ago. The majority of adults reported having two meals per day, while 75 percent of children have 3 to 4 meals per day. A worrying finding is that 20 percent of adults eat only once a day. Simulation results show an increase in the share of the severely food insecure population, from 23 percent in 2005-06 to 28 percent in 2008.

Wani (2008) examined in his research work on Kashmir centric food vision that we have to achieve higher targets of productivity by vertical expansion as horizontal land expansion is not possible. Our target of 4 ton/hectare of rice or wheat shall make Jammu and Kashmir self-sufficient; a food security base shall need 5ton/hectare. On an average we have 2-3 ton/hectare rice and marginally less wheat production in the state. The per capita food grain consumption is marginally more than rest of the Indian state because of severe cold and more calories are needed. An estimated food grain of 210 million tons at present may need to be doubled in next 10 years to overcome the food availability problems.

Chattopadhyay (2008) highlighted the role of Climate Change and Food Security in India and mentioned that while the magnitude of impact varies greatly by region, climate change is expected to impact the agricultural productivity and shifting crop patterns. According to the study major impacts of climate change will be on rain fed crops (other than rice and wheat) though temperature increase will reduce rice yields also. An increase of 2-4°C is predicted to result in reduction of yields, which account for nearly 60 percent of cropland area. The loss in farm-level net revenue will range between 9 and 25 percent for a temperature rise of 2-3.5°C. The study found that increase in temperature (by about 2°C) reduced potential grain yields in most places. Regions with higher potential productivity (such as northern India) were relatively less impacted by climate change than areas with lower potential productivity (the reduction in yields was much smaller). Climate change is also predicted to lead to boundary changes in areas suitable for growing certain crops. Sinha and Swaminathan (1991) also showed that an increase of 2°C in temperature could decrease the rice yield by about 0.75 ton/hectare in the high yield areas; and a 0.5°C increase in winter temperature would reduce wheat yield by 0.45 ton/ha. Aggarwal and Sinha (1993) – using WTGROWS model showed that a 2°C temperature rise would decrease wheat yields in most places.

Shuja-ul-Rehman (2008) examined the food security scenario in J&K state with particular reference to Kashmir and mentioned that the state of Jammu and Kashmir in general and the valley of Kashmir in particular is bestowed with considerable land and water resources paving the path for large scale agricultural production especially sustainable mixed farming systems. A few decades back Kashmir was a producer state

with potential for self sufficiency and export. However, changing land use pattern, stagnant agricultural production and misplaced policy priorities have transformed the state as a whole and Kashmir in particular into a major importer of food items with tremendous dependence on other states.

Surinder (2009) in his work mentions that fortunately, the need for enhancing food security has seldom been lost sight of by successive Governments in India ever since Independence. This has been sought to be achieved through several policy initiatives, social welfare schemes and administrative measures involving food as a component of assistance, and are launched with the dual objective of providing food and alleviating poverty. The most significant recent initiative in this direction is the launch of National Rural Employment Guarantee Act (NREGA). Such measures can potentially take care of both food security and livelihood security. Another significant recent measure is the setting up of a National Food Security Mission (NFSM) which essentially aims at boosting the production of food grains like rice, wheat and pulses. However, there are several formidable threats to food security. The physical health of soil, including its fertility, lack of assured irrigation, Climatic change etc.

Mittal and Sethi (2009) in their work mention that agriculture in the South Asian Region is caught in a low equilibrium trap with low productivity of staples, supply shortfalls, high prices, low returns to farmers and area diversification - all these factors can be a threat to food security. The region has the highest concentration of undernourished (299 million) and poor people with about 40 per cent of the world's hungry. Estimates by the Food and Agricultural Organization (FAO) indicate that by 2010, Asia will still account for about one-half of the world's undernourished population, of which two-thirds will be from South Asia. An important initiative of Indian Government towards food security was the launch of the National Food Security Mission (2007) to increase the production of rice by 10 million tons, wheat by 8 million tons and pulses by 2 million tons by the end of the Eleventh Plan (2011-12).

Adrian, Scott, and Peter (2010) in their research mention that accelerated climate change affects components of complex biological interactions differentially, often causing changes that are difficult to predict. Crop yield and quality are affected by climate change directly, and indirectly, through diseases that themselves will change

but remain important. These effects are difficult to dissect and model as their mechanistic bases are generally poorly understood. Nevertheless, a combination of integrated modeling from different disciplines and multi-factorial experimentation will advance our understanding and prioritization of the challenges. Food security brings in additional socio-economic, geographical and political factors. Enhancing resilience to the effects of climate change is important for all these systems and functional diversity is one of the most effective targets for improved sustainability.

Bazaz (2010) highlighted in his study that the increase in the area under rice and wheat in Jammu and Kashmir is not in consonance with the increase in the population of the state. According to his study, from 1966-67 to 2007-08 (40 years), the area under rice and wheat increased by 14% and 12% respectively, while as in the same time period the population of the state increased by 270%. Thus the rising population amounts to the food deficit of the state.

Vijay Kumar (2011) mentions that a fifteen member delegation of Agricultural Technologists from Nepal arrived on a two day visit to Jammu to study the strategies and technological interventions adopted by the State Agriculture Department to boost the production of maize in the State. The delegation observed that technological achievements & experiences in Jammu division of J&K State would be of considerable significance to help agricultural production & address food security and livelihoods of people as the sociology and topography of the two Himalayan regions was much similar. They however suggested the Department of Agriculture Jammu that the basic strategy is to evaluate & identify the most suitable location specific varieties and hybrids of the maize crops & introduce the outstanding ones in the maximum possible area to realize the optimum yield potential.

The food insecurity in the state of J&K could be assessed from the fact that in a significant move against poverty, the Scheduled Tribe Gujjars and Bakarwals of Jammu and Kashmir appealed the United Nation in the year 2011 to provide food security to more than six lakh nomadic families of their tribe under *"World Food Programme"* (WFP) as they are suffering from intense food-deficit due to low-income and deficiency of resources.

A broad based, diverse and comprehensive methodological framework has been adopted for the accomplishment of the objectives taken for the study. Since the main purpose of the study was to quantify the cropping land use dynamics and its impact on food budget of the state of Jammu and Kashmir. Therefore, on the basis of various geo-physical and socio-economic indicators, various data sets needed were generated to serve the purpose. An outline of the methodology used is presented below.

3.1 IDENTIFICATION OF VARIABLES

In order to achieve the objectives taken for the study, the present study analyzed the following variables grouped under three broad headings-cropping land use variables, socio-economic variables and geo-physical variables. The cropping land use and socio-economic variables were analyzed by taking district as unit of analysis.

(I) Cropping land use variables

(i) Net sown area
(ii) Area under paddy
(iii) Area under maize
(iv) Area under orchards
(v) Cropping intensity

(II) Socio-economic variables

(i) Human population
(ii) Percentage of working population in agriculture
(iii) Gross area irrigated
(iv) Per capita food consumption
(v) Agricultural productivity
(vi) Physiological density (man- land ratio)

(vii) Food imports

(III) Geo-physical variables

(i) Altitude

(ii) Soil

(iii) Temperature

(iv) Precipitation

3.2 MATERIALS

As the nature of the study was very diverse, the data base required was also broad and comprehensive. The various data layers were collected and generated from different sources with diverse nature and characteristics as presented in table 3.1.

Table 3.1: Type and source of data sets used

Data set		Source	Date of acquisition
Topographic maps		Survey of India	1971
Primary data		Sample survey	2012, 2013
Secondary data	Agricultural Productivity	Directorate of Agriculture, Srinagar/Jammu	1981- 2011
	Cropping land use variables	Financial Commissioners Office, Srinagar/ Jammu	1981-2011
	Food imports data	Consumer Affairs & Public Distribution Department, Srinagar/Jammu	1981-2011
	Climatic variables	Regional Meteorological Centre, Srinagar/Jammu and IMD Pune	1981-2011
	Population variables	Census of India, J&K Series, Srinagar/Jammu	1981-2011

3.2.1. Survey of India Toposheets

The survey of India topographic maps of the year 1971 on 1:50,000 scale were used to delineate the study area. These toposheets were geo-referenced and a mosaic of toposheets was prepared. These toposheets were used to generate base map and various data layers such as physiography map, altitude zonation map, drainage map, soil map etc.

3.2.2. Sample Survey / Field Survey

Sample survey was conducted in order to collect the data regarding different physical, socio-economic and demographic variables which are influencing the

cropping land use system in the state directly or indirectly. Stratified random sampling has been carried out for this purpose. Stratification was done and only those tehsils from districts have been selected for primary survey where cropping land use shift has occurred (Table 3.2). This was ascertained from the altitude zonation map of the state and from other related secondary sources of data. From every district hundred households were surveyed selecting at least from four to ten villages depending upon the number of tehsils which amount to the total survey of 1200 households in the study area.

Table 3.2: Sample frame of the study

District	Tehsil	Number of households surveyed	Number of villages/wards surveyed	Total
Srinagar	Srinagar North	25	05	50
	Srinagar South	25	05	
Ganderbal	Lar	25	05	50
	Ganderbal	25	05	
Budgam	Beerwah	33	06	100
	Budgam	34	07	
	Chadoora	33	06	
Anantnag	Anantnag	20	04	60
	Bijbhera	20	04	
	Dooru	20	04	
Kulgam	Kulgam	20	04	40
	Devsar	20	04	
Pulwama	Pulwama	20	04	80
	Tral	20	04	
	Awantipora	20	04	
	Pampore	20	04	
Shopian	Shopian	20	04	20
Baramulla	Rafiabad	12	03	75
	Baramulla	13	03	
	Kreeri	12	03	
	Tangmarg	13	03	
	Sopore	12	03	
	Pattan	13	03	
Bandipora	Bandipora	13	03	25
	Sonawari	12	03	
Kupwara	Kupwara	50	10	100
	Handwara	50	10	
Jammu	Akhnoor	20	05	80
	Jammu	20	05	
	R.S. Pora	20	05	
	Bishnah	20	05	
Samba	Samba	20	04	20
Rajouri	Thanamandi	33	06	100
	Darhal	33	06	
	Budhal	34	07	
Poonch	Haveli	50	10	100
	Mendhar	50	10	

Doda	Doda	50	10	50
Kishtwar	-	-	-	-
Ramban	Ramban	50	10	50
Udhampur	Udahampur	33	06	67
	Chenani	34	07	
Reasi	Reasi	33	06	33
Kathua	Hiranagar	50	10	100
	Kathua	50	10	
Total		**1200**	**245**	**1200**

Source: *Computed from Census of India, 2011*

The two districts of Ladakh were not taken for primary survey as the area under all the crops grown there has increased on account of land reclamation as against the other districts where cropping land use change is significant. A structured schedule (Annexure- I) was used as a tool for primary data collection. The distribution of sample tehsils is given below.

3.2.3. Secondary Data

Ancillary data comprising reports, official data and publications relevant to the present study were obtained from different sources. The data pertaining to the population dynamics have been obtained from census of India- J&K Series, 2011. The data related to food imports was collected from consumer affairs and public distribution department (CAPD) office, Srinagar and Jammu. Cropping land use data have been obtained from financial commissioner's office Srinagar and Jammu. Productivity data of the different crops selected for the study has been acquired from Directorate of agriculture, Srinagar and Jammu. Data related to climatic variables (temperature and precipitation) has been obtained both from Indian meteorological department (IMD), Pune and regional meteorological centre Srinagar and Jammu.

3.2.4 Software's used

(i) ERDAS IMAGINE 9.0

It is primarily aimed at geospatial raster data processing and allows the user to prepare, display and enhance digital images for mapping use in GIS or in CADD software.

(ii) Arc View GIS 3.2a

The software is essentially required for the process of digitization of geo-referenced toposheets and satellite imageries. Moreover, projecting the data on maps is impossible without the use of Arc View GIS.

3.3 METHODS

The data sets generated and collected were tabulated and analyzed using appropriate methodologies and techniques to accomplish the objectives selected for the study. The flowchart of the methodology adopted is given in Fig. 3.2. A brief description of the various steps of methodology is given below:

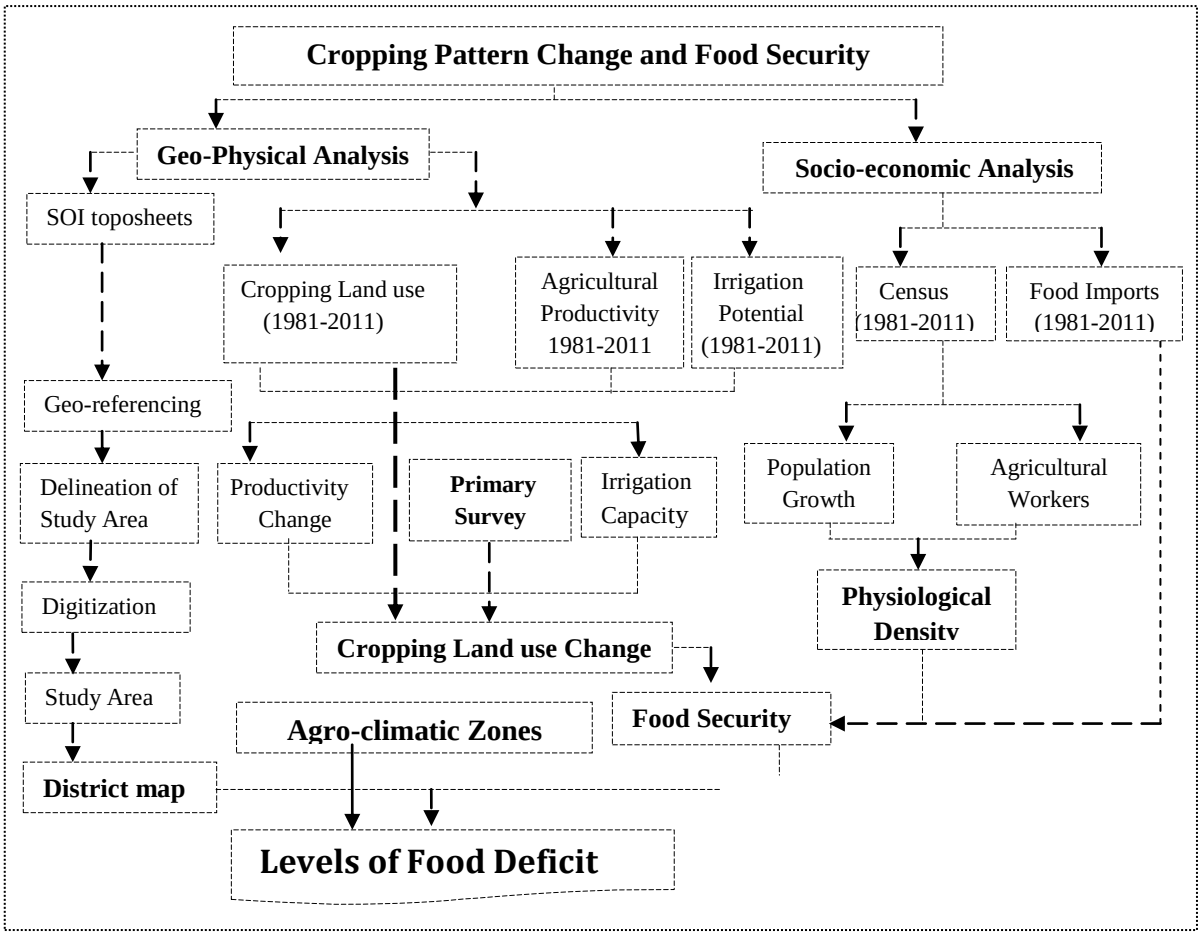


Fig. 3.2: Flow chart showing methodological framework of the study

3.3.1 Geo- referencing

The relevant survey of India toposheets were scanned and geo-referenced in a common frame to make them compatible for the subsequent analysis. The method of image registration or "geo-referencing" can be divided into two types: "image to image registration" and "image-to-map registration". First of all the toposheets were individually geo-referenced to a common projection (UTM, Zone 43 North, WGS 84) using 16 well distributed ground control points for each toposheet with the help of the coordinate system already available on the toposheets and a mosaic was prepared.

3.3.2. Cropping Land use Analysis

The cropping land use analysis was carried as it is intimately related with the production and food budget of any area. The data on various cropping land use variables chosen for the study, *viz,* net sown area, gross cropped area, area under paddy, wheat, maize, orchards, fallow land, land put to non-agricultural use etc. has been arranged in five year interval period and time series analysis has been carried out to analyze the spatio-temporal change in the variables. The change has been depicted by making use of graphs and charts/bars. These variables were calculated and compared between districts to gauge their spatial dynamics in the study area.

3.3.3 Food Import Analysis/ Food deficit determination

In order to ascertain the food deficit trends in the various districts of Jammu and Kashmir, the data on food imports, population, and per capita food consumption has been collected. The total population of each district in the year 1980 was multiplied by the per capita food consumption in the same year to get the total requirement and the domestic production of respective districts of the same year was subtracted from it to get the food deficit of each district in 1980.

3.3.4 Delineation of micro agro-climatic zones

For the delineation of the micro agro-climatic zones, '*superimposition principle'* was used based on those of WMO-UNEP (1971-2000) and FAO (1993). The different map layers needed were prepared by using appropriate methodology. From base map, physiography and Altitude zonation were prepared. Soil map was generated from Indian council of agricultural research (ICAR) database. For the preparation the PT index map, the meteorological stations were identified by superimposing their location on the altitude zonation map and district boundary map. Then '*Arithmetic average method'* and '*Thiessen Polygon Method'* have been employed to calculate the average depth of rainfall over an area of the stations. The formula's used are;

(i) $P_{ave} = \frac{\Sigma\, Pi}{n}$ (ii) $P_{ave} = \sum_1^n Pi \ \frac{Ai}{A}$

Where, 'P_{ave}' is the average depth of rainfall over the area, 'ΣP_i' is the rainfall amounts at individual precipitation stations, 'n' is the number of these stations, 'Ai' is the weighting factor and 'A' is total area of the basin or region.

The Thiessen polygon method attempts to allow for non-uniform distribution of stations by providing a weighting factor for each station. The stations are plotted on a base map and are connected by straight lines. Perpendicular bisectors are drawn to the straight lines, joining adjacent stations to from polygons known as *'Thiessen polygons'* (Fig 3.3). Each polygon area is assumed to be influenced by the meteorological/precipitation station inside it, i.e., if there are n stations with rainfall values P_1, P_2, P_3,…..P_n and A_1, A_2, A_3 …… A_n are the area of the respective thiessen polygons surrounding these stations (influence areas) respectively, the average depth of rainfall for the entire region or catchment is calculated by formula (ii).

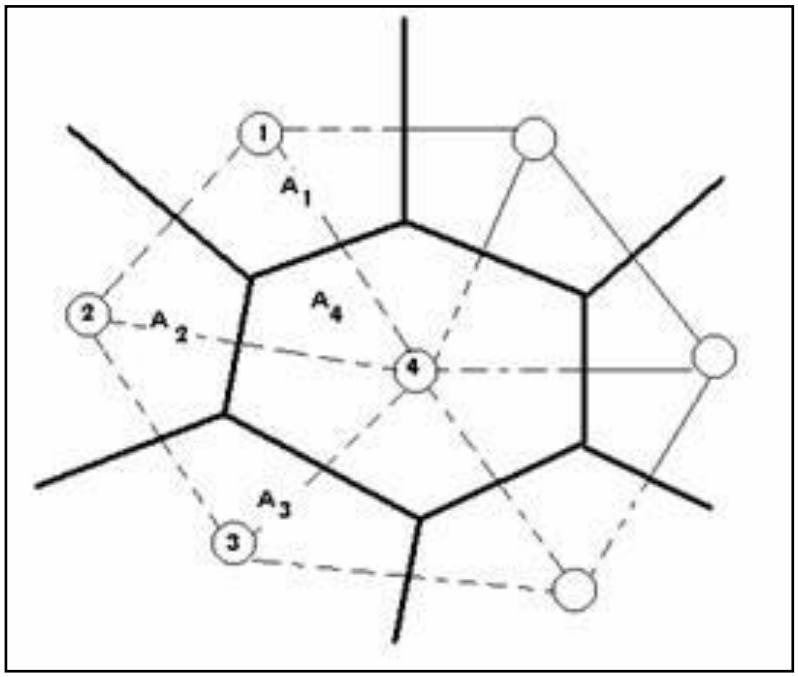


Fig. 3.3

3.3.5 Statistical analysis

(I) Standardized Score

In statistics, a standard score indicates by how many standard deviations an observation or datum is above or below the mean. It is a dimensionless quantity derived by subtracting the population mean from an individual raw score and then dividing the difference by the population standard deviation. This conversion process is called *standardizing* or *normalizing*. Standard scores are also called *z-values*, *z-scores*, *normal*

scores, and *standardized variables*; the use of "Z" is because the normal distribution is also known as the "*Z distribution*". They are most frequently used to compare a sample to a standard normal deviate (standard normal distribution, with $\boldsymbol{\mu = 0}$ and $\boldsymbol{\sigma = 1}$), though they can be defined without assumptions of normality. The standard score of a raw score $\boldsymbol{x}$ is

$$z = \frac{x - \mu}{\sigma}$$

*Where, **'μ'** is the mean of the population and **'σ'** is the standard deviation of the population*

The standard score (more commonly referred to as a z-score) is a very useful statistic because it allows calculating the probability of a score occurring within normal distribution and enables to compare two scores that are from different normal distributions. The standard score does this by converting (in other words, standardizing) scores in a normal distribution to z-scores in what becomes a standard normal distribution. In the present study, z-score has been used extensively to remove the biasness of scale of variables and for carrying out spatial variation analysis of different variables taken for the study.

(II) Correlation and Regression Analysis

Correlation and regression analysis are related in the sense that both deal with relationships among variables. The correlation coefficient is a measure of linear association between two variables and its value varies between -1 and +1. In simple linear regression, the model used to describe the relationship between a single dependent variable y and a single independent variable x is

$$\mathbf{y = a_0 + a_1 x + k}$$

a_0 and a_1 are referred to as the model parameters, and is a probabilistic error term that accounts for the variability in y that cannot be explained by the linear relationship with *x*. The formulas used in correlation and regression analysis are;

(i) Coefficient of Correlation, $r = \frac{\sum d_x d_y}{\sqrt{\left(\sum d_x^2 \sum d_y^2\right)}}$

(ii) The Linear Regression equation for *y* on *x* is; Y= a+b*x*, where 'b' is the slope and 'a'

is the intercept (the point where the line crosses the Y-axis); **a= y- b** $\bar{x}$ and

$$b = \frac{\sum d_x d_y}{\sum {d_x}^2}$$

(III) Crop Combinational Analysis

The crop combination analysis technique identifies and locates areas sharing significant proportion of crops at higher rank, thus helps to understand the agricultural mosaic, cropping pattern, crop concentration, cropping variation, crop diversification and operation of a given area thus aiding to draw a rough sketch of agricultural topology and provide agricultural regionalization. For the delineation of crop combination regions, Rafiullah's (1956) maximum positive deviation method has been used in the study.

The expression is:

$$\mathbf{d} = \frac{\mathbf{\Sigma D^2 P - \Sigma D^2 N}}{\mathbf{N^2}}$$

Where, d= deviation

Dp = positive deviation from median value of crop combination

Dn = negative deviation from median value of crops

N = number of crop combination

Greater is the dominance of crops, lesser is the crop combination. In positive deviation method, the differences of the actual values are calculated from the mid values of the theoretical standard, thus giving the wanted critical combination unlike others. There is no arbitrary selection; the maximum variance of combination will be sorted from the calculation derived from data.

(v) Proportional weightage method

Since the productivity data is not available at agro-climatic zone level, therefore the productivity of districts has been used to generate the productivity database for the agro-climatic zones by using the *'proportional weightage'* method.

4.1 LOCATION AND EXTENT

The state of Jammu and Kashmir constitutes northern most extremity of India and is situated between 32° 17′ to 37° 05′ north latitude and 73° 26′ to 80° 30′ east longitude (Fig. 4.1). It falls in the great northwestern complex of the Himalayan Ranges with marked relief variation, snow-capped summits, antecedent drainage, complex geological structure and rich temperate flora and fauna. The state is 640 km in length from north to south and 480 km from east to west. It consists of the territories of Jammu, Kashmir, Ladakh and Gilgit and is divided among three sovereign Asian states of India, Pakistan and China. The total area of the State is 2,22,236 km^2 comprising 6.93 per cent of the total area of the Indian territory including 78,114 km^2 under the occupation of Pakistan and 42,685 km^2 under China. The cultural landscape of the state represents a zone of convergence and diffusion of mainly three religio-cultural realms namely Muslims, Hindus and Buddhists. The population of Hindus is predominant in Jammu division; Muslims are in majority in Kashmir division while Buddhists are in majority in Ladakh division. Jammu is the winter capital while Srinagar is the summer capital of the state for a period of six months each. The state constitutes 6.76 per cent share of India's total geographical area and 41.83 per cent share of Indian Himalayan Region (Nandy, *et al*, 2001).

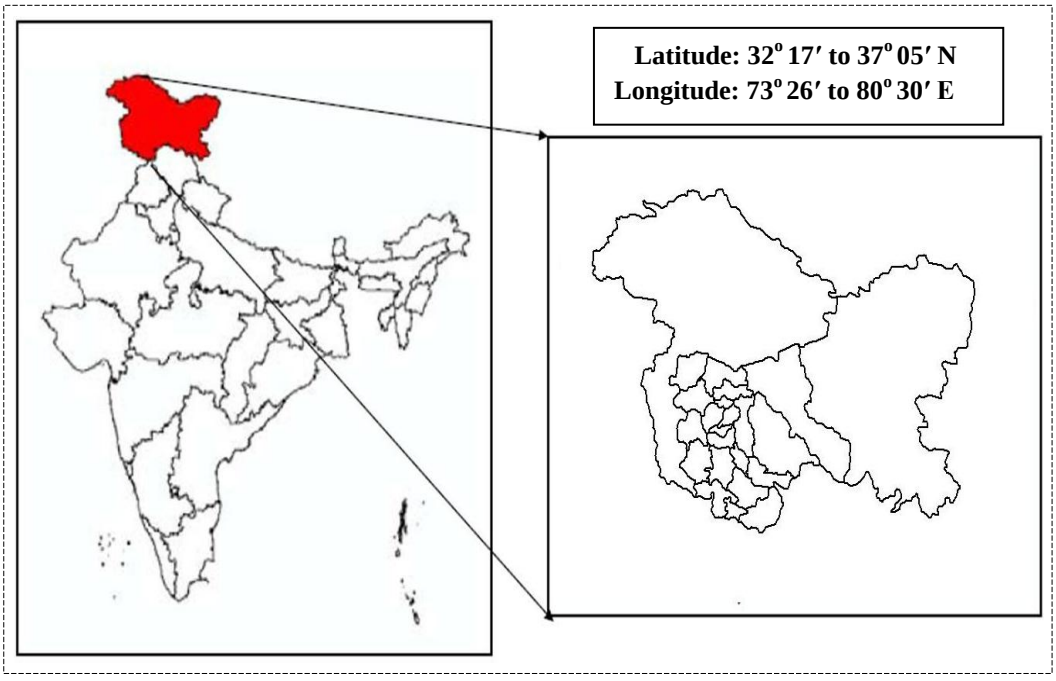


Fig. 4.1: Location of Jammu and Kashmir

It ranks 6th in area and 17th in population among states and union territories of India while it is the most populated state of Indian Himalayan Region constituting 25.33 per cent of its total population. The state is bounded on north by China and Afghanistan, Tibet on east, Pakistan on west and on south by Himachal Pradesh and Punjab states of India. The State is well connected with rest of the country by air, rail and road. The National Highway NH-1A connects the capital cities of Srinagar and Jammu with rest of the country. The mountain chains that adorn the region include the Karakoram Range, Kunlun range, the Zanskar range and Nanga Parbat. The State of Jammu and Kashmir has many Himalayan rivers flowing through it; the most significant among these are the Indus, Jhelum and Chenab. Among the glaciers the important ones are the Baltoro and Siachen Glaciers. There are many low lying valleys in the state like Tawi Valley, Chenab Valley, Poonch Valley, Sind Valley and Lidder Valley, but the main Valley is the valley of Kashmir, which is 120 km wide and occupies 15,520 km^2 area.

4.2 HISTORICAL SETTING

Kashmir is mentioned in the epic *'Mahabharata'*. In 250 BC, Ashoka, the great Mauryan king, established the city of Purana Adesthan (Pandrethan) and built many viharas and chaityas. Later Central Asian nomadic tribes (Indo-Greeks, Sakas, Parthens and Kushans) conquered Kashmir and ruled over the territory for about six centuries (Shali, 1993). Local kingdoms ruled extensively in this region until the 14th century AD when Muslims invaded the region (Bamzai, 1962). The greatest Muslim king of early medieval age in Kashmir was *Zain-ul-Abidin*, who ascended the throne in 1420 AD and ruled up to 1470. His long rule not only contributed extensively to the spread of art, culture and music, but he also created a strong army and annexed many regions nearby Kashmir (Hasan, 2005). This was the time of golden rule in Kashmir when peace and harmony prevailed. After the death of King *Zain-ul-Abidin*, a period of destruction came calling to Kashmir and many raiders from outside looted the state and made the people and local rulers their captive. In 1586, Akbar annexed Kashmir into his vast empire. It was during 1627-58 AD that Jahangir and Shah Jahan developed the world famous Mughal Gardens of Kashmir e.g. Shalimar Bagh, Nishat Bagh and Chashma Shahi (Koal, 2005). After two centuries of peace and development, Kashmir came into the hands of the Pathans in 1752, when the Afghan ruler Abdul Shah Abdali

attacked this region. In 1819 A D, Kashmir was annexed by Ranjit Singh and made a part of his Sikh empire.

The two Anglo-Sikh wars fought between the Sikhs and British resulted in the complete extinction of the Sikh sovereignty in Kashmir. The British gave away Kashmir to Ghulab Singh for the sum of 75 lakh rupees under the Treaty of Amritsar (Rai, 2004). This entitled Ghulab Singh to have his complete sway over the dominion. He extended his territory by annexing Ladakh. Ghulab Singh died in 1857 and was replaced by Rambir Singh (1857-1885). Two other Marajahs, Partab Singh (1885-1925) and Hari Singh ruled in succession. Maharaja Hari Singh ascended the throne in 1925. In 1932 Kashmir's first political party - All Jammu and Kashmir Muslim Conference was formed by Sheik Abdullah and his colleagues. The party was later renamed as The National Conference in 1939 and continues to be a major political party in Kashmir today. Thus this northernmost state was founded by Maharaja Gulab Singh in 1846 and was the biggest princely state in India before the partition of the country in August 1947. Later on Hari singh signed the Instrument of Accession with India in 1947. Since then the state of Jammu and Kashmir has acquired a unique geo-political status in the Indian sub-continent.

4.3 ADMINISTRATIVE DIVISIONS

Jammu and Kashmir is a multi-lingual, multi-religious and multi-racial state and each group has its own distinct and peculiar cultural ethos, further deepened by geographical divisions created by formidable mountain ranges. The state comprises of three natural divisions, namely Jammu, Kashmir and Ladakh. For administrative purposes, the state is divided into two main divisions, i.e., Kashmir and Jammu division. A Divisional Commissioner heads the administration of each division. The two districts of Ladakh region, namely, Leh and Kargil are part of the Kashmir division for purpose of administration. District Development Commissioner heads each district. In Ladakh region, the *'Ladakh Autonomous Hill Development Council (LAHDC)'* was established in 1995 as part of decentralized administration. The districts are divided into blocks for development purposes and into tehsils for revenue purposes. The state consists of 22

districts and seventy six tehsils with Kashmir and Jammu divisions equally having 10 districts each and the remaining two districts belonging to Ladakh division.

Jammu Region: The Jammu region is situated on the North Indian plains, close to the Siwalik ranges. This region comprises the plains, hills and mountains south and west of the mighty Pir Panjal range that separates Kashmir Valley from the plains of the subcontinent. North of the Siwaliks, the rest of the Jammu region is drained by the Chenab River whose vast catchment area includes several narrow valleys that extend deep into the Himalayas. Jammu is about 305 meters above the mean sea level (MSL). Jammu is famous for its ancient temples and palaces. Today, the Jammu region comprises the districts of Kathua, Jammu, Udhumpur, Doda, Rajouri, Ramban, Kishtwar, Reasi, Samba and Poonch.

Kashmir Region: The Kashmir region or valley is a significant part of the state. The valley is an ancient lake basin 140 km long and 32 km wide (Raza, 1978). The average elevation of the valley is 1630 m above MSL. The tall mountains that surround the valley rising up to 5400 m ensure that the weather here is pleasant for most of the year. The region is famous for its picturesque natural beauty and among other things is known for its Dal Lake that reflects the surrounding snow-capped mountain peaks. Its rich alluvial soil well drained by rivers and streams, yields rice, saffron, vegetables and a variety of fruit. Wular Lake in Kashmir valley is the largest fresh water lake of India which acts as a drainage basin for Jhelum river. The Valley is known for its fresh apples and the intricate embroidery stitching. It comprises of ten districts namely, Anantnag, Baramulla, Badgam, Kupwara, Pulwama, Shopian, Kulgam, Bandipora, Ganderbal and Srinagar.

Ladakh Region: Ladakh constitutes the eastern-most part of the state of Jammu and Kashmir. It comprises of two districts, namely, Leh and Kargil. This is one of the most breathtakingly beautiful parts of the state and its surreal landscape has often been termed as ‘moonscape’. Ladakh covers about 1,17,000 km^2 and includes the Karakoram Range and the upper Indus River valley. Ladakh is one of the highest places on earth with the average altitude being above 3700 m. Situated on the leeward side of the mountain, it hardly gets any rain. The region is sparsely populated and people live

traditional life, herding sheep and yak and growing barley near the river beds in summer. Physical features that characterize the region are its uplands, craggy barren cliffs and plateaus. The mighty river Indus flows right through Ladakh. Leh is famous for its adventure sports. The region is famous for the Leh Palace and the Namgyal Tsemo Gompa monastery.

4.4 PHYSIOGRAPHY

The state of Jammu and Kashmir possesses a peculiar geo-physical setting as all the major landforms i.e. mountains, plateaus, plains and valleys are present in its landscape. Geographically, the state is divided into four zones – the mountainous and semi-mountainous plain known as Kandi belt, hills including Siwalik ranges, mountains of Kashmir valley and Pir Panjal range, and Tibetan tract of Ladakh and Kargil. The state has a number of lakes, rivers, rivulets and glacial regions. The Physiography of the territory as a whole is divided into seven zones those are closely associated with the structural components of the western Himalayas. These include:

(i) The Plains: The outer plain also known as *Andarwah* and *Bajwat* is a part of Great Plains of India. The rocks of this region are of fluviate and sub-aerial formation. Its width varies from 5-25 kilometers and it stretches from river Ravi to River Chenab for an extension of 110 kilometers with the elevation of 330 to 360 meters. The narrow zone of plains in the Jammu region is characterized by interlocking sandy alluvial fans that have been deposited by streams discharging from the foothills and by a much-dissected pediment (eroded bedrock surface) covered by loams and loess (wind-deposited silt) of the Pleistocene Epoch (i.e. those about 10,000 to 1,600,000 years old). Besides Ravi and Chenab the region is also drained by Ujh, Basantar, Tawi and Manawar Tawi. This plain is badly dissected by a series of deep and shallow ravines which carry off the seasonal flood waters of monsoon rains. Such is the number of ravines that there are 200 bridges on the Jammu railway line which passes through this region (Khan, 2001). The mountains of Jammu almost run parallel to the outer plain region. Rainfall is low, amounting to about 15 to 20 inches (380 to 500 millimeters) a year, and it occurs mainly in the form of heavy but infrequent rain showers in the summer (June to September) when the monsoon winds blow. These plains are highly

fertile owing to the favorable climatic conditions and assured irrigation which enables the cultivation of crops throughout the year. Jammu, Kathua, Samba, Hiranagar and Akhnoor belong to the outer plains (Husain, 1987). The countryside has been almost entirely denuded of trees, and thorn scrub and coarse grass are the dominant forms of vegetation. At higher elevations the topography changes and the hill slopes appear wooded.

(ii) The Siwaliks: The outermost relatively low hills of the Himalayas along its whole length from the Indus to the Brahmaputra are known as the Siwaliks. The width is between 20-50 kms and the altitude ranges between 600 -1200 meters in the state. The Siwaliks are made of the younger tertiary rocks (Husain, 1987). The rocks are deposited in the parallel folded zones. Subjected to folding these low hills resulted in the formation of a series of anticlinal hills with sloping plateaus, gently towards the plain. The hills consist of clay, sand, round pebbles and boulders which are badly dissected by ravines and seasonal stream courses. A series of wide longitudinal valleys called duns lie to the north of Siwalik hills. Udhampur, Sunderbani, Bosahli, Ramkot and Dansal are typical examples of such duns. The slope facing the outer plains is gentle covered with deciduous forests while the northern slopes are steep with dense vegetation. Due to the presence of ravines, the Siwaliks appear as isolated and broken hills. Rainfall increases with elevation, and the lower scrubland gives way to pine forests at higher altitudes. The undulating slope adjacent to the plains up to an elevation of 300 m between Ravi and Chenab rivers is locally known as Kandi Characterized by numerous torrents, hilly soils and scarcity of water. Xerophytic vegetation is common in these areas while agriculture is subjected to the availability of rainfall. Lake Mansar and Surinsar are situated at an elevation of 600 meters to the east of Jammu city in the Siwalik hills. The important towns are Jammu, Jasrota, Samba and Akhnoor.

(iii) The Middle Himalayas: The middle Himalayas are also known as the middle mountains, lesser Himalayas or Pir Panjal. They have an east-west extension. They vary in elevation between 1820 m to 2240 m with a width of about 60 kms in the eastern part of Jammu division and 10 kms near Rajouri. This physical division lies between the Ravi in the east and the Poonch in the west and continues up to Muzafarabad. They are locally known as Pahar (mountain) in Jammu region. They are composed of highly

compressed and altered rocks of various geological ages, ranging from the puranas and carboniferous to Eocene (Wadia, 1928). Consisting of an ancient rock core of granites, gneisses, quartz rocks and slates, it has been subject to considerable uplift and fracturing and was heavily glaciated during the Pleistocene Epoch (Diener, 1912). Several important rivers like Tawi, Manawar Tawi, Basantra and Ujh have their sources in middle Himalayas. However, Chenab is an important river of this region and the famous Salal Hydroelectric project near Reasi is constructed on it. The mountains are orthoclinal which is helpful in preserving soil and supporting huge and thick temperate vegetation like deodar, oak, pine, spruce and fir. The range receives considerable precipitation in the form of winter snowfall and summer rain and has extensive areas of pasture above the tree line. The people are largely dependent on forestry, lumbering, herding and tourist activity.

(iv) The Valley of Kashmir: Between the Pir Panjal and the western end of the Great Himalayan ranges lies a deep asymmetrical basin called the Vale of Kashmir and has an area of 15220 km^2. Average height of the valley is 1630 metres above mean sea level (Lawrance, 1996) but the surrounding mountains, which are always snow-clad, rise from 3000-4000 metres above MSL. The river Jhelum, originating from the *'Sunna Brari Peak'* near Verinag in Anantnag district passes through the middle of the Valley at a very slow speed and ultimately flows out through a narrow gorge at Baramulla. There are also some small valleys in this region. On the north of Baramulla is Lolab valley which is 6 kms long and 4.4 kms wide. It has many meadows and groves of walnut trees. Forests are so thick that they hide villages in them. Sind is the largest tributary of the river Jhelum. The Sind valley is 100 Kms long upwards and its scenery is diversified. At the head of the valley is the Zojilla pass which leads to Ladakh. Towards Pahalgam lies the Lidder Valley. Its length is 64 Kms. It has glaciers, grassy meadows, huge rock walls and gorges in its upper mountains. The path to the holy Amaranth cave passes through this valley. The Kolahoi and Sheshnag streams join at Pahalgam to form the Lidder River. The karewa formation covers a wide range of area on the southern periphery of the valley all along its longitudinal extent. They are divided into sloping karewas and flat topped karewas on the basis of surface characteristics. The sloping karewas are found along the flanks of Pir Panjal range,

where they form a continuous series, reaching from Shalura in the north-west to below Shopian in the south-east. The flat topped karewas consist of horizontal beds and attain a thickness of 92 m near Anantnag. Up to 2000 m, woodlands of deodar cedar, blue pine, walnut, willow, elm, and poplars occur; from 2000 to 3000 m coniferous forests with fir, pine, and spruce are found; from 3000 to 3500 m birch is dominant; and above 3500 m there are meadows with rhododendrons and dwarf willows as well as honeysuckle. The climate is characterized by an annual rainfall of about 30 inches, some of which is derived from the summer monsoon winds and some from winds associated with winter low-pressure systems. Snowfall often is accompanied by rain and sleet.

(v) The Greater Himalayas: The Greater Himalayan range along with the Zanskar range lie in the northern side of Kashmir valley (Raza, et al. 1978). Geologically complex and topographically immense, the Great Himalayas contain ranges reaching more than 6000 m in altitude and deeply entrenched, remote valleys. The region was heavily glaciated in the Pleistocene (Wadia, 1928) and remnant glaciers and snowfields are still present. Beyond this range lies the high plateau-desert which is devoid of any kind of vegetation. The elevated plateaus and ridges are separated from one another by great depressions (fig.4.2). The altitude rises further north till the peak K_2 (second highest peak in the world) in the Karakorum range attains the height of 8621 m. The Zanskar range is situated at an altitude of 5940 m. This range is famous for its two river valleys-the Zanskar and the Suru. The famous Kargil town lies in the Suru valley. The Karakoram region is aptly named the "roof of the world." The zone receives some rain from the southwest monsoon winds in the summer months and hence the lower slopes are forested, but the mountains constitute a climatic divide, representing a transition from the monsoon climate of the Indian subcontinent to the dry, continental climate of Central Asia.

(vi) The Ladakh plateau: Ladakh is the loftiest inhabited region of the world. Most of the surface area of Ladakh is mountainous and uninhabited as it comprises of old deserts and desolate plateaus intervened by difficult passes and valleys. The mountain chain of Ladakh stretches through the region from south-east to north-west with the altitude ranging between 5180-6400 m. Owing to the great aridity of the atmosphere,

the climate is extreme, from burning heat of some of the deserts to several degrees below freezing point at night.

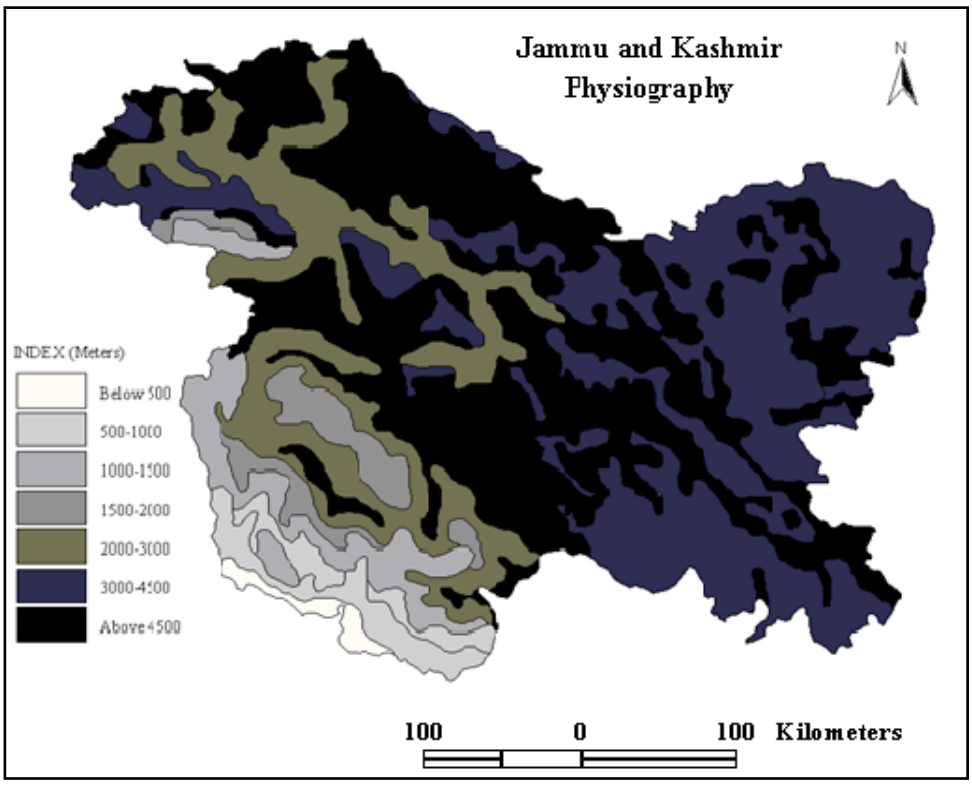


Fig. 4.2: Physiography of Jammu and Kashmir

4.5 DRAINAGE

The drainage system of Jammu and Kashmir is of recent origin owing to the mountain building process of late Tertiary age. The drainage system is antecedent in nature which means that most of the rivers are older than the mountains they traverse. The state is drained by river Indus and its tributaries like Jhelum, Kishanganga, Ravi and Chenab and their tributaries. Fresh and transparent water of these rivers and their tributaries form the most significant features of the landscape. These rivers have the perennial flow due to melting of snow in the Himalayas where from they originate (Fig 1.3). Indus and Chenab have their sources to the north of Greater Himalayas while Jhelum has its origin near Verinag in the Pir Panjal Range.

Indus: The Indus is one of the largest (25^{th}) river systems in the world. The common name of Indus river is *'Singge-Chhu'* which means the *'Lion-River'* or *'Sher-Darya'*. It rises from the northern slopes of Tibet near Mansarowar lake and enters Jammu and Kashmir state near Gartok where it meets Gurtang stream at an altitude of 4245m. The

Indus river flows in a north-westerly direction through the trough between the Kailash and the Ladakh range. Hanle, Suru and Zanskar are the left bank tributaries while Shyok, Shigar, Astor and Gilgit are the right bank tributaries. The river has many alluvial fans and river terraces on its either sides stretching over a distance of 30 kms. The flow is subjected to extreme variations with the maximum flow in the summer months (June to August) when the snow melt is high. The total length of the river is 2900 kms of which it runs for a distance of 966 kms in Jammu and Kashmir and finally through Pakistan falls in the Arabian sea near Karachi.

Jhelum: The river Jhelum rises from Pir Panjal Ranges about one kilometer ahead of Verinag. The river Jhelum is known as Veth in Kashmir valley. When it leaves Kashmir at Baramulla it is called the Kashur Darya and after joining the Kishanganga it is called Jhelum. Jhelum joins the Indus in the Punjab state of Pakistan. The river meanders in the valley, enters the Wular lake, leaves it near Sopore and flows in the narrow Gorge across the Pir Panjal from Baramulla to Muzafarabad (Raza, et al. 1978). In ancient times the river Jhelum served as the most important highway of Kashmir. The famous waterfall of Aharbal (21m) is formed by the stream of Vishav. The Jhelum and its tributaries are the main channels of drainage which sculpture the area during their course. The discharge is maximum during south-west monsoon when heavy and widespread rainfall occurs throughout the length and breadth of the valley. Sandran, Breng, Arpat, Lidder, Harwan, Sind, Erin, Madhumati, Pohru and Viji-Dakil are the right bank tributaries while Vishav, Rambiara, Romushi, Dudhganga, Sukhnag and Ningal are the left bank tributaries.

Kishanganga: This is an important tributary of river Jhelum. It has its origin in Kishansar lake located in Drass mountains and hence named as Kishanganga. It drains the Gurez valley and finally merges into Jhelum river at Domel near the city of Muzafarabad. The total length of the river is 288 kms. Throughout the Gurez front, the river is completely frozen over during the winter season. It separates the valley of Kashmir from Pakistan at present.

Chenab: This river is formed by two streams of Chandra and Bhaga at an elevation of 4891 m in Himachal Pradesh. The river flows between the Himalayas and the Pir Panjal

Range and then takes a turn to the south through a gorge. It flows through Doda, Reasi and Akhnoor. From Akhnoor the river assumes the plain stage and is navigable. From Tandi to Kishtiwar the river has many gorges, rapids and falls. At Kishtwar the river receives a perennial tributary known as Wadwan stream and makes a typical gorge about 1000 feet below Kishtiwar valley. The Chenab is about 1180 kms long in the state of Jammu and Kashmir. Important power projects of Salal Hydel Project (345MW) and Dulhasti (390MW) are generating electricity through the waters of river Chenab in Reasi and Kishtwar areas respectively.

Tawi: This river arises from Sewajdhar near Badarwah. The river passes through Ram Nagar, Chenani, Udhumpur, Nagrota and Jammu before its confluence with Chenab at Akhnoor. It has a total length of 120 kms.

Ravi: This river rises from the southern slopes of the Pir Panjal. The river passes through Madhupur and Kathua before entering into Pakistan to meet Indus. Total length of this river is about 65 kms.

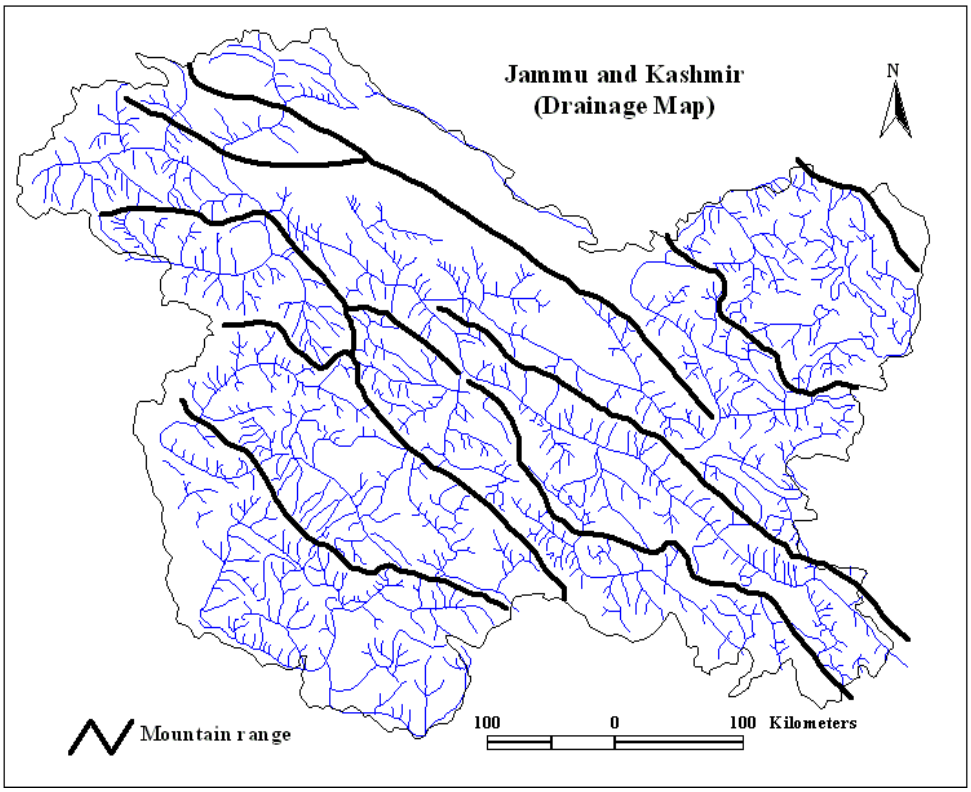


Fig. 4.3: Drainage system of Jammu and Kashmir

4.6 CLIMATE

The climate of the state differs from region to region on account of great variations in altitude, location and topography. The tropical heat of the Punjab and the arctic cold of Ladakh are the extremes and there are certain places where snow makes the life stagnant for about five to seven months in a year. The climate of the state varies from sub-tropical in Jammu plains to semi-arctic cold in Ladakh with Kashmir and Jammu mountainous tracts having temperate climatic conditions. There is marked spatial variation in the temperature and precipitation regime across the state. Leh is the coldest (-28°C average) while Jammu is the hottest. The mean monthly temperature is lowest in January and highest in July except in Jammu where highest temperature is experienced in June. Mean monthly temperature in January varies from –17°C at Drass to 14°C at Jammu; Kargil and Leh being the stations of below freezing average. Considering the overall distribution of different climatic elements, four units become obvious:

1. The windward (Jammu region)
2. The leeward (Ladakh region)
3. The high altitude Kashmir (Himadri, Pir Panjal)
4. The Kashmir valley

In the winter nights, temperature goes down below zero and very often heavy snowfall occurs during November to February. The snow is mostly received by Kashmir valley than Jammu and Ladakh. The annual rainfall varies from region to region with 92.6 mm in Leh, 650.5 mm in Srinagar and 1115.9 mm in Jammu. In the outer hilly region of the Jammu Province, climate has three main seasons: (i) hot weather season from April to June, (ii) a rainy season from July to September and (iii) cold weather season from October to March. The altitude of the State rises steeply from 305 metres to 6910 metres above mean sea level. There are the hot plains of the Jammu Province and the cold dry tableland of Ladakh. The area has different weather conditions at different places because of the lofty mountains like the Pir-Panjal, the Zanskar and the Karakoram that check the moisture-laden winds from entering the valleys. In summers, the outer plains and the outer hills receive rainfall from monsoon winds while in winters, winds from the Mediterranean cause snowfall and rainfall in the Valley of

Kashmir. The moisture-laden winds cause rainfall in the forests on the hills making the temperature to fall in summer; hence, the thickly wooded areas such as Pahalgam and Gulmarg have milder weather conditions than that of Srinagar. Similarly, the climate of the valley of Kashmir is comparatively milder than that of the Outer Plains as it is on higher altitude therefore making it one of the most liked tourist destinations during summer.

The climate of the valley of Kashmir has its own peculiarities. The seasons are marked with sudden change and the climate can be divided into six seasons (Table 4.1) of two months each (Raina, 2002). In the Kashmir Province there is not much rise in the temperature up to and end of May, but in June, July and August the temperature can rise up to 32ºC in shade. After August there is a decrease in the temperature and by the end of October it becomes cold and by January cold becomes intense with the snowfall. The snowy period lasts for two and half months beginning December through January to middle of March. During winter Dal Lake sometimes gets frozen, enabling people to skate over it. The distinctive feature of Kashmir's climate is the absence of monsoon rain, because the monsoons cannot cross the mountains enclosing Kashmir on the south.

Table 4.1: Seasons of Kashmir Valley

Season	Time period	Local Name
Spring	16 March to 15 May	*SONTH*
Summer	16 May to 15 July	*RETKOL*
Rainy season	16 July to 15 September	*WAHARAT*
Autumn	16 September to 15 November	*HARUD*
Winter	16 November to 15 January	*WANDAH*
Ice cold	16 January to 15 March	*SHISHUR*

Source: *Hussain, M., "Geography of Jammu and Kashmir", Pp. 148*

4.7 SOILS

Soil is the medium that supports the growth of the vegetable kingdom. The naturally occurring thin layer of unconsolidated material on the earth's surface that has been influenced by the parent material, climate, relief and physical, chemical and biological agents is known as soil. According to revenue records the land is classified on the availability of water resources i.e., land depending on rainfall is called *Barani*; that watered by wells is called *Chahi*; that irrigated by canals is *Nahari* and the land

moistured by rivers is called *Sailabi*. The soils in Jammu and Kashmir vary in colour, structure and texture. The rural folk and cultivators recognize their soils by different nomenclature and as such no soil map on the basis of scientific data has been prepared so far. The existing geo-climatic conditions have produced a wide range of soils both of residual as well as alluvial origin. The outer plain of Jammu with alluvial soils was deposited by the running water and fluvio-glacial action. The hilly and mountainous area are generally covered by the residual soils, while the upper reaches of Chenab, Jhelum and their tributaries are covered with alluvial and moronic soils. On the basis of rock strata and pedogenic character, the following major categories of soils may be identified in the state:

(i) Hilly and Mountainous Soils (high attitude soils): These soils cover the entire mountainous track of the state between 700-3500 m above MSL. The undulating topography and steep slopes affect the runoff and drainage system. The soil profile as well as the depth of the soil is shallow and the soils are immature and susceptible to erosion. These soils are generally acidic in character, deficient in potash and therefore need regular manuring and fertilizers for good yield. These soils are ideal for the cultivation of maize, wheat, barley, pulses, fodder and oil seeds. However temperate fruits (apple, peach, pear, almond) are suited to such soils. The higher altitudes (2500-4000 m) are reserved as alpine pastures where Gujjars and Bakarwals rear their folk during summer (Zutshi, 2001).

(ii) Karewa Soils (mid altitude soils): These are the lacustrine deposits found as elevated plateaus in Kashmir valley, Kishtiwar and Badarwah. These soils are composed of fine silty clays with sand and gravel (Husain, 1996). Commercial and crash crops like saffron, apple, almond, walnut, peach, pear, cherry etc are grown in these soils along with some leguminous and fodder crops. Pampore karewa is world famous for saffron cultivation, Soil erosion and hence decreasing fertility is the most important problems faced by these soils.

(iii) Alluvial Soils (low altitude soils): Sand, silt and mud brought down by rivers during floods and deposited on the temporary submerged land is known as alluvial soil. These soils are most fertile on which 2-3 crops can be raised in a single year. Geologically the alluvium is differentiated into *Bhangar* or old alluvium and *Khadar* or

new alluvium. *Khadar* is relatively coarse in texture and contain more sand than *Bhangar*. The alluvial soils are devoted to the cultivation of paddy during Kharif and mustard and fodder crops during Rabi season in Kashmir valley. In Jammu, crops like wheat, paddy, mustard, barley, sugarcane and barseen are raised in these soils. The alluvial tracts are densely populated and are the rice and wheat bowls of the state. The soil of Ladakh is bare and rocky with bare gravel slopes. Moreover, the Kashmiri farmers have classified their soils into *Gurti, Behil, Sekil, Nambal, Zabelzamin* and *Dazanlad* on the basis of their empirical experience.

4.8 NATURAL VEGETATION

The term natural vegetation is used loosely to describe any plant life that is not organized or influenced by mankind. The state is well endowed in forest resources. The forests have great diversity in species and varieties, ranging from the lush green margs (alpine pastures) to evergreen conifers on the gentle slopes of the Middle and the Greater Himalayas, and from scrub jungles of the foothills to the deciduous forests of the Siwaliks and the Pir Panjal Range. The natural vegetation of the state has great altitudinal variations and latitudinal zonation. There is hardly any vegetation at 5550 m above mean sea level (MSL) because most of the plants cease growth when the soil temperature drops below 5°C. There is a great diversity in the natural vegetation of the state as about 4000 species belonging to 1500 genera are found in the state. Some of the important forests of the state consist of deodar, juniper, pine, spruce, fir, yew, alder, elm, sorrel, poplar, birch, maple and mulberry. Being situated at higher latitudes and characterized by undulating and mountainous topography, most of the forests of the state belong to the coniferous category. The lower end of the greater Himalayas is quite rich in timber forest. The state is relatively poor in natural vegetation as compared to the other Himalayan states of India. During the last 60 years a substantial proportion of forests has been cleared and brought under agriculture and pastures. Forests have numerous productive, protective and bio-aesthetic functions. Forests constitute 14.5 per cent of the state's total geographical area. About 35 per cent of the total forest area lies in Jammu division, the rest being shared by Kashmir and Ladakh divisions (Table 4.2). The most valuable timer, that of Deodar (Oak) is mainly found in Baramulla, Anantnag, Doda and Udhumpur districts. In order to understand the spatial distribution of different

types of natural vegetation, the forests of the state may be classified into the following categories.

(i) Subtropical Forests: These forests are confined to the Siwaliks and lower slopes of the middle Himalayas. There is great diversity of trees in these forests because of the various edaphic factors and seasonality of rainfall. The dominant species are teak, sal, shisham, papal, tun, silver-pine, and reed. These forests are mainly utilized for fuel wood, timber, agricultural implements and miscellaneous purposes.

(ii) Temperate Forests: As the latitude and altitude increases towards the north, the subtropical forests are replaced by temperate forests. The slopes of Pir Panjal, Greater Himalayas, Karakorum and Zanskar between 1500 m to 3000 m are dominated by temperate forests. Deodar, pine, silver fir, spruce, alder, cedar, sorrel, birch and hazal are the dominant species.

(iii) Alpine Pastures: Alpine pastures also known as margs lie between 3600 m to 4000 m above mean sea level. The climate in these margs is extremely cold over most parts of the year which is supporting only some of the dwarf varieties of birch and junipers making shrubby appearances. The lush green and nutritious grasses of these pastures are utilized by the Gujjars and Bakarwals who practice transhumance.

Table 4.2: District-wise forest area, Jammu and Kashmir, 2008-09

District	Area under Forests (Km^2)			Percentage to total forest area
	Forest area	Wild life area	Total forest area	
Anantnag	2068	546.75	2614.75	7.34
Pulwama	810	273.25	1083.25	3.039
Srinagar	380	311	691	1.94
Badgam	477	3.25	480.25	1.35
Baramulla	2690	384.75	3074.75	8.63
Kupwara	1703	-	1703	4.78
Leh	29	13018	13047	36.61
Kargil	7	112	119	0.33
Jammu	959	256.5	1215.5	3.41
Udhampur	2343	42.25	2385.25	6.69
Kathua	991	44.75	1035.75	2.91
Doda	5555	418	5973	16.76
Rajouri	1267	-	1267	3.55
Poonch	951	-	951	2.67
Total	**20230**	**15410**	**35640**	**100**

Source: *Forest department, J&K, 2008-09*

Forests are mainly found where the annual rainfall is about 100 cm. However, scrub forests are found where rainfall is less than 100 cm. Forests are one of the most important resources of Jammu and Kashmir. More than 99 per cent of forest area is confined to the province of Jammu and Kashmir only (Table 4.6 and Fig. 4.4). The forest area of 2008-09 shows that 35640 km^2 of the state's area is under forest (table 4.6) which constitutes 35.15 percent of the total geographical area of the state on this side of the line of Control. Out of this, more than 99 per cent of the forest area is confined to the province of Jammu and Kashmir only, with the largest area of 5973 km^2 in the district of Doda (Fig. 4.4) and smallest area of 119 km^2 in the district of Kargil.

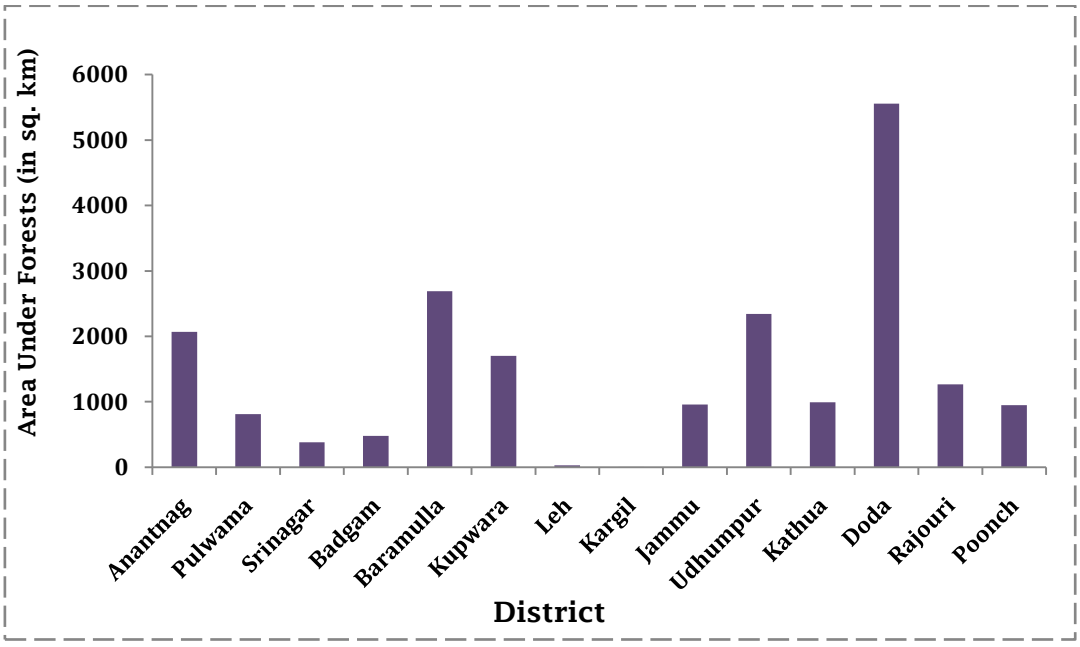


Fig. 4.4: Area under forests in Jammu and Kashmir

District wise the total forest area is observed more in Leh (36.61per cent), because of the fact that it has got the highest percentage of the total wild life area (84.47 per cent) of the state (Table 4.6). It is followed by Doda (16.76 percent), Baramulla (8.63 percent), Anantnag (7.34 percent) and Udhampur (6.69 percent). The least forest area is observed in Kargil (0.33 percent) [Fig. 4.5]. Vegetation is influenced by climate, rainfall soil and altitude. Since these factors vary as the altitude rises from the outer plains of Jammu Province to the loftiest mountain ranges of the Inner Himalayas, it is but natural that the vegetation should vary from the Inner Himalayas to the middle mountains and the outer plains of Jammu region. Over 19,236 km^2 is under coniferous softwood (Pine) and 946 km^2 under non-coniferous softwood. In the coniferous

category, fir accounts for 3355 km^2, kail for 1874 km^2, chir for 1773 km^2 and deodar for 1122 km^2.

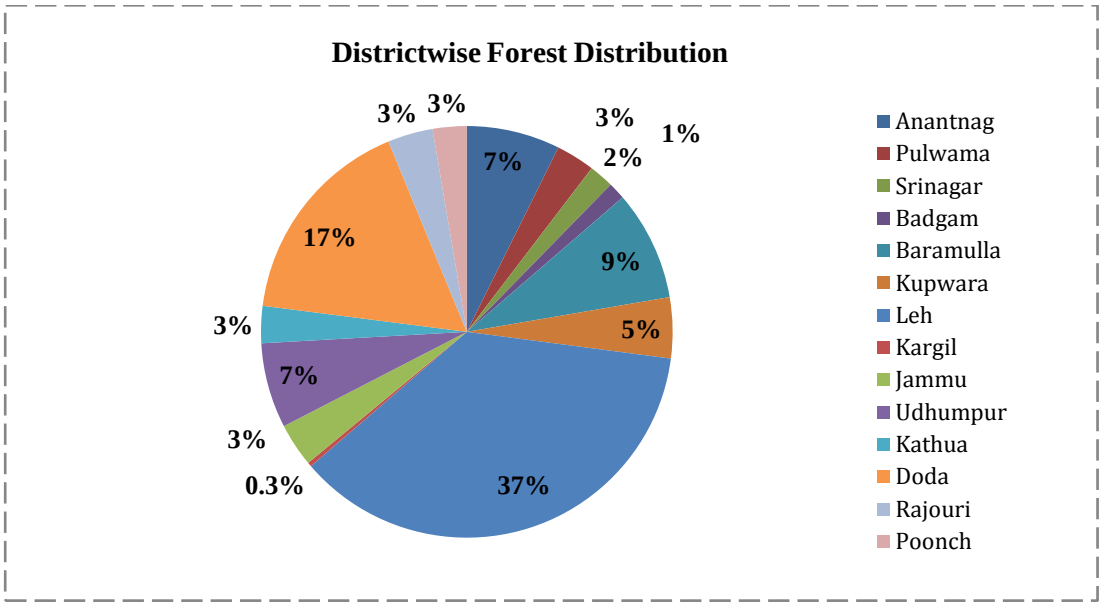


Fig 4.5: District wise forest distribution in Jammu and Kashmir

4.9 DEMOGRAPHIC PROFILE

The state has a population of 12548926 (census of India, 2011) with a density of 124 persons per km^2. The most striking feature of population is its uneven distribution, which is closely related with relief and climate. The important population characteristics are discussed below:

(i) Population distribution: The spatial distribution of population in Jammu and Kashmir is highly uneven. The physical factors like terrain, topography, slope, climate, soil, natural vegetation and accessibility have largely controlled the distribution and density of population in the state. In general, about 85 percent of the total population of the state is occupying the Jammu plain and Kashmir valley (Jhelum floor), 14 percent population is living in the Kandi areas and the side valleys within 2000 m above mean sea level (MSL) while the remaining 1 per cent is sprinkled in the high altitudinal zones of the Himalayas, Zanskar, Ladakh, and Karakorum Ranges (Qazi, 2005). Kashmir province constitutes 55 per cent of the total state's population while 42.64 percent is distributed in Jammu province (Fig. 4.6) and the rest 2.3 percent population is dwelling in Ladakh province (table 4.3). The population distribution pattern among the districts indicates high concentration in Jammu district followed by Srinagar, Anantnag and

Baramulla. These four districts also have maximum concentration of urban population. Least concentration of population is in Leh, Kargil, Poonch, Rajouri, Kathua and Budgam districts.

Table 4.3: Division wise distribution of population, Jammu and Kashmir, 2001 and 2011

S. No.	Division	Population 2001		Population 2011	
		Absolute	Percentage	Absolute	Percentage
01.	**Kashmir**	5441341	54.04	6907623	55.05
02.	**Jammu**	4395712	43.65	5350811	42.64
03.	**Ladakh**	232864	2.31	290492	2.31
	Total	**10069917**	**100**	**12548926**	**100**

Source: *Census of India, 2001 and 2011*

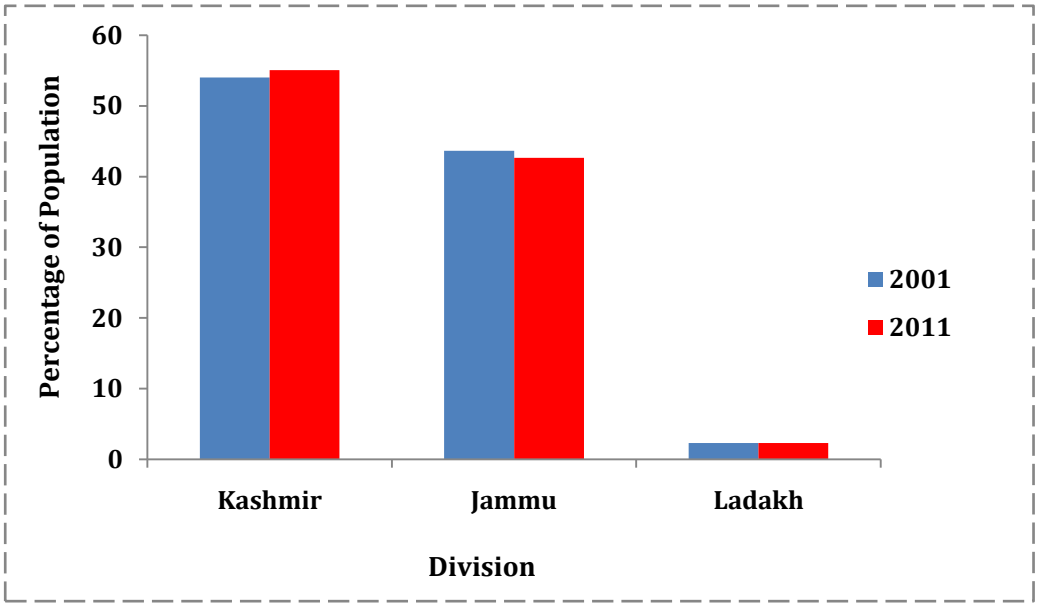
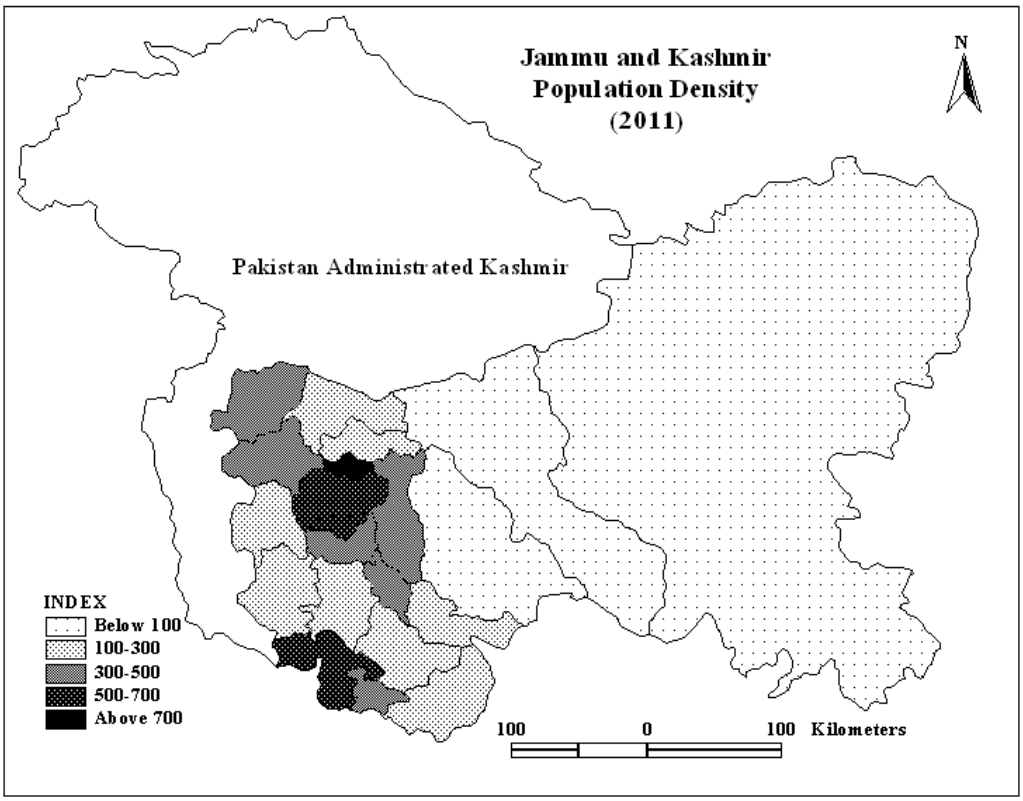


Fig. 4.6: Province wise population (in percent) of Jammu and Kashmir

(ii) Population Density: The density of population in the state has shown tremendous increase after independence. It has increased from 32 persons per km^2 in 1951 to 124 persons per km^2 in 2011 (table 4.4). The density of population has increased more than two fold in the last 30 years only. Density of population in the state is 124 persons per km^2 (table 4). Srinagar and Jammu districts recorded high density of population of 2860 and 674 persons per km^2 respectively, mainly on account of being the state's administrative capitals which have made them the hub of socio-economic activities.The lowest population density is found in the Ladakh division (Fig 4.7) with only 3 persons per km^2 in Leh district. The population distribution and density pattern indicates an

overwhelming influence of geo-physical disposition across the different regions of the state. In addition to this centralized distribution of small manufacturing and service sectors in few urban centers have also influenced the population density and distribution pattern as well. Since social, economic and technological development are in the early stages, agricultural land capability (growing season, irrigation) and carrying capacity of land (soil fertility) and concentration of non-agricultural economic activities especially service activities has played significant role in population concentration and high density of population in Jhelum Valley Floor consisting of Srinagar, Badgam, Pulwama, Anantnag and Baramulla districts. Similarly in Jammu division high concentration and density of population is found in Jammu plains consisting of Jammu and Kathua districts. On the other hand, Leh, Kargil and Doda district recorded least density of population due to harsh environment control and the absence of social and economic development activities.



Source: *Census of India, 2011*

Fig. 4.7: Population density of Jammu and Kashmir (2011)

Table 4.4: District wise demographic profile of Jammu and Kashmir, 2011

S.No.	District	Area (km^2)	Population (persons)		Growth rate (%)	Density persons /km^2	Sex ratio	Literacy (percent)
			2001	2011				
01	**Kupwara**	2587	667674	875564	31.14	338	843	66.92
02	**Badgam**	1243	621750	735753	18.34	592	883	57.98
03	**Leh**	43215	120347	147104	22.23	3	583	80.48
04	**Kargil**	14843	122477	143388	17.07	10	775	74.49
05	**Punch**	2187	382513	476820	24.65	218	890	68.69
06	**Rajouri**	2715	496125	619266	24.82	228	863	68.54
07	**Kathua**	2983	525044	615711	17.27	206	877	73.50
08	**Baramulla**	2320	832650	1015503	21.96	438	873	66.93
09	**Bandipora**	2622	361592	385099	6.50	147	911	57.82
10	**Srinagar**	444	1046880	1269751	21.29	2860	879	71.21
11	**Ganderbal**	1402	218415	297003	35.98	212	869	59.99
12	**Pulwama**	827	453000	570060	25.84	689	913	65.00
13	**Shopian**	462	216947	265960	22.59	576	951	62.49
14	**Anantnag**	2559	759995	1070144	40.81	418	937	64.32
15	**Kulgam**	1181	300198	422786	40.83	358	951	60.35
16	**Doda**	2124	328765	409576	24.58	193	922	65.97
17	**Ramban**	935	220655	283313	28.40	303	901	56.90
18	**Kishtwar**	8686	195914	231037	17.93	27	917	58.54
19	**Udhumpur**	2654	471695	555357	17.74	209	863	69.90
20	**Reasi**	2344	254275	314714	23.77	134	891	59.42
21	**Jammu**	2266	1393135	1526406	9.57	674	871	83.98
22	**Samba**	788	279780	318611	13.88	404	886	82.48
	Total	**101387**	**10269852**	**12548926**	**24.61**	**124**	**883**	**68.74**

Source: *Census of India, 2011;*

(iii) Population Growth: The size of population and its growth have a direct bearing on the economic development, social well being and political stability of a region. Population growth is, thus, pivotal in the regions demographic dynamism (Chandna, 1992). The population of the state has increased more than two fold in the state during the last 30 years. In the first two decades of the 20th century the population growth was below 10 per cent (Table 4.5). After 1931, it was rising at a constant rate of 10 per cent per decade up to 1961, were from it has an unprecedented rise of 29 per cent per decade which is one of the highest growth rates in the country (17.64 percent for India). The districts of Kulgam, Anantnag, Ganderbal, Kupwara, Poonch and Rajouri have registered high decadal population growth rate (Fig. 4.7) than the state average of 24.6 percent, while it is very low in the districts of Bandipora and Jammu. Further, it is below the state average in both the districts of Ladakh region. However, decadal population growth was the highest (40.83 percent) in Kulgam district and the lowest (6.5 per cent) in Bandipora district.

Table 4.5: Decadal population growth, Jammu and Kashmir (1901 – 2011)

Year	Population	Density (Persons/km^2)	Percentage Growth	Urban Population		
				Absolute	Percent	Growth (in %)
1901	2139362	21	-	158748	7.42	-
1911	2292535	23	+7.16	268518	11.71	+69.2
1921	2424359	24	+5.75	267754	11.04	-0.28
1931	2670208	26	+ 10.14	317805	11.90	+8.7
1941	2946728	29	+ 10.36	386565	13.11	+21.64
1951	3253852	32	+ 10.42	457213	14.05	+ 18.28
1961	3560976	35	+9.44	593315	16.66	+29.77
1971	4616632	46	+29.65	858221	18.58	+44.65
1981	5987389	59	+29.69	1260403	21.05	+46.86
1991*	7803900	77	+30.34	1676914	21.94	+33.04
2001	10069917	99	+29.04	2505309	24.87	+49.4
2011	12548926	124	+24.61	*3815585	30.4	+52.3

Source: *Census of India, 2001; * Projected figures*

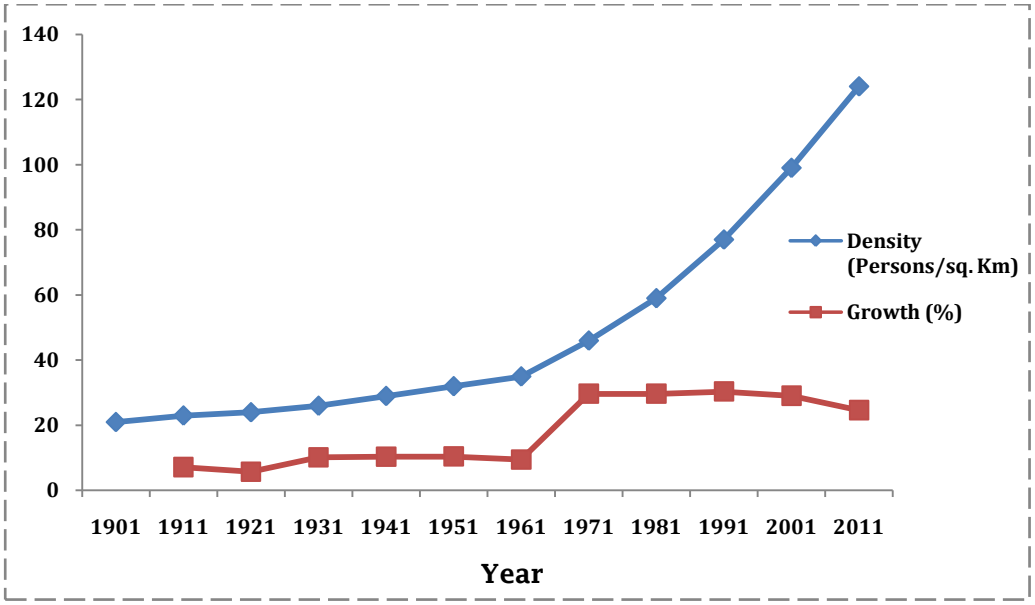
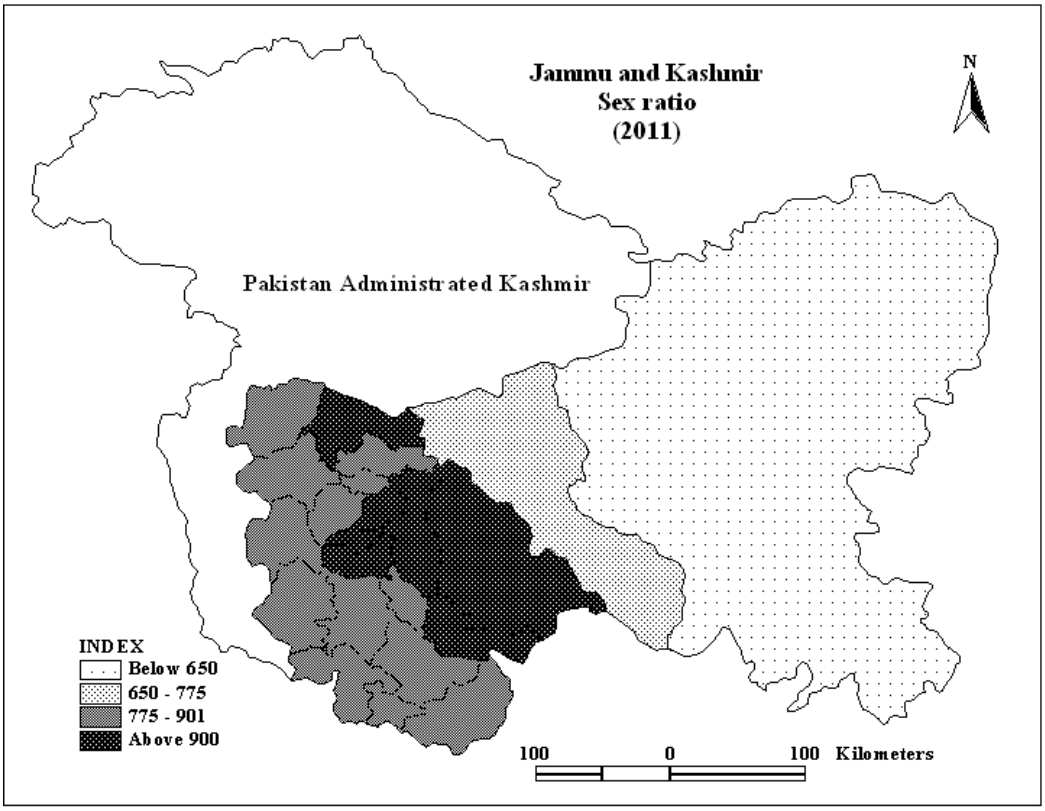


Fig. 4.8: Population growth and density of Jammu and Kashmir (1901-2011)

4.10 SEX COMPOSITION

The state of Jammu and Kashmir recorded a sex ratio of 883 (females per thousand males), as compared to the national average of 914 in 2011. Low sex ratio has been recorded in spite of the fact that the state witnesses male sex selective out-migration for seeking economic avenues. It therefore depicts higher mortality rates for females in the state due to low level of social development. Kargil registered least sex ratio of 775 females per thousand males (Fig. 4.9) while Kulgam and Shopian districts have the highest sex ratio of 951 females per thousand males.



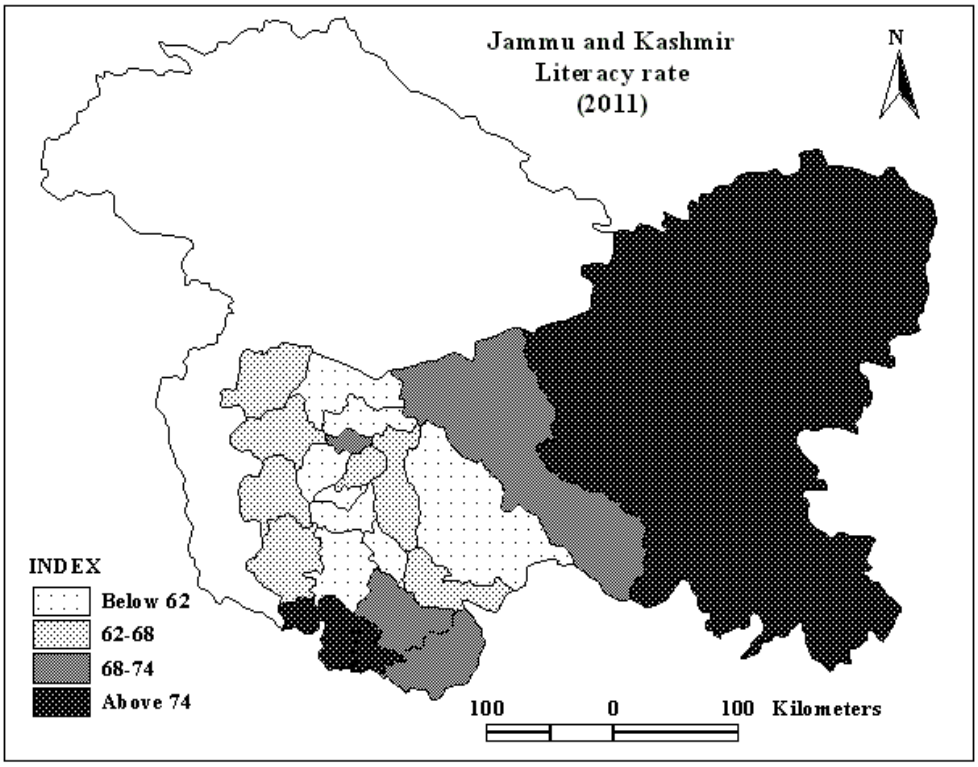
Source: *Census of India, 2011*

Fig. 4.9: Sex ratio in Jammu and Kashmir

4.11 LITERACY RATE

Literacy rate is a vital parameter to gauge the socio-economic transformation of the population. The process of education in terms of improved qualification and skills would help in the formation of human capital stock which has an overwhelming influence on the socio-economic development of a region as it determines the rate and pattern of resource utilization. As per census of 2011, the literacy rate in the state of Jammu and Kashmir is 68.74 percent as compared to national average of 74.04 percent. Male literacy rate in the state was 78.26 percent, while female literacy rate was 58.01 percent (Table 4). Both male and female literacy rates were below the national average of 82.14 percent for males and 65.46 percent for females. The district-wise pattern of literacy rate indicates high rate for Jammu, Samba and Leh districts, while low literacy rates were recorded for Ramban, Bandipora and Badgam districts in the State (Fig. 4.10). Districts of Jammu division recorded higher literacy rates as compared to the districts of Kashmir division. Female literacy rate is low in all the 22 districts as compared to the male literacy rate. This reflects a poor social awareness for female

education in the state due to existing socio-cultural beliefs. The lower social development contributes to low level of technological skills leading to under utilization of resources.



Source: *Census of India, 2011*

Fig. 4.10: Literacy rate in Jammu and Kashmir

4.12 ETHNIC GROUPS

The mosaic of ethnic group in Jammu and Kashmir State is complex because of constant impulses of immigration from the north-west, west, south and east directions. In the process of peopling of the region, the Dards in the north-west, the Ladakhis in the east, the Gujjars and Rajputs in the south and Paharis in the south-east have closely influenced the existing ethnicity of the people. The racial composition of the State was also influenced by the immigrants from the territories of Turkmenia, Tajikistan, Uzbekistan, Kazakhstan, Georgia, Azerbaijan (U.S.S.R.) Turkey, Iraq, Iran and Afghanistan. The various ethnic groups of the Jammu and Kashmir State though intermingled have their areas of high concentration. For example, Kashmiri's are mainly concentrated in the Valley bottom; Dards occupy the valley of Gurez; Hanjis are confined to water bodies of Kashmir; Gujjars and Bakarwals are living and oscillating

in the Kandi areas; Dogras occupy the outskirts of the Punjab plain, while Chibhalis and Paharis live between Chenab and Jhelum rivers. Moreover, there are numerous small ethnic groups like Rhotas, Gaddis and Sikhs which have significant concentration in isolated pockets of the State.

4.13 URBANIZATION

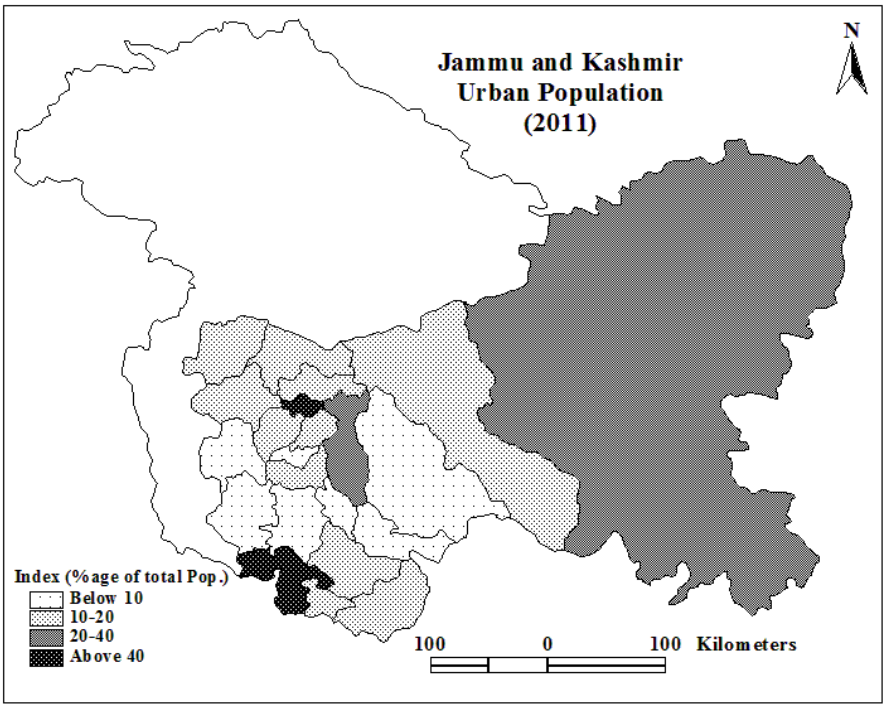
The state of Jammu and Kashmir has almost 28 percent of the total population in urban areas. Out of the total urban population, 63.42 percent was concentrated in Kashmir province, while 34.77 percent was concentrated in Jammu division and the rest 1.81 per cent urban population was found in Ladakh division. In the case of Kashmir division, major urban centers are concentrated mainly along Jhelum Valley Floor recording 95 per cent of the total urban population of Kashmir division. The other regions have negligible proportion of urban population.

Table 4.6: District wise distribution of Urban Population, Jammu and Kashmir, 2011

S.No.	District	Population	Level of urbanization		Percentage to urban population
			Persons	Percent	
01.	**Kupwara**	870354	104729	12.03	3.05
02.	**Baramulla**	1008039	182500	18.10	5.32
03.	**Bandipora**	392232	65361	16.66	1.90
04.	**Srinagar**	1236829	1219516	98.60	35.52
05.	**Ganderbal**	297446	47039	15.81	1.37
06.	**Budgam**	743745	97912	13.16	2.85
07.	**Pulwama**	560440	80462	14.36	2.34
08.	**Shopian**	266215	16360	6.15	0.48
09.	**Anantnag**	1078692	282887	26.23	8.24
10.	**Kulgam**	424483	80613	18.99	2.35
11.	**Leh**	133487	45671	34.21	1.33
12.	**Kargil**	140802	16338	11.60	0.48
13.	**Doda**	409936	32689	7.97	0.95
14.	**Ramban**	283713	11811	4.16	0.34
15.	**Kishtwar**	230696	14865	6.44	0.43
16.	**Udhumpur**	554985	108208	19.50	3.15
17.	**Reasi**	314667	26996	8.58	0.79
18.	**Poonch**	476835	38630	8.10	1.13
19.	**Rajouri**	642415	52314	8.14	1.52
20.	**Jammu**	1529958	765013	50.00	22.28
21.	**Samba**	318898	53650	16.82	1.56
22.	**Kathua**	616435	89713	14.55	2.61
Jammu and Kashmir		**12531302**	**3433277**	**27.40**	**100.00**

Source: *Census of India, 2011*

The Srinagar urban agglomeration recorded a concentration of 35.52 percent of the state urban population, whereas the Jammu city, the second largest urban centre in the state, registered 22.28 percent of urban population (Fig. 4.11). Thus, the two cities together constitute 57.80 percent of the total urban population. It indicates that these two cities occupy primate city position having concentration of economic and service activities (Bhat, 2008). The district wise proportion of urban population indicates very low level of urbanization in majority of districts compared to the state average. Only Srinagar and Jammu districts have high proportion of urban population. The reasons for low percentage of urban population up to 1951 are poor socio-economic development, backwardness and dependence on agricultural sector. Afterwards urban population increased because of tourism and planned development. From 1981 AD to 1991, growth in urban population was stagnating because of political unrest in the state.



Source: *Census of India, 2011*

Fig. 4.11: Urban Population in Jammu and Kashmir

4.14 ECONOMIC PROFILE

The economic life in Jammu and Kashmir State has witnessed significant changes generated through agricultural development, tourism activity and trade interactions. The standard of living has witnessed significant improvement due to introduction of income generating activities. Service sector occupations, especially government services have

increased tremendously, improving the income situation of the people. Export of fruits, handicrafts, carpets etc. has improved the economic condition of the business community; however artisan community did not register any significant economic changes. The disparities in the economic conditions are glaring between rural and urban areas, as well as among various cross-sections of people in the society (Zutshi, 1996). The Jammu and Kashmir economy depends mostly on traditional form of occupation. Unaffected and unaltered by modern day industrial developments and changing times, the indigenous traditional occupations of farming, animal husbandry and horticulture forms the backbone of the economy of the state of Jammu and Kashmir. Farming is one of the predominant economic activities of the state. The valley of Kashmir along with other side valleys of the region form suitable grounds to grow various kinds of crops that earn a large chunk of revenue for the state. Another important economic activity of the state is animal husbandry. Apart from farming, the local inhabitants also keep many animals like sheep, goat, yak etc. Sheep rearing is an important industry of the region. The fine quality of wool produced by the sheep are used for weaving colorful and attractive woolen carpets, shawls and other woolen garments that form an integral part of the handloom products of the state. Horticulture is one of the budding industries of the state that earns large revenue. The favorable weather helps in the production of many kinds of fruits.

Contribution of primary sector (agriculture and allied activities) to the state economy for the year 2009-10 has been 22.63 per cent with secondary sector 29.55 per cent and tertiary sector 47.82 per cent (Digest of statistics, 2010-11). The relative share of primary, secondary and tertiary sectors to GDP at national level has been 16.99 per cent, 25.84 per cent and 57.17 per cent respectively for the year 2009-10. The state's percentage share in India's GDP is only 0.70 percent. It has declined from 0.85 per cent in 1999-00 to 0.70 percent in 2008-09. While as the national income has grown at a robust rate of 8.2 per cent during the last five years, the state income has shown a much lower rate of 6 per cent. The per capita income of state is 20604 INR which is far below the national average of 27442 INR and hence the state ranks 22nd in the country. During the year 2008-09 the gross state domestic product (GSDP) has registered a growth rate of 6.12 per cent against the targeted growth rate of 7.5 per cent (Economic Survey Report, 2008-09). The slow growth rate can be attributed to the sluggish growth

of manufacturing and construction activities within the secondary sector, with the growth in agriculture remaining stagnant at 1.79 per cent. Tourism, trade and transport have been badly hit during the peak summer season of 2008, 2009 and 2010 by the prolonged civil strife in the state and hence achieving the projected growth rate of 8 percent appeared to be quite difficult. The contribution of primary sector to gross state domestic product (GSDP) has decreased from 31.5 per cent in 1990-00 to 26.9 per cent in 2007-08 while that of secondary sector has increased from 22.6 per cent in 1999-00 to 27.2 per cent in 2007-08. However the share of tertiary sector to GSDP has remained constant.

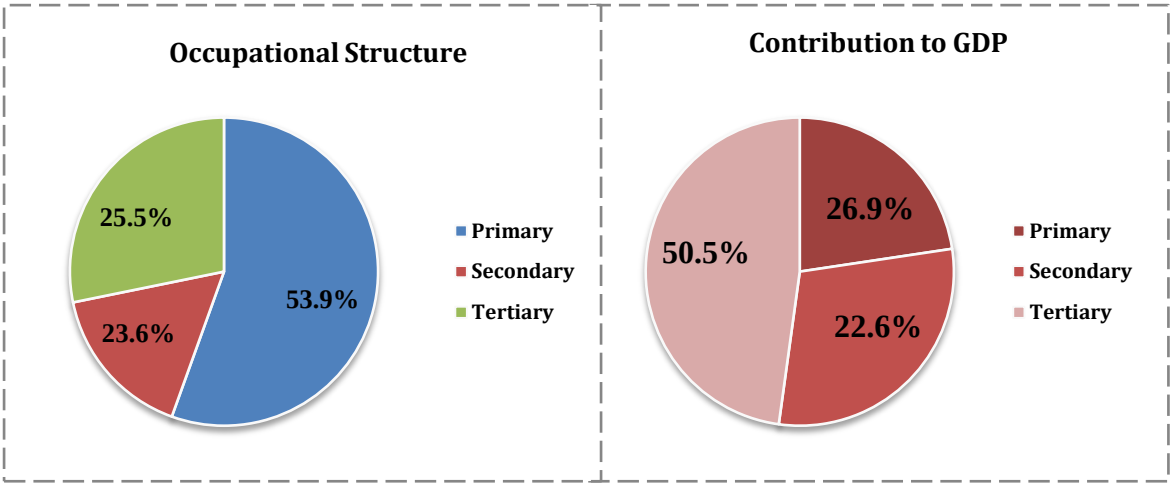


Fig 4.12: Occupational structure and its contribution to GDP in Jammu and Kashmir

Table 4.7: Sectoral distribution of workforce, Jammu and Kashmir

Year	Workforce (lakhs)			Sectoral share (percent)		
	Primary	Secondary	Tertiary	Primary	Secondary	Tertiary
1999-2000	16.34	4.79	8.29	55.5	16.3	28.2
2004-2005	22.57	9.62	8.46	53.9	23.6	25.5

Source: *Directorate of Economics and statistics, 2008-09*

It is clear from table 4.7 that in spite of increase in the number of employees in primary and tertiary sectors, the share of workers has decreased by 1.6 per cent and 2.7 percent respectively while it has increased in secondary sector by a significant proportion of 7.3 per cent. It can be inferred from Fig. 4.12 that primary sector is utilizing 54 per cent of the total workforce but contributes only 23 per cent to state GDP while as secondary

and tertiary sector utilize 23.6 percent and 25.5 percent of the total workforce but contribute 29.55 percent and 47.82 percent to state GDP respectively.

4.14.1 AGRICULTURE

Agriculture is the mainstay of more than seventy percent people in Jammu & Kashmir and fifty four percent of the total work force directly depends on this sector for their livelihood. Major food crops grown in the state are wheat, paddy and maize. Besides, barley, jowar and bajra are also cultivated in some parts of the state. Agro-climatic condition of the state support horticulture; about 5 lakh families, directly or indirectly are engaged with horticulture activities. Although the net area sown has remained more or less same (7.30 lakh hectare in 1990-91 to 7.39 lakh hectare in 2008-2009), the area under fruit and vegetable cultivation has marginally increased over the same period of time. In respect of fruit and vegetables, it has gone up from 60041 thousand hectare in 1990-91 to 87421 thousand hectare in 2008-2009. Production of food grains has registered an increase of 3.62 per cent during the year 2008-09 as it has increased to 16275 thousand quintals from 15707 thousand quintals during the year 2007-08 (Economic Survey Report, 2008-09).

Rice, the staple crop, is planted in May-June and harvested in late September. Maize is the second-most important crop. The best soil for rice is reclaimed swamp and enormous crops are raised from the black peaty land, which lies under the banks of river Jhelum. In the high villages occupied by the Gujjars, very fine crops of maize are grown. In 2008-09 maize was cultivated on 31.14 per cent of the total area under food crops fallowed by wheat 27.46 per cent and rice 25.41 per cent. Jammu district has the highest area under rice cultivation (18.63 per cent of the total area under rice in the state) fallowed by Kathua (13.08 per cent), Anantnag (9.82 per cent) and Kulgam (7.1 per cent) while Rajouri has the highest area under maize (14.80per cent) fallowed by Udhumpur (10.87 per cent), Doda (8.17 per cent) and Jammu (7.45 per cent). Jammu also leads in the area under wheat (29.78 per cent) fallowed by Kathua (19.14 per cent), Samba (10.5 per cent) and Udhumpur (10.25 per cent). The average yield of rice has increased from 16.9 quintals per hectare (Q/ha) in 2001-02 to 21.88 Q/ha in 2008-09 with the highest yield of 24.5 Q/ha in Kashmir Division (Digest of Statistics, 2008-09). The average yield of Maize has increased from 16.48 Q/ha in 2001-02 to 20.05 Q/ha in

2008-09 with the highest yield of 23.58 found in Jammu division. Wheat has also increased its yield from 113.21 Q/ha in 2001-02 to 17.35 Q/ha in 2008-09 with the highest yield of 17.5 recorded in Jammu division. Large orchards in the valley of Kashmir produce apples, pears, peaches, walnuts, almonds, cherries and apricot. Apple cultivation is carried on 65.15 per cent of the area under orchards fallowed by pear 6.17 per cent, citrus 6.01 per cent and mango 5.26 per cent. The state leads in terms of production of apples, walnuts, pears, saffron, almonds and apricots, and has a huge potential for export of processed food and allied services.

The state of Jammu and Kashmir is the largest producer of saffron in the Indian subcontinent. It is a gifted crop which fetches a fair price in both national and international market. The cultivation of saffron is restricted to the Karewas in Kashmir valley and Kishtwar district in Jammu division. It has been grown on the table lands of Pampore since last 2500 years and is the world's costliest spice. The Pulwama district with 73 per cent of the total saffron area leads in both area and production. Artificial floating gardens on the lakes are favorable for the cultivation of flowers and vegetables. In Ladakh, there is only one cropping season-Kharif, which extends from March to October. Cultivation in Ladakh is restricted to near the main valleys of Indus, Shyok and Suru rivers, where apricot, barley, buckwheat, turnips and mustard are grown. Recently, strawberry cultivation has also been introduced in Ladakh. Pastoralism and cattle breeding have long been the vital features of the Ladakh economy. The Kashmir goat raised in the region provides pashmina for the production of fine fabrics.

4.14.2 TOURISM

Kashmir is known as the paradise on earth because of its numerous scenic spots along with other important tourism attractions such as shrines, monasteries, temples and caves in the three regions. Major tourist places are Chashma Shahi springs, Shalimar Bagh and Dal Lake, etc., in Srinagar; Gulmarg, Pahalgam and Sonamarg, etc., in the Valley; various ancient temples, Buddhist sites and scenic beauty in Ladakh; Vaishno Devi temple and Patnitop near Jammu, etc. Tourism is considered to be central nerve of the state economy with both forward and backward linkages and trickle down effects. The tourism sector with a revenue generation of more than Rs 3000 crores, provides employment to about 5 lakh people. It contributes 16 per cent to state domestic product.

The sector with its potential for employing people across the skill spectrum and positive externalities for other sectors like handicrafts, handlooms and transport occupies an important place in the development and employment strategy of the state. Tourism as an industry not only preserves the culture and heritage but also conserves the fragile environment of the state. The state is endowed with rich tourism resource and like its power potential tourism too has harnessed only one fourth of potential so far.

Tourist arrivals in the valley have waxed and waned in tandem with the security situation. After declining to an all-time low of 27,356 visitors in 2002, it steadily increased to 6 lakh plus in 2010. The number of pilgrims who visited Amarnath had gone up to 5 lakh in 2008 while 81.8 lakh tourists visited Vaishno Devi in 2009. However, the total tourist arrival has decreased considerably in 2010 (table 4.8 and Fig 4.13). Though the total tourist arrivals in Ladakh are lower than in the other two regions, it attracted the largest number of foreign visitors. Ladakh's potential to develop as an important international tourist destination in the state is evidenced by the steady increase in foreign visitors whose numbers have risen from 22,000 in 2004 to 30,446 in 2009. Tourism Department alone has earned Rs 73 crore in 2006-07 (Economic Survey Report, 2008-09). The 2009 Performance Review of Jammu and Kashmir Economy stresses that developing, expanding, and upgrading tourist infrastructure is a priority in the initiatives being pursued in the state and national development plans. Fifteen development authorities have been established, more than tripling the previously existing total of four. They are specifically charged with developing tourist infrastructure in new areas while upgrading facilities in popular tourist destinations. Directorate of Economics & Statistics Jammu and Kashmir Economy survey report for 2008-09 mentions that the revenue earnings made under the public sector in tourism sector from 2004-05 till 2007-08 was about rupees 103.62 crore. The percentage increase has been 10.48 per cent for the year 2007-08 as compared to 2006-07. The economic and social impacts on the local community depend on how much of the income is generated by tourists go to the host communities. In most all-inclusive package tours more than 80 per cent of traveller's fees go to the airlines, hotels and other outside companies, not to local businessmen and workers.

Table 4.8: Tourist arrivals to Kashmir valley and pilgrim tourists

S.No.	Year	No. of tourists		Growth in percent	
		Kashmir Valley	Yatris	Kashmir valley	Yatris
01	**1980**	595117	19578	---	---
02	**1985**	503614	42000	-15.37	114.53
03	**1990**	10722	4824	-97.87	-88.51
04	**1995**	8520	60000	-20.53	1143.78
05	**2000**	11912	173334	39.81	188.89
06	**2005**	605382	388000	4982.11	123.84
07	**2010**	601252	264413	-0.68	-31.85

Source: *Department of Tourism, Srinagar, 2010*

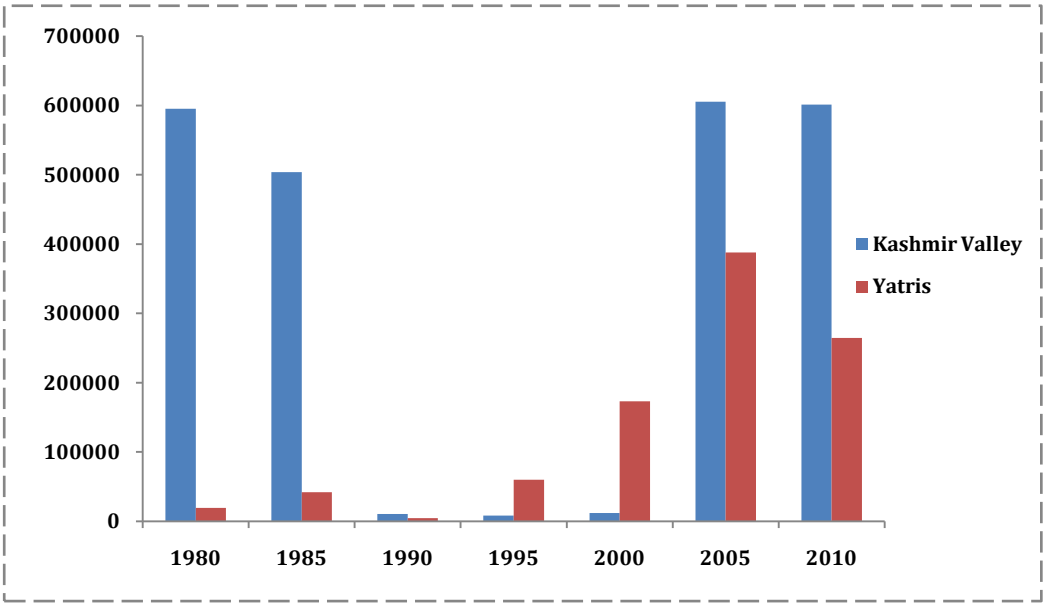


Fig. 4.13: Tourist arrivals in Kashmir Valley (1980-2010)

In a way the state is economically dependent upon the tourism to a larger extent. State Govt. has also been prioritizing the importance of the state tourism. Jammu & Kashmir tourism Development Corporation (JKTDC) is looking after the interests of tourists coming from outside state and country. The said corporation does make necessary and proper arrangements for providing all sort of adequate facilities to the tourists and the kind of facilitation includes transport, lodging, boarding etc. The corporation provides various types of tour packages to the visitors all the time. Similarly, there are numerous travel agencies operational in the State to look after the best interests of the tourists by providing adequate facilitation of transportation, lodging, boarding etc to them.

4.15 HYDROELECTRIC POWER

The Jammu and Kashmir state is rich in hydel power resources. The state power development corporation has estimated a total hydel power potential of 20000 MW and identified about 16000 MW for the four rivers in the state- Chenab (10853.81 MW), Jhelum (3141.30 MW), Indus (1598.7 MW) and Ravi (417.00 MW).

Table 4.9: Installed Capacity of Power houses under the State and Centre sector

State Sector				Centre Sector	
S.No.	**Name of the Power House**	**Installed Capacity (2008-09) (MWs)**	**Energy Generated (2008-09) (MUs)**	**Name of the Power House**	**Installed Capacity (2008-09) (MWs)**
	Thermal			**Hydel**	
1	Gas Turbine Pampore- I	75.00	0	NHPC -Salal	690.000
2	Gas Turbine-II	100.00	0	NHPC- Uri-I	480.000
3	Diesel	20.74	16.64	NHPC- Dulhasti	390.000
	Total	**175.74**	**16.64**		
	Hydel				
A	**Jhelum River Basin**				
1	LJHP*	105.00	491.872		
2	USHP-I	22.6	84.86		
3	USHP-II	105.00	244.34		
4	Ganderbal	15.00	22.20		
5	Karnah	2.00	2.633		
6	Pahalgam	3.00	6.63		
	Sub-Total	**252.60**	***852.535***		
B	**Chenab River Basin**				
7	Baghliar	450.00	707.63		
8	Chenani-I	23.30	57.10		
9	Chenani-II	2.00	2.81		
10	Chenani-III	7.50	11.13		
11	Baderwah	1.00	0		
	Sub-Total	**483.80**	***778.67***		
C	**Ravi River Basin**				
12	Sewa-III	9.00	7.68		
D	**Indus River Basin**				
13	Stakna	4.00	5.59		
14	Sumoor	0.10	0.05		
15	Bazgoo	0.30	0.55		
16	Hunder	0.40	0.58		
17	Iqbal Bridge	3.70	7.98		
18	Haftal	1.00	0.18		
19	Marpachoo	0.75	0.15		
20	Igoo Marshelong	3.00	10.09		
	Sub- Total	**13.30**	***25.17***		
	Gross Total (Hydel Power Generated)	**758.70**	**1692.530**	**Total**	**1560.000**
	Intermediate Consumption (Baglihar+Auxiliary Consumption)		33.940		
	Net (Hydro Power Generated)		**1658.590**		

Source: *Economic Survey Report, Jammu and Kashmir, 2008-09*

Despite the fact that the state could be among the frontline states owing to huge hydel power potential but it is presently facing an acute shortage of energy resources as the current generation is only 1658.59 MW where as the current demand on account of domestic, industrial, agricultural and other demands is estimated about 2000 MW. This acute deficiency in energy sector has impeded not only the industrial development but also the other ancillary sectors of the state. If the power sector is fully developed, the state would certainly attain the status of power exporting states. The hydel power is harnessed through state and central sectors as indicated in the table 4.9 above.

5.1 AGRO CLIMATIC ZONATION-CONCEPTUAL FRAMEWORK

The importance of climate in influencing land cover, *viz*, natural vegetation or land use, requires no emphasis. Climate dictates to a large extent what the natural vegetation is and which crops can be grown; additionally it is mainly responsible together with soils for yearly variation in yields. The climate not only affects growth patterns, persistence, quality and yield, but also influences the response of each cultivar to different management practices (Chapman and Brown, 1978). Climate is the most determining factor in the evaluation of agricultural potential and it defines the limits between which various crops can develop on the basis of soil and terrain composition (Verheye, 2010).

By definition, an agro-climatic zone is a land unit, in terms of major climate and growing period that is climatically suitable for a certain range of crops (Balaguru, 2010). The problem of selecting the correct land for the cultivation of certain agriculture crops is a long-standing and mainly empirical issue (Kalogirou, 2002). Therefore many researchers have tried to prepare a standard framework for suitable and optimum agriculture land use. FAO (1976, 1984 and 1985) classifies agricultural potential based on soil and environmental characteristics into five classes including highly suitable, moderately suitable, marginally suitable, currently not suitable and permanently not suitable. Agro climatology is the application of climatic concepts and principles to the design and management of sustainable agricultural systems (Gliessman 1992). The agro climatic environment of a crop, land use or a farming system has physical, chemical and biological aspects. Viewing the agro ecosystem as a functional system of complementary relations between living organisms and their environment that are managed by humans with the purpose of establishing and increasing agricultural production provides a basis for integrating the overlapping agro climatic and environmental traits with sociological, economic, political, and other cultural components of agriculture (Francis 1986). All of these may vary across space and time. Consequently, varieties and management methods have different optima in different places (Brinkman 1987). Thus, agro-climatic classification is an extension of the climate classification keeping in view the suitability to agriculture. Agro-climatic zonation schemes are standard tools for prioritizing agricultural research because they offer relevant available information about the target environments (Corbett, 1996).

5.2 METHODS OF DELINEATION

The agro-climatic classification is an extension of the climatic classification keeping in view the suitability to agriculture. Generally, the climate types may be distinguished on rainfall and temperature and as these two characteristics are influenced by altitude, therefore this parameter is also taken for classification of climate zones. Earlier Koeppen's (1915) and Thronwaite's (1933) method was devised for climatic classification, but with passage of time many new parameters have been added to distinguish the two areas. The important parameters and methods used by various agencies/departments are discussed below;

(i) The most innovative agro-climatic classification was developed by Papadakis (1978) and FAO for agro-ecological zones (AEZ) project. The Papadakis system is innovative in the sense that it does not use mean climatic data but specific minimum, maximum or hazards that influence more directly crop development. These parameters permit the more accurate definitions of winter severity, summer heat and moisture regime (Verheye, 2010).

(ii) National commission on agriculture (1971) classified the country into 127 agro-climatic zones on the basis of three parameters, *viz*, temperature, precipitation and crops grown.

(iii) The zonation theory (1972) that guided Russian geographers laid major emphasis to the links between climate, soils, and vegetation distribution over the world. The zonation concept is also visible in Voloboyev's classification of geographical zones (1972) and soil groups based on a world zonal pattern determined by moisture and temperature criteria and technically translated into hydro- and thermo- ranges respectively.

(iv) Trewartha's classification (1942) of world into seven climate/vegetation/ soil weathering zones is another example of the diagnostic weight given to climatic parameters.

(v) The planning commission (1989) has divided India into 15 major agro-climatic regions on the basis of a commonality of agro-climatic factors like soil type, rainfall, temperature, water resources, etc. In this innovative approach, based on agro-climatic zones, an overall development profile of each region was formulated through an optimal mix of land stock management, crop production,

animal husbandry, aquaculture, horticulture, forestry and agro-processing activities.

(vi) UNESCO (1979) has developed a simple system for differentiating agro-climatic zones based on three major criteria: *Moisture regime, winter type* and *summer type*. The moisture regime is determined by the aridity index. The winter type is determined by the average mean temperature during the winter months. The summer type is determined by the average mean temperature during summer months.

(vii) Water balance method: This method is based on '*water balance concept'*. The different crops require different amount of water, so on that basis zonation of crops is done to delineate micro agro-climatic zones. It is most useful method for agricultural purposes (National Mission for Sustainable Agriculture, 1996).

5.3 SIGNIFICANCE OF AGRO-CLIMATIC ZONATION

Optimal use of land for sustained and ultimately increased agricultural production requires effective land-use planning. This in turn requires comprehensive information on land resources so that development strategies and research programmes can be assessed in terms of geographical and climatic realities (Henrickson, 2005). In recent years a new dimension to agricultural planning has been added through agro-climatic regionalization. These regions, taking into account the salient features of regional climate at meso and micro level, help in evolving suitable crop land use and agricultural practice to obtain optimum farm output. The prime objectives of agro-climatic regional planning are to optimize agricultural production, increase farm income and create more employment opportunities through the scientific utilization of agricultural and allied resources. The potential for growth and diversification would be fully exploited taking a holistic view of the climate, soil type, topography, water resources and irrigation facilities and relating them to the requirements of output and employment. The Planning Commission of India (1989) has laid down following four objectives for agro-climatic regional planning:

(I) Attempt a broad demand-supply balance of major commodities at the national level but based on a careful analysis of potential and prospects of various zones; (II) Maximize net income of producers; (III) Generate additional employment, particularly

of landless labourers, and (IV) Provide the framework for the scientific and sustainable use of our natural resources, particularly land, water and forests, in the long run.

Agriculture is by far the most important of the world economic activities and is directly related with the food security. Since agriculture is highly location-specific, grouping the available land area in the state into different agro-climatic regions based on certain identifiable characteristics becomes all the more important. This may help the planners to engage in more rational planning and optimizing resource use for the present and in preserving them for the future. The purpose of an agro-climatic zone map is therefore to show the areas that are climatologically suitable for particular crops and to guide the work of planners and farmers (Francus, 2010). Agro-climate influences crop growth, yield and sustenance (Singh, 2011). Proper agro climatic zoning and seasonal climate forecasts are crucial elements in minimizing climatic risks (Sue *et al,* 2010). The agriculture system in many parts of the world is characterized by low productivity due to low external inputs, soil erosion, and other losses (Ali, 1985). This causes severe socio-economic impacts that include food insecurity, famine, pests and economic losses. These impacts seem to spread over large areas and differ in severity, magnitude and duration. The problem has caused public outcry for adequate agro-climatic information for planning and management purposes. There is heterogeneity in the landscape, climate, soils, and crops grown in the Jammu and Kashmir state (Khan *et al,* 2001). Therefore generation of an agro-climatic zone map showing areas suitable for various agricultural alternatives in J&K using information on altitude, rainfall, temperature, soils and other relevant parameters is very important for the efficient land use planning and sustainable agricultural system.

5.4 DELINEATION OF MICRO-AGRO CLIMATIC ZONES OF JAMMU AND KASHMIR

An eclectic approach has been adopted in the research work to delineate the micro agro-climatic zones of the state. From the base map, different map layers, *viz,* physiography and Altitude zonation were prepared. Soil map was generated from Indian Council of Agricultural Research (ICAR) database. Precipitation temperature index map has been prepared by using the meteorological data from all the 54 stations located in the study area. Precipitation-temperature ratio (PT Index) has been calculated and a choropleth

map has been prepared to devise PT zonation map. Cropping land use map was obtained by using the necessary data obtained from concerned departments. The different map layers obtained were superimposed to derive the agro-climatic zone map of the study area. The classification of the zones was based on those of WMO-UNEP (1971-2000) and FAO (1993).

The different maps needed to delineate Jammu and Kashmir into micro agro-climatic zones have been prepared by using appropriate methodology for each as presented below:

(a) *Preparation of Altitude Zonation map:* For the preparation of altitude zonation map, the survey of India toposheets on scale 1:50,000 were geo-referenced, then digitized and further processed to get the state divided into five altitudinal zones.

The southern part of the state has low altitude than its northern and north-eastern parts. The Ladakh province lies above 3000m altitude, while as Jammu plains have altitude between 500-1500 metres. The Valley of Kashmir lies between 1000-1700m altitude surrounded on all sides by mountains.

(b) *Preparation of the Precipitation-Temperature ratio (PT Index) map:* For preparing the PT index map, firstly the stations were identified by superimposing their location on the altitude zonation map and district boundary map. The district boundary map has been used as various places of same altitude in the state do not receive equal precipitation or temperature owing to the difference in other factors, *viz*, natural vegetation, physiography, wind direction, aspect of slope etc. Moreover, '*arithmetic average method'* and '*Thiessen Polygon Method'* have been employed to calculate the average depth of rainfall over an area. The formula's used are;

(i) $P_{ave} = \frac{\Sigma\, Pi}{n}$ (ii) $P_{ave} = \sum_1^n Pi\ \frac{Ai}{A}$

Where, 'P_{ave}' is the average depth of rainfall over the area, 'ΣP_i' is the rainfall amounts at individual precipitation stations, 'n' is the number of these stations, 'Ai' is the weighting factor and 'A' is total area of the basin

Then the precipitation and temperature data was arranged and a ratio between the two was obtained (Table 5.1) and finally a choropleth map was drawn (Fig.5.1) which reflected the various PT zones.

Table 5.1: Precipitation-Temperature Ratio's

S.No.	Zone Code	Yearly Average Rainfall (in mm)	Yearly Average Temperature (in ^{0}C)	Precipitation-Temperature Ratio
01.	**A**	659	26.66	24.72
02.	**B**	967	22.54	42.90
03.	**C**	1238	11.44	108.22
05.	**D**	884	14.65	60.34
06.	**E**	1386	45.48	30.47
07.	**G**	1210	45.3	26.71
08.	**F**	1412	47.46	29.75
09.	**H**	1336	44.13	30.27
10.	**I**	1592	40.32	39.48
11.	**K**	1387	31.75	43.69
12.	**J**	1642	41.33	39.73
13.	**L**	1329	27.29	48.70
14.	**M**	976	29.12	33.52
15.	**Ladakh**	**157**	**8.5**	**18.47**

Source: *Indian Meteorological Department (IMD) Pune, India*

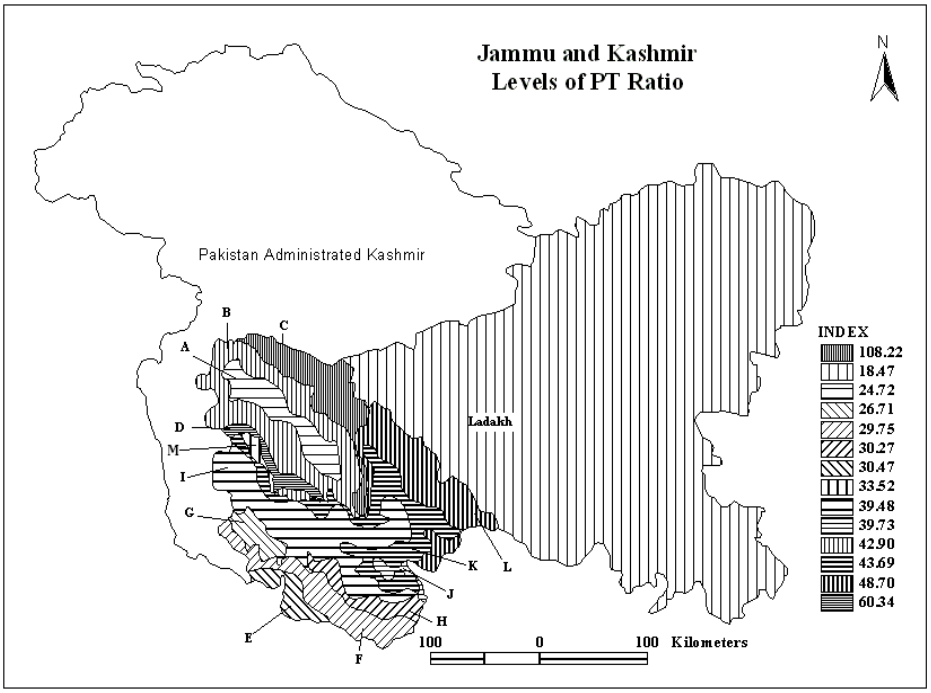
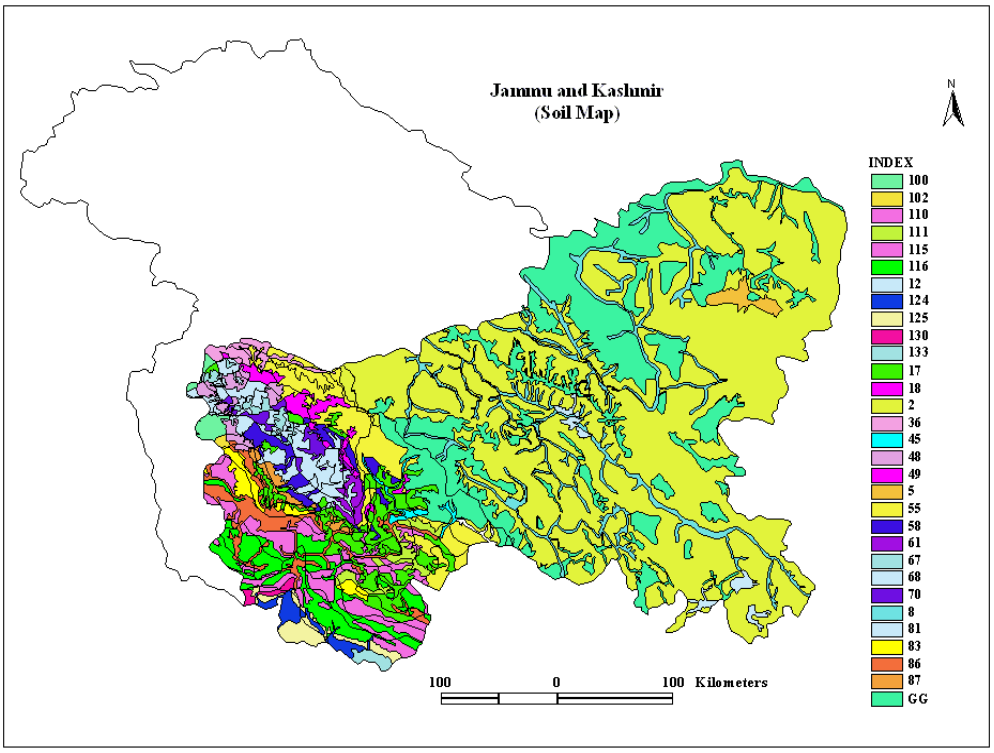


Fig. 5.1: Precipitation-temperature index map of Jammu and Kashmir

(c) *Preparation of Soil map:* In order to prepare the soil map and identify the major soil groups, the data source prepared by the National Bureau of Soil Science and Land use Planning (ICAR) Nagpur was used and as many as 31 soil classes have been identified (Fig. 5.2).



Source: Modified from Indian Council of agricultural research (ICAR) database, Nagpur, 2011

Fig. 5.2: Soil map of Jammu and Kashmir

Index

100	Very shallow, excessively drained, loamy soils on steep slopes with severe erosion
102	Very shallow, excessively drained, loamy soils on steep slopes with very severe erosion
110	Shallow, excessively drained, coarse-loamy soils on steep slopes with severe erosion
111	Medium deep, excessively drained, coarse-loamy soils on steep slopes with severe erosion
115	Medium deep, excessively drained, coarse-loamy soils on moderate slopes with moderate erosion
116	Deep somewhat, excessively drained, loamy-skeletal soils on gentle slopes with moderate erosion
12	Deep, excessively drained, sandy-skeletal, calcareous soils on gentle slopes with erosion and moderate stoniness
124	Deep, well drained, coarse-loamy calcareous soils on gentle slopes with moderate erosion and slight stoniness
125	Medium deep, well drained, coarse-loamy soils on gentle slopes with moderate erosion
130	Shallow, excessively drained, loamy-skeletal soils on gentle slopes with moderate erosion
133	Deep, moderately well drained, coarse-loamy, calcareous soils on very gentle slopes with slight erosion and moderate flooding
17	Shallow, loamy, calcareous soils on steep to very steep slopes with strong stoniness and severe erosion
18	Medium deep, excessively drained, coarse-loamy, calcareous soils on steep slopes with moderate stoniness and severe erosion
2	Shallow, excessively drained, sandy-skeletal soils on very steep slopes with sandy surface,

	severe erosion and strong stoniness
36	Deep, excessively drained, sandy-skeletal soils on steep slopes with sandy surface, very severe erosion and moderate stoniness
45	Medium deep, somewhat, excessively drained, mesic, loamy-skeletal soils on steep slopes with severe erosion and strong stoniness
48	Medium deep, moderately well drained, mesic, fine loamy-skeletal soils on steep slopes with severe erosion and slight stoniness
49	Medium deep, excessively drained, loamy-skeletal soils on moderately steep slopes with severe erosion and moderate stoniness
5	Deep, excessively drained, calcareous soils on moderate slopes with sandy surface, moderate erosion and slight stoniness
55	Deep, well drained coarse-loamy soils on gentle slopes with moderate erosion and strong gravelliness
58	Deep, well drained, calcareous, fine-loamy soils on nearly level slopes with very slight erosion
61	Medium deep, well drained, loamy-skeletal soils on moderate slopes with severe erosion and strong stoniness
67	Deep, moderately well drained, fine-loamy soils on very gentle slopes with slight erosion
68	Deep, moderately well drained, calcareous, fine-silty soils on nearly level slopes with slight flooding
70	Deep, well drained, fine soils on gentle slopes with moderate erosion
8	Deep, excessively drained, soils on gentle slopes with sandy surface, moderate erosion and slight stoniness
81	Deep, moderately well drained, fine soils on very gentle slopes with loamy surface
83	Shallow, excessively drained, loamy soils on moderately steep slopes with moderate erosion and stoniness
86	Shallow, excessively drained, loamy soils on very steep slopes with moderate erosion and stoniness
87	Medium deep, somewhat excessively drained, fine- loamy soils on moderately steep slopes with moderate erosion and stoniness
NA	Not Available
GG	Glaciers

(d) *Preparation of Cropping Land use map:* The data pertaining to the various crops grown in the different parts of the state of Jammu and Kashmir has been used for obtaining the cropping land use map of the area under study. Since the temperature and precipitation regimes are different in the different parts of the state, therefore different types of crops are grown in different districts. Fig. 5.3 shows the crop combination in different districts. The crop combination map has been prepared by using Rafiullah's method.

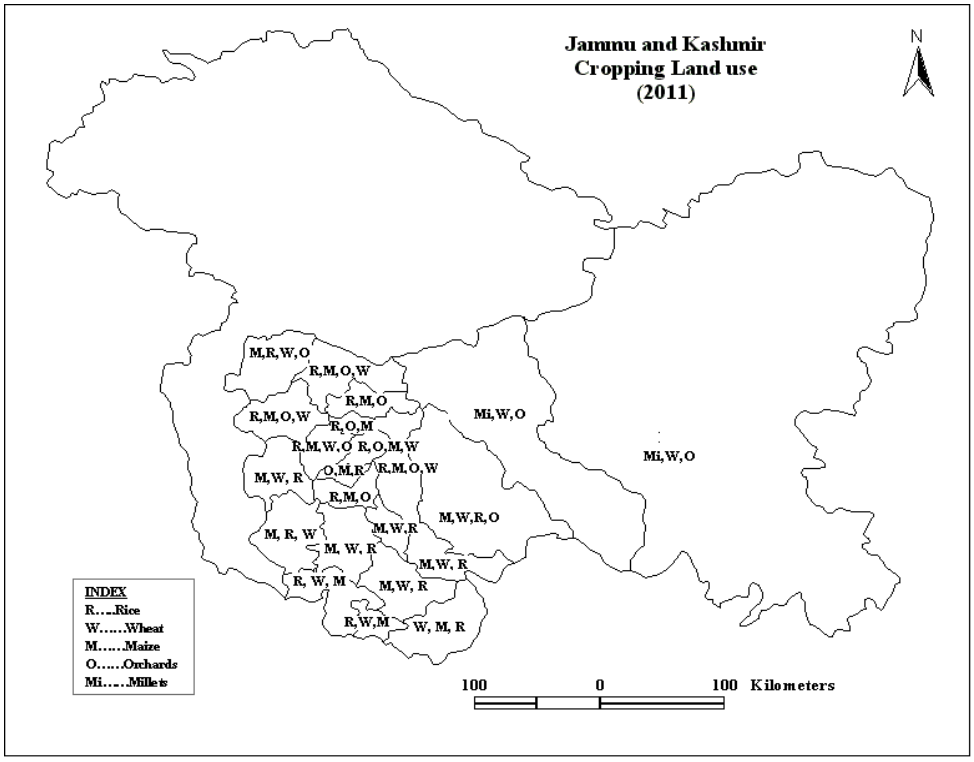


Fig. 5.3: Cropping land use map of Jammu and Kashmir

It is clear from the map that the cropping land use varies from one district to another. Maize is dominant crop in the districts having more area under mountains and less plain area like Kupwara, Rajouri, Poonch, Ramban, Doda, Kishtwar and Udhampur. Rice is dominant crop in all the districts of Kashmir valley except Kupwara and Srinagar. In Jammu province, Jammu district has substantial area under rice cultivation. In Ladakh province, millets, wheat and orchard cultivation is practised.

(e) *Preparation of agricultural productivity map:* The productivity data is not available at agro-climatic zone level, therefore the productivity of districts has been used to generate the productivity database for the agro-climatic zones by using the *'proportional weightage'* method.

The agricultural productivity varies from one region to another owing to the different soil types, climatic parameters etc (table 5.2 and Fig 5.4 and 5.5).

Table 5.2: Productivity of Crops grown in agro-climatic zones

Agro-climatic Zone	Agricultural productivity (Q/ha)		
	Paddy	Maize	Wheat
1K	21.87	12.9	12.37
2K	20.58	14.63	14.01
1 J	25.76	21.41	18.91
2J	21.03	18.97	18.87
2'J	21.12	17.03	19.09
3 J	22.99	14.9	18.42
3'J	20.38	12.35	19.1
4 J	20.05	15.61	18.84
L	-	-	19.39
Average	**21.97**	**15.98**	**17.67**

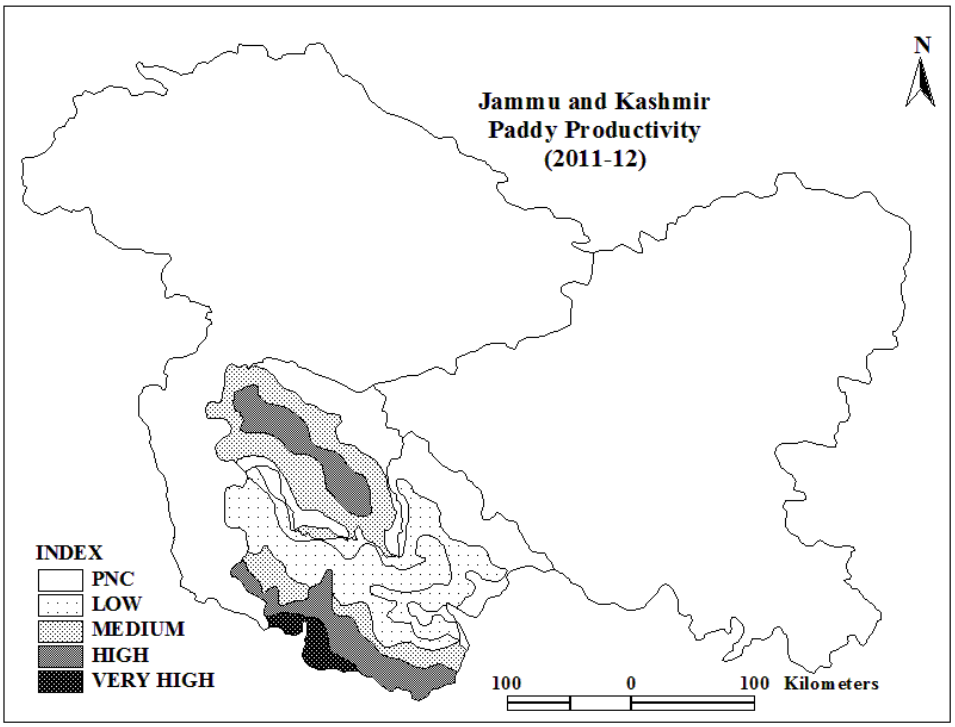


Fig. 5.4: Productivity of paddy in Jammu and Kashmir

The figure shows that productivity of paddy is high in the areas of Jammu, Kathua, Samba districts in Jammu province and in Kashmir province, it is more in Jhelum valley floor (area on both sides of river Jhelum) including the areas of Anantnag, Kulgam, Pulwama, Srinagar, Baramulla, Bandipora and Kupwara districts. The productivity of paddy is low in areas of Poonch, Rajouri, Doda, Udhampur etc. *PNC* in the figure refers to the areas where *'paddy is not cultivated'*.

From the Fig. 5.5, it is evident that productivity of wheat is high in the areas of Jammu and Ladakh divisions of the state. Kashmir Province has low to medium levels of productivity. The areas of higher productivity are parts of Jammu, Rajouri, Poonch, Udhampur, Doda, Leh and Kargil districts. The lowest productivity is found in Jhelum valley floor of Kashmir valley. *WNC* in the figure refers to the areas where *'wheat is not cultivated'*.

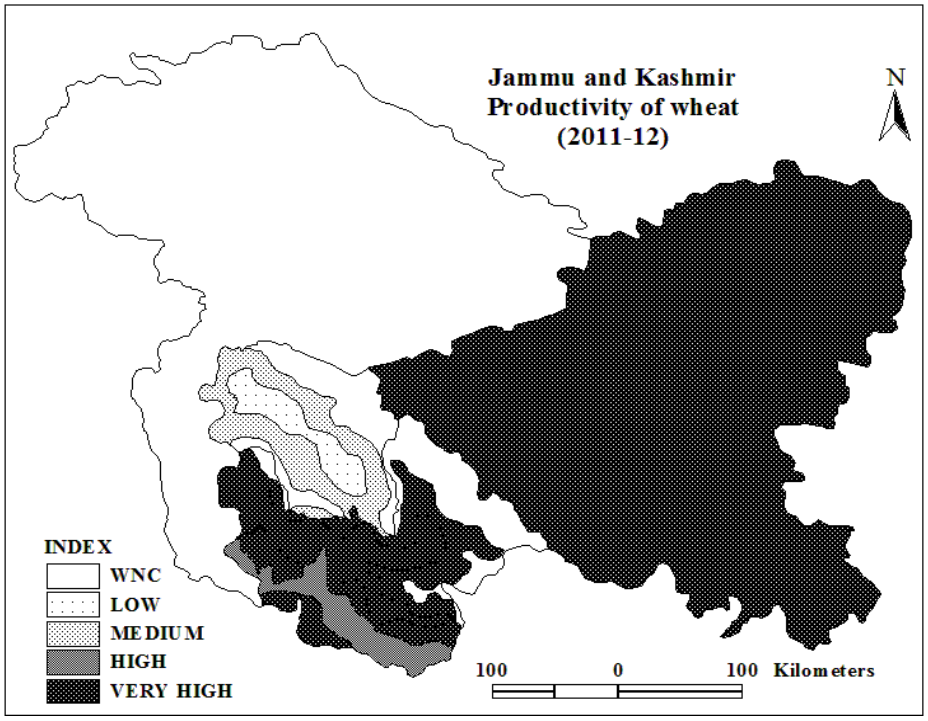


Fig 5.5: Productivity of wheat in Jammu and Kashmir

The different map layers were superimposed and thus, an agro-climatic zone has been prepared.

Since five climatic zones are not feasible for agricultural crop growth because of high altitude, therefore they have been designated as 'climatic zones' and not agro-climatic zones. The characteristics of both climatic and agro-climatic zones are highlighted (Table 5.3).

Table 5.4: Characteristics of micro agro-climatic zones of Jammu and Kashmir

Zone Code	Altitude (in Meters)	Dominant Soil Group	Crops Grown	Area (in km^2)	Productivity (Q/ha)			Average Precipitation (in mm)	Temperature(^{0}C)	
					Rice	Maize	Wheat		M.Max	M.Min
1K	1000-1700	68, 81, 70	Rice, Maize, Mustard	4443.2	21.87	12.9	12.37	660	19.34	7.32
2K	1700-3000	58, 81, 18	Rice, Maize, Orchards	6045.21	20.58	14.63	14.01	967	16.62	5.92
3K	Above 3000	55, 18, 36	-	1000.94	-	-	-	1476	13.12	-0.23
3'K	Above 3000	17, 87, 58	-	4168.15	-	-	-	914	14.31	0.14
1J	Below 500	125, 124, 130	Basmati rice, Wheat,	1336.49	25.76	21.41	18.91	1386	28.09	17.39
2J	500-1000	115, 116, 86	Maize, Wheat, Rice	1570.67	21.03	18.97	18.87	1336	27.23	16.90
2'J	500-1000	116, 86, 115	Maize, Rice, Wheat	1166.68	21.12	17.03	19.09	1210	27.80	17.50
3J	1000-2000	116, 115, 125	Wheat, Rice, Maize	4131.09	22.99	14.9	18.42	1412	30.19	17.27
3'J	1000-1700	115, 86, 116	Maize, Rice, Wheat	7432.03	20.38	12.35	19.1	1592	25.48	14.84
4J	1700-3000	17, 116, 115	Maize, Wheat, Rice	5442.42	20.05	15.61	18.84	1387	22.32	9.43
5J	Above 3000	86, 17, 48	-	376.01	-	-	-	976	19.60	9.52
5'J	Above 3000	17, 115, 116	-	5843.8	-	-	-	1642	26.60	14.73
5"J	Above 3000	GG, 55, 17	-	440.91	-	-	-	1329	20.20	7.09

Note: "K, J, and *L"* represent *Kashmir*, *Jammu* and *'Ladakh Region'* and index of soil groups is given above

5.5 BRIEF DESCRIPTION OF AGRO-CLIMATIC ZONES

(I) Zone 1K: This zone covers the Jhelum valley floor in Kashmir Valley. Therefore being fertile, it is devoted to rice, maize and mustard cultivation. It receives adequate precipitation and the temperature is favourable for crop cultivation. The productivity of rice is more in this zone than zone 2K.

(II) Zone 2K: This zone lies between 1700-3000m and therefore besides rice and maize, orchard cultivation is dominant in this zone. The overall agricultural productivity in this zone is neither too low nor too high. It receives more precipitation but less temperature than zone 1K.

(III) Zone 3K and 3'K: These two zones lie above 3000m and therefore crop cultivation is not possible. These zones receive more precipitation especially in the form of snow. These zones cover substantial area of Bandipora, Ganderbal, Anantnag and Budgam districts of Kashmir valley.

(IV) Zone 1J: This zone has the lowest altitude (below 500m) and is basically an extension of Northern plains of India. It is very fertile and is known for *'Basmati rice'* cultivation. It receives sufficient rainfall and adequate insolation, therefore has highest productivity among all the zones.

(V) Zone 2J: This zone has an altitude of 500-1000m. It is adjacent to zone 1J and it includes the areas of Kathua and Udhampur. Maize is dominant crop in this zone followed by wheat and rice.

(VI) Zone 2'J: This zone occupies the areas of Rajouri and Samba districts. It is a productive zone and all the crops grown in this zone have high productivity. This zone receives sufficient rainfall and insolation.

(VII) Zone 3J: This zone lies between 1000-2000m and occupies the areas of Kathua, Jammu, Rajouri and Samba districts. It is agriculturally productive and also has substantial area (4131km^2). Wheat, Rice and Maize are grown in this zone.

(VIII) Zone 3'J: This zone occupies the areas of Udhampur, Reasi, Poonch, Rajouri, Ramban and Doda districts. It has an altitude of 1000-1700m and occupies an area of 7732 km^2. It receives maximum annual precipitation than other zones (1592mm/annum).

(IX) Zone 4J: This zone lies on higher altitude and therefore receives comparatively less insolation. It includes the areas of Kathua, Doda, Kishtwar and Poonch districts.

(X) Zone L: This zone occupies the areas of Leh and Kargil districts. It lies above 3000m. Millets, Barley and Wheat is grown. Besides, it is famous for apricot cultivation. It occupies highest area (93531 km^2) among all the zones and being cold desert, it receives less precipitation (157mm/annum). The temperature is also low in this zone with mean maximum of 11.11° C and mean minimum of -2.53° C.

(XI) Zone 3K, 3'K, 5J, 5'J, and 5''J: These five zones lie above 3000m altitude. Therefore these zones are not suitable for crop cultivation and so have been designated as climatic zones and not agro-climatic zones. Zone 3K and 3'K occupy the parts of Ganderbal, Bandipora, Kupwara and Budgam districts, while as zones located in Jammu division (5J, 5'J, and 5''J) occupy the parts of Kishtwar and Doda districts.

5.6 TREND OF FOOD CROP PRODUCTIVITY IN AGRO-CLIMATIC ZONES OF JAMMU AND KASHMIR

Agricultural productivity is the yield per unit of land. It is an important indicator of agricultural development. It depends both on the physical as well as socio-economic factors, *viz*, climate, soil, irrigation, per capita income, literacy, sex ratio and occupational structure etc. Since the productivity data is not available at agro-climatic zone level, therefore the productivity of districts has been used to generate the productivity database for the agro-climatic zones by using the *'proportional weightage'* method.

The productivity of all the major crops grown in the state has increased over the period of time and the trend of the major crops grown in different agro-climatic zones is discussed in the succeeding paras;

The productivity of paddy in the agro-climatic zones of Jammu and Kashmir has increased from 9.22 quintals/hectare to 21.97 quintals/hectare, thus implies a total increase of 12.75 quintals/hectare during these twenty eight years [Table 5.4 and Fig. 5.6, 5.7].

Table 5.5: Productivity of paddy in agro-climatic zones of Jammu and Kashmir

Zones	Productivity of paddy (quintals/hectare)							
	1980-81	**1985-86**	**1990-91**	**1995-96**	**2000-01**	**2005-06**	**2011-12**	**Change (q/ha)**
1k	8.84	9.72	10.96	12.57	14.73	16.84	21.87	**13.03**
2k	9.96	10.96	12.37	14.18	16.62	19.00	20.58	**10.62**
1 J	10.66	11.90	13.10	15.49	18.32	22.73	25.76	**15.10**
2J	8.48	10.24	11.44	13.28	15.55	17.99	21.03	**12.55**
2'J	8.70	9.57	10.66	12.01	13.91	16.22	21.12	**12.42**
3 J	9.28	10.83	12.04	14.01	16.40	19.50	22.99	**13.71**
3'J	8.80	10.26	11.17	12.86	15.08	17.29	20.38	**11.58**
4 J	9.05	11.02	11.79	13.45	15.61	17.42	20.05	**11.00**
L	-	-	-	-	-	-	-	**-**
Mean	**9.22**	**10.56**	**11.69**	**13.48**	**15.78**	**18.37**	**21.72**	**12.50**

Source: *Compiled by using data obtained from financial commissioner's office and formula (i), 2011*

The productivity has not increased much in the first fifteen years (1980-1995) and due to the use of improved seeds and fertilizers; it has increased at a fairly good rate in the last sixteen years (1995-2011).

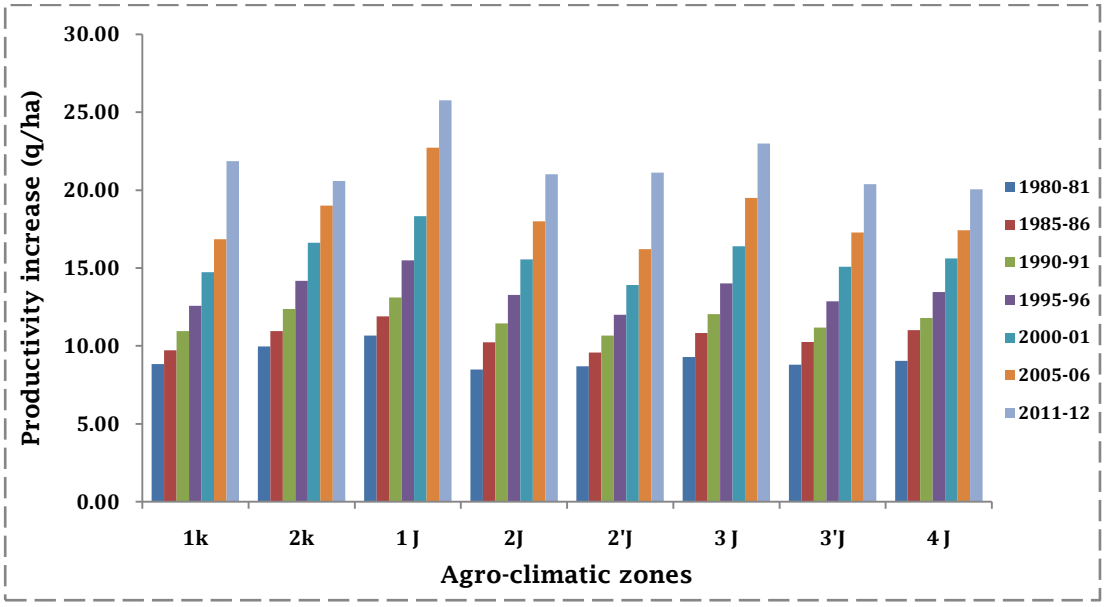


Fig 5.6: Trends in the paddy productivity in Jammu and Kashmir

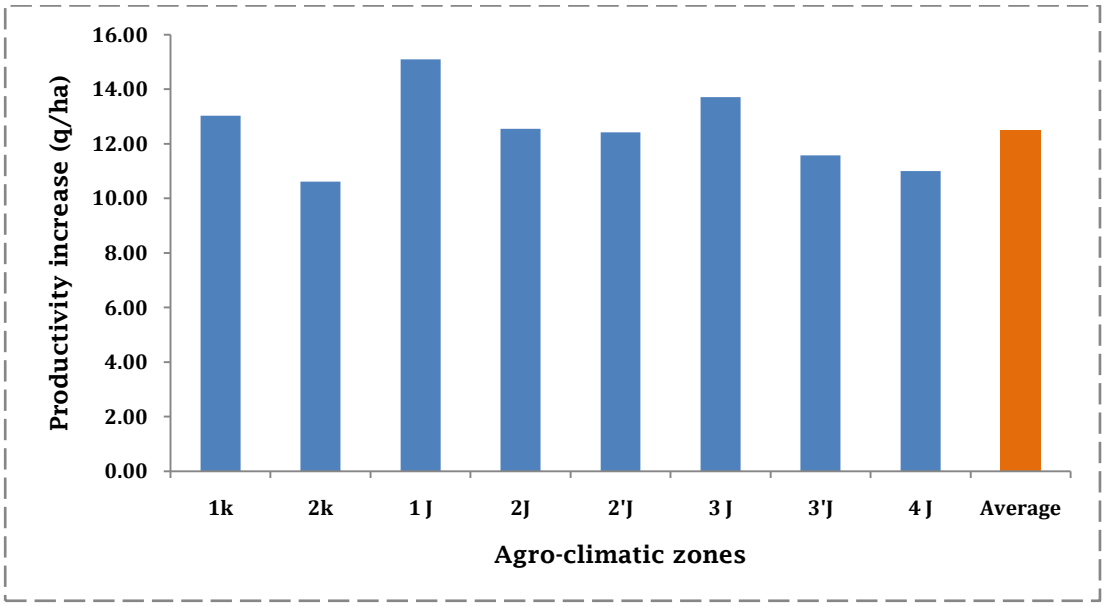


Fig 5.7: Paddy productivity growth in Jammu and Kashmir

Three zones out of the total in the state have more productivity increase than state average (12.75 q/ha). The highest productivity increase has been observed in zone 1J (15.10 q/ha), followed by 3J (13.71 q/ha) and 1k (13.03 q/ha), while as lowest increase is observed in zone 2k (10.62 q/ha) and 4J (11 q/ha) [Fig. 5.10]. The productivity of rice is not possible in one zone of the state (*zone L*) because of the unfavourable geographical conditions for the growth of the crop. The productivity of maize in all the agro-climatic zones of the state has increased. In absolute values, it has increased from

8.30 quintals/hectare in the year 1980 to 15.98 quintals/hectare 2011, thus implies a total increase of 7.67 quintals/hectare. Like paddy, the productivity has increased at a slower rate in the first fifteen years than the last sixteen years (table 5.5 and Fig. 5.8).

Table 5.5: Productivity of maize in agro-climatic zones of Jammu and Kashmir

Zones	Productivity of maize (quintals/hectare)							
	1980-81	1985-86	1990-91	1995-96	2000-01	2005-06	2011-12	Change (q/ha)
1k	5.71	6.08	6.88	7.88	8.94	10.26	12.9	**7.19**
2k	6.46	6.88	7.79	8.92	10.13	11.62	14.63	**8.17**
1 J	11.12	12.15	13.25	14.56	15.74	17.81	21.41	**10.29**
2J	8.1	9.18	10.45	11.93	13.54	15.36	18.97	**10.87**
2'J	8.53	9.75	10.87	12.77	14.94	17.7	17.03	**8.5**
3 J	9.39	10.47	11.63	13	14.43	16.42	14.9	**5.51**
3'J	8.24	9.44	10.67	12.37	14.22	16.55	12.35	**4.11**
4 J	8.86	10.09	11.3	12.52	14.08	16.51	15.61	**6.75**
L	-	-	-	-	-	-	-	-
Mean	**8.30**	**9.26**	**10.36**	**11.74**	**13.25**	**15.28**	**15.98**	**7.67**

Source: *Compiled by using data obtained from financial commissioner's office and formula (i), 2011*

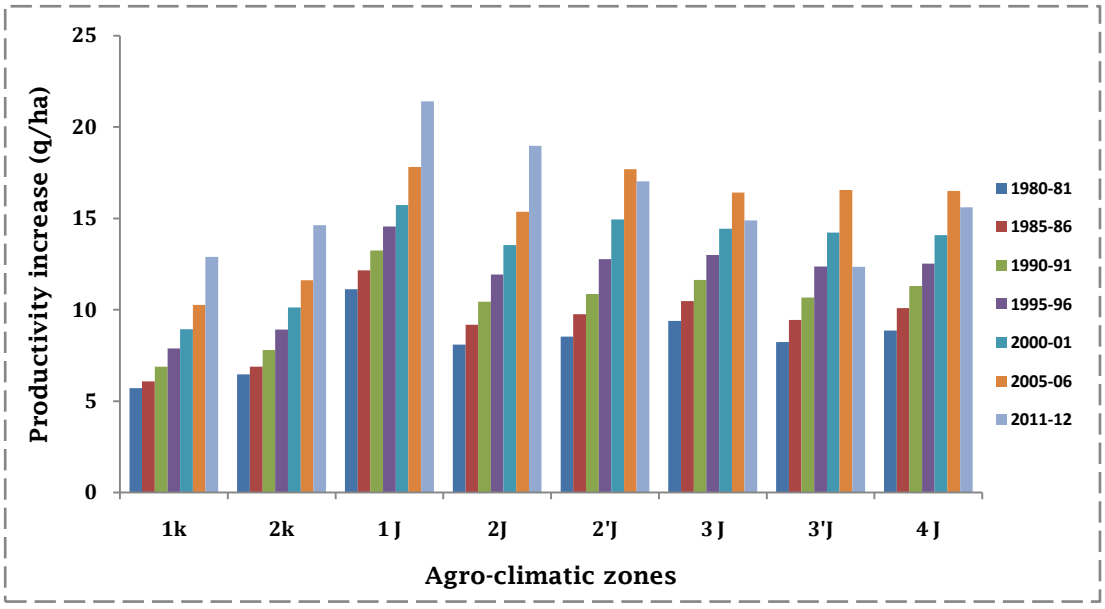


Fig. 5.8: Trends in the maize productivity in Jammu and Kashmir

The highest increase in productivity among the various zones is recorded in 2J (10.87q/ha), followed 1J (10.29 q/ha) and 2'J (8.50 q/ha), while the lowest is observed in 3'J (4.11 q/ha) and 3J (5.51 q/ha). Four zones out of eight agro-climatic zones have low productivity increase than state average (Fig. 5.9).

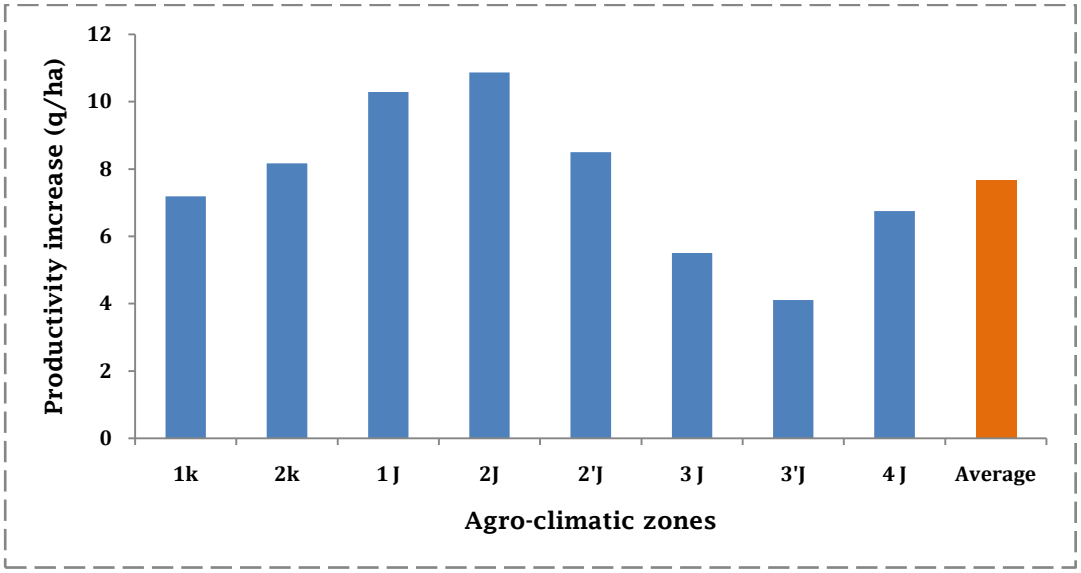


Fig 5.9: Maize productivity growth in Jammu and Kashmir

The wheat has also shown significant increase in productivity in all the agro-climatic zones of the state. It has increased from 7.41 quintals/hectare to 17.67 quintals/hectare, thus implies a total increase of 10.26 quintals/hectare (table 5.6 and Fig 5.10).

Table 5.6: Productivity of wheat in agro-climatic zones of Jammu and Kashmir

Zones	Productivity of wheat (quintals/hectare)							
	1980-81	1985-86	1990-91	1995-96	2000-01	2005-06	2011-12	Change (q/ha)
1k	5	5.62	6.44	7.46	8.45	9.82	12.37	**7.37**
2k	5.67	6.37	7.31	8.46	9.58	11.12	14.01	**8.34**
1 J	10.51	11.83	13.36	14.72	14.97	16.43	18.91	**8.40**
2J	7.01	8.04	9.78	12.04	13.64	15.45	18.87	**11.86**
2'J	7.3	8.55	9.98	11.65	13.71	16.3	19.09	**11.79**
3 J	8.22	9.4	11.03	12.97	14.07	15.81	18.42	**10.2**
3'J	7.61	8.78	10.05	11.65	13.25	15.6	19.1	**11.49**
4 J	7.86	9.16	10.04	11.63	12.7	15.01	18.84	**10.98**
L	7.5	8.59	9.775	11.3	13.51	15.725	19.39	**11.89**
Mean	**7.41**	**8.48**	**9.75**	**11.32**	**12.65**	**14.59**	**17.67**	**10.26**

Source: *Compiled by using data obtained from financial commissioner's office and formula (i), 2011*

Like in case of paddy and maize, the productivity of wheat has also increased at a slower rate in the first fifteen years (1980-1995) than the last sixteen years (1995-2011) taken for the study.

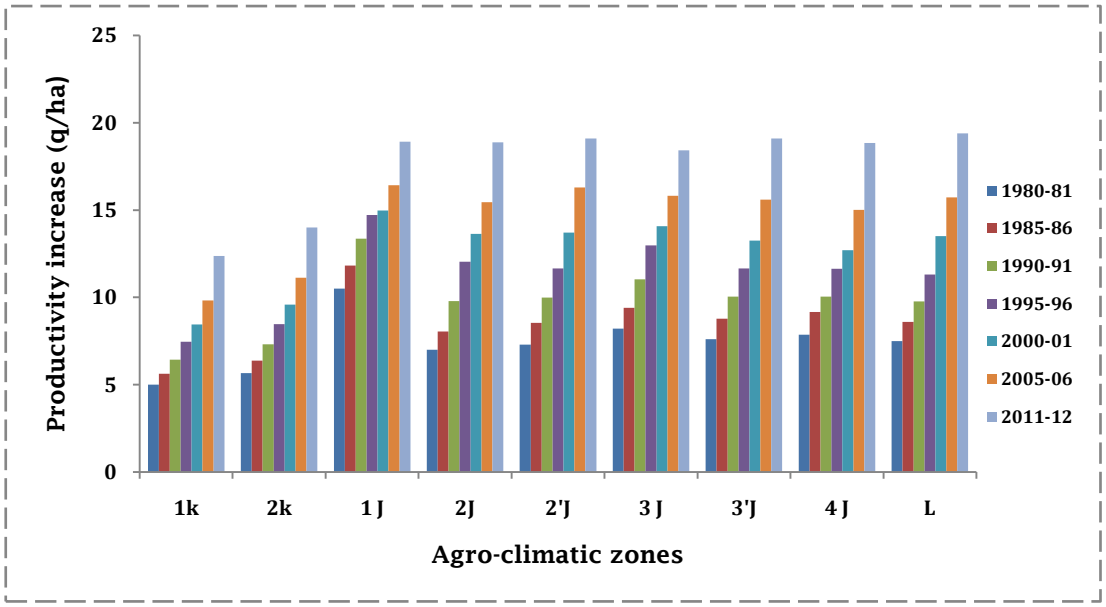


Fig. 5.10: Trends in the wheat productivity in Jammu and Kashmir

Regional variations in the increase in productivity are observed across different agro-climatic zones of the study area. The highest increase is recorded in L (11.89 q/ha), followed by 2J (11.86 q/ha) and 2'J (11.79 q/ha), while the lowest is observed in 2k (8.34 q/ha) and1k (7.37 q/ha). Four agro-climatic zones have recorded low productivity increase than state average (Fig. 5.11).

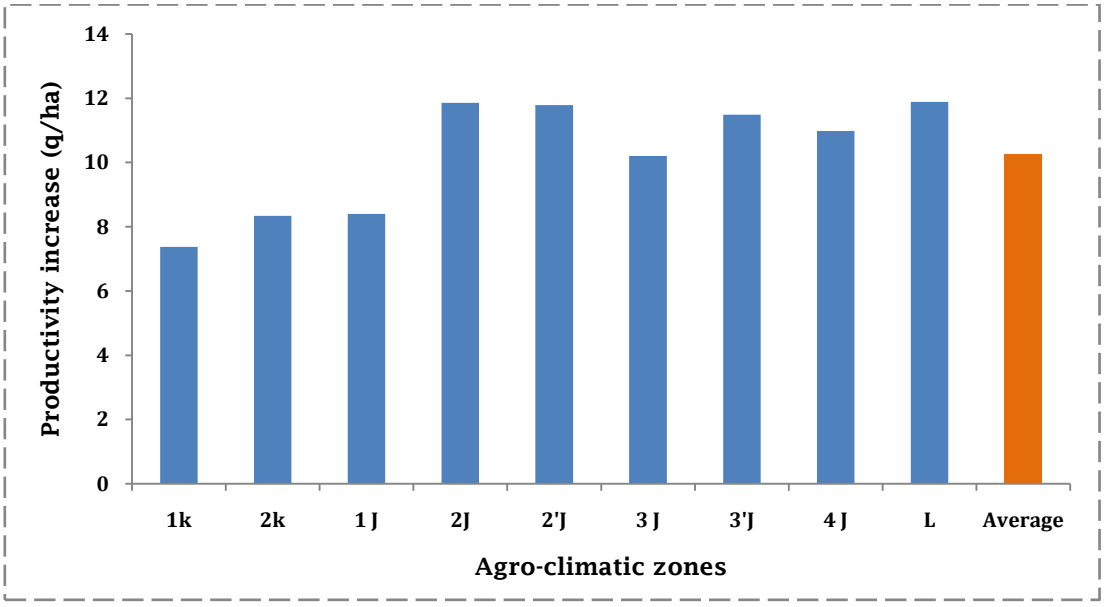


Fig. 5.11: Wheat productivity growth in Jammu and Kashmir

5.7 LEVELS OF CROP PRODUCTIVITY IN AGRO-CLIMATIC ZONES

The determination and measurement of spatial variation of agricultural productivity is of vital importance for agricultural planning and development. In the present study, for the determination of the levels of crop productivity among the different agro-climatic zones of Jammu and Kashmir, the productivity of the three crops discussed above have been taken. Therefore the variables are;

1. Productivity of rice (x_1)
2. Productivity of wheat (x_2) } in quintals/hectare
3. Productivity of maize (x_3)

Since the agricultural productivity is not uniform in the agro-climatic zones of the study area but exhibit great variations. The respective weights of the indicators chosen are: W_1= 11.18, W_2= 6.84 and W_3=5.30. Thus it is observed that the highest weight is shown for the productivity of paddy (11.18) and the lowest (5.30) is observed for productivity of maize, while as productivity of wheat is possessing medium weight (Table 5.7).

Table 5.7: Agricultural productivity indicators in agro-climatic zones

Zones	Paddy (X_1)	Wheat (X_2)	Maize (X_3)
1k	21.87	12.37	12.9
2k	20.58	14.01	14.63
1 J	25.76	18.91	21.41
2J	21.03	18.87	18.62
2'J	21.12	19.09	17.03
3 J	22.99	18.42	14.9
3'J	20.38	19.1	12.35
4 J	20.05	18.84	15.61
L	0	19.39	0
Total	**173.78**	**159**	**127.45**
Mean	**21.72**	**17.67**	**15.93**

Source: *Compiled by using tables 5.4, 5.5, and 5.6*

The indices for all the districts have also been calculated by taking state as 100 (for average composite index of 17.69) as given below (table 5.8).

Table 5.8: Composite Index of Agricultural Development in Jammu and Kashmir

S.No.	Zone	Composite index	Indices
01.	1k	17.13	97
02.	2k	17.36	98
03.	1 J	22.82	129
04.	2J	19.87	112
05.	2'J	19.62	111
06.	3 J	19.87	112
07.	3'J	18.22	103
08.	4 J	18.71	106
09.	L	5.59	32
	Average	**17.69**	**100**

Source: *Compiled from by using table 5.7*

The range of composite indices varied across the agro-climatic zones from the minimum value of 32 in '*Zone L*' including the areas of Leh and Kargil to the maximum of 129 in '*Zone 1J*' including the areas of Jammu, Samba etc. which indicates that the former is highly advanced in the agricultural productivity and the latter is highly disadvantaged.

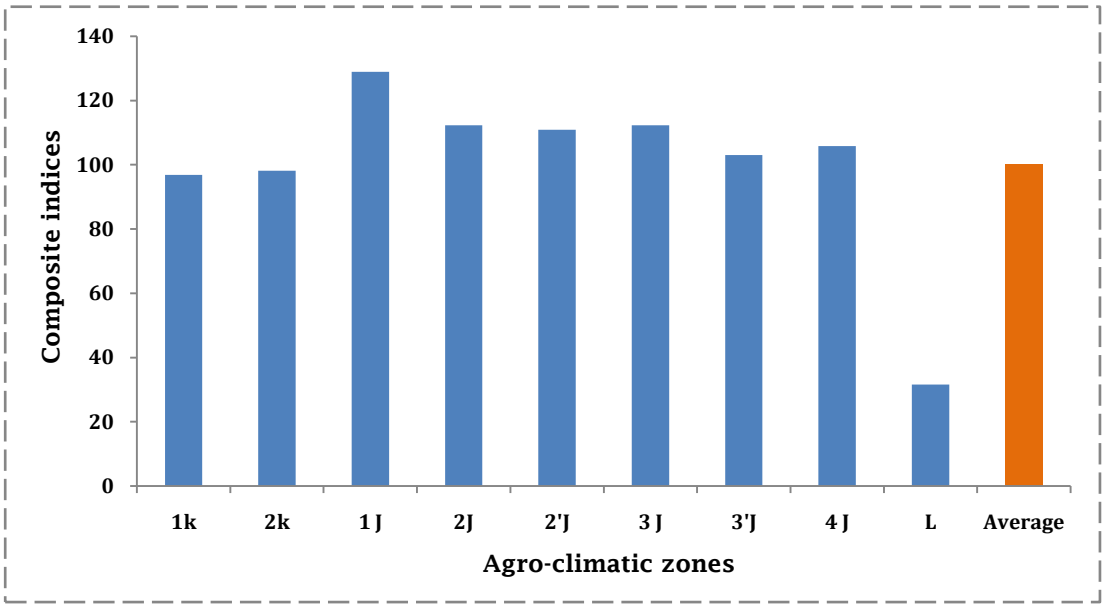


Fig. 5.12: Composite indices of agro-climatic zones in Jammu and Kashmir

The other zones which perform well in agricultural productivity are *2J, 2'J, and 3J* (indices value between 110 and 120). The other zones are comparatively less developed

and have the indices value below 110 (Fig. 5.12). The composite indices of agricultural productivity of different agro-climatic zones in the state are grouped into four categories which are produced in table 5.9and Fig. 5.13. The zones in which agriculture is not possible are denoted by '*ANP*'.

Table 5.9: Ranking of zones in respect of agricultural productivity

Index Value	Above 110	100 to 110	90-100	Below 90	Total
Category	High	Medium	Low	Very Low	
Name of zones	*1J,2J, 2'J, 3J*	*3'J, 4J*	*1k, 2k,*	*L*	
No. of zones	04	02	02	01	09
Percentage area to zones total	44.4	22.2	22.2	11.11	100

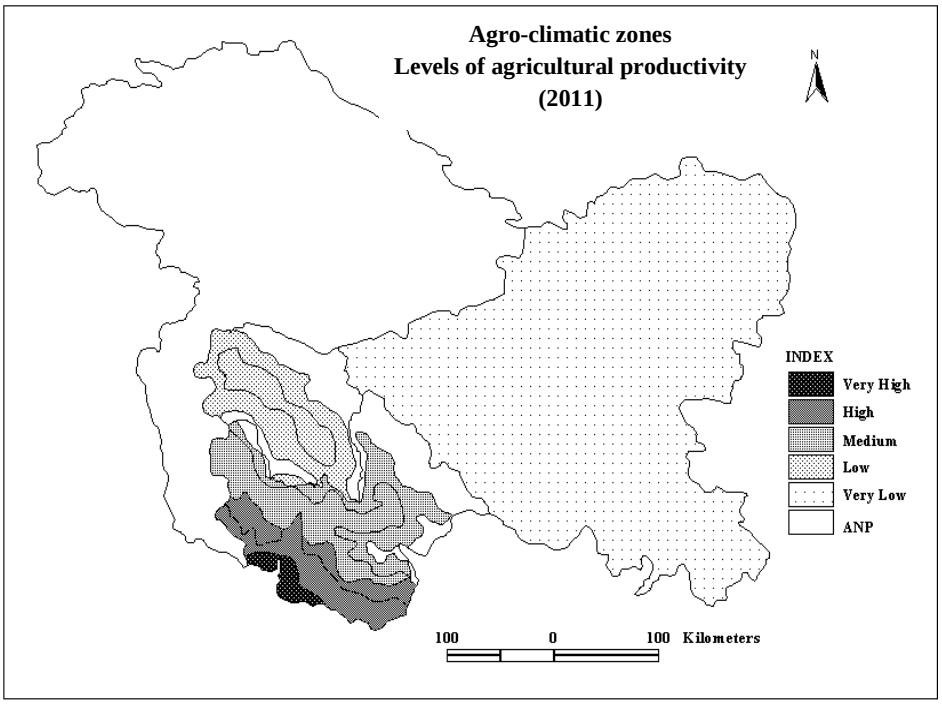


Fig. 5.12

Agriculture and its allied activities are the predominant sector of the economy of Jammu and Kashmir (Hussain, 2006). The state economy is a high cost mountain economy and has a number of characteristics that pose special development challenges (Singh, 2006). Agriculture is the main stay of state economy as more than sixty percent of the population derives their income directly or indirectly from agriculture sector. Agriculture is a vital component of primary sector. The Jammu and Kashmir state is basically agrarian in nature. As per census 2011, 19.74 lakh persons comprising 17.12 lakh as cultivators and 2.62 lakh as agricultural labourers depend directly on agriculture for their livelihood forming 47 percent of the total working force (42.12 lakh persons). The Agriculture and allied sectors contributed about 27 percent to the GSDP while as Agriculture sector specifically contributed 8 to 9 percent to the GSDP during 2007- 07 (Digest of statistics, 2006-07). The agriculture sector in the state shows profound changes in cropping land use, agriculture work force, food deficit etc. which are discussed below.

6.1 CROPPING LAND USE DYNAMICS - AN ANALYSIS

The cropping system of any locality is the cumulative results of the past and present decisions by individuals, communities or governments and it keeps on changing in any country, state or region in consonance with change in prices of goods, Govt. policies and other related factors (Gupta & Singh, 1979). The trends in the net sown area, area under different crops (paddy, wheat, Maize), area under orchards, irrigated area, cropping intensity, productivity, physiological density, and percentage of working population in agriculture etc in the study area from the year 1980 to 2011 are analyzed in the proceeding discussion.

(I) Net Sown Area

Net sown area refers to the total area sown in an agricultural year. In the study area the average net sown area has increased from 7.05 percent of the total geographical area in 1980 to 7.29 percent in 2008, though with spatial variations across the districts. The net

sown area has increased overall in the state by 3.36 percent (715306 ha in 1980 to 739319 ha in 2008). It has increased substantially in the districts of Jammu province except Kathua district (-3.56 percent), while as it has decreased in three out of six districts in Kashmir province.

The net sown area increased in Jammu province on account of efficient land reclamation and increased use of technology, while as same process could not be repeated in Kashmir valley at that scale because of paucity of land which could be brought under cultivation. In the two districts of Ladakh namely Leh and Kargil, the net sown area has increased as firstly ample land is available for purposes other than agriculture and secondly efforts are used to bring more land under cultivation (Fig. 6.1). Srinagar district lost the maximum net sown area (8088 ha) on account of developmental activities and urbanization, while as district Jammu has received considerable increase in it (95166 to 113941ha) on account of efficient land reclamation and enhanced irrigation facilities. Four districts (Srinagar, Budgam, Pulwama and Kathua) have registered negative growth in the net sown area.

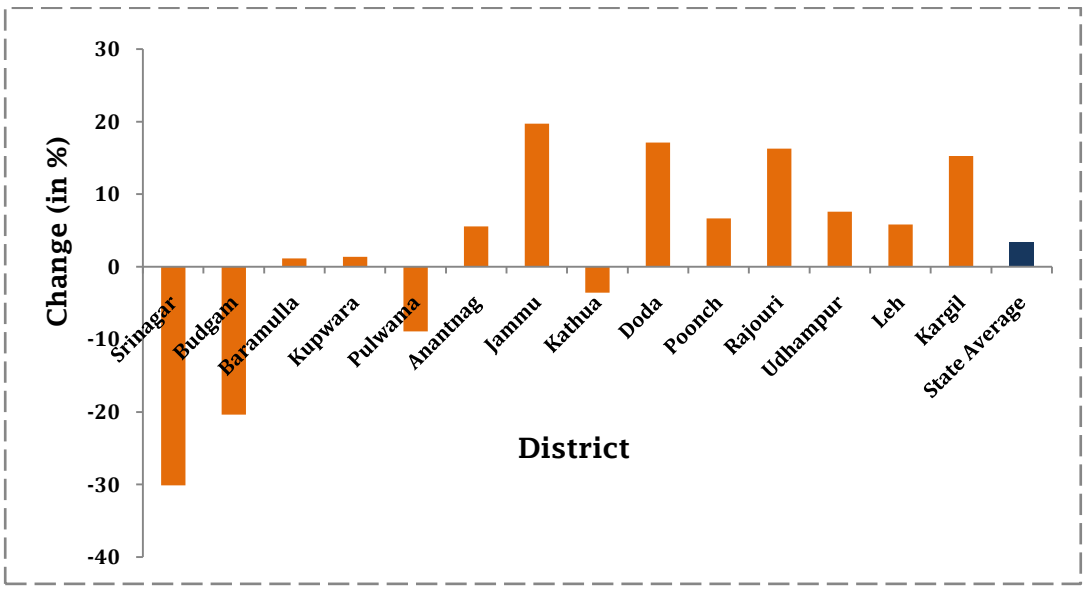


Fig. 6.1: Percent change in net sown area in Jammu and Kashmir (1980-2008)

(II) Gross cropped/sown area

Gross cropped/sown area means the total area sown plus the area sown more than once in the same year. This is an indicator which reflects the feasibility of the area to be

sown more than once a year. The areas where only once crops are grown in a year have gross cropped area almost equal or slightly greater than the net sown area. The gross cropped area in the study area has increased from 9.60 percent of geographical area in 1980 to 11.33 percent in 2008.

The gross cropped area has increased overall at state level by 174904 hectares (17.96 percent). However, it has increased more in the districts of Jammu province than Kashmir (Fig. 6.2).

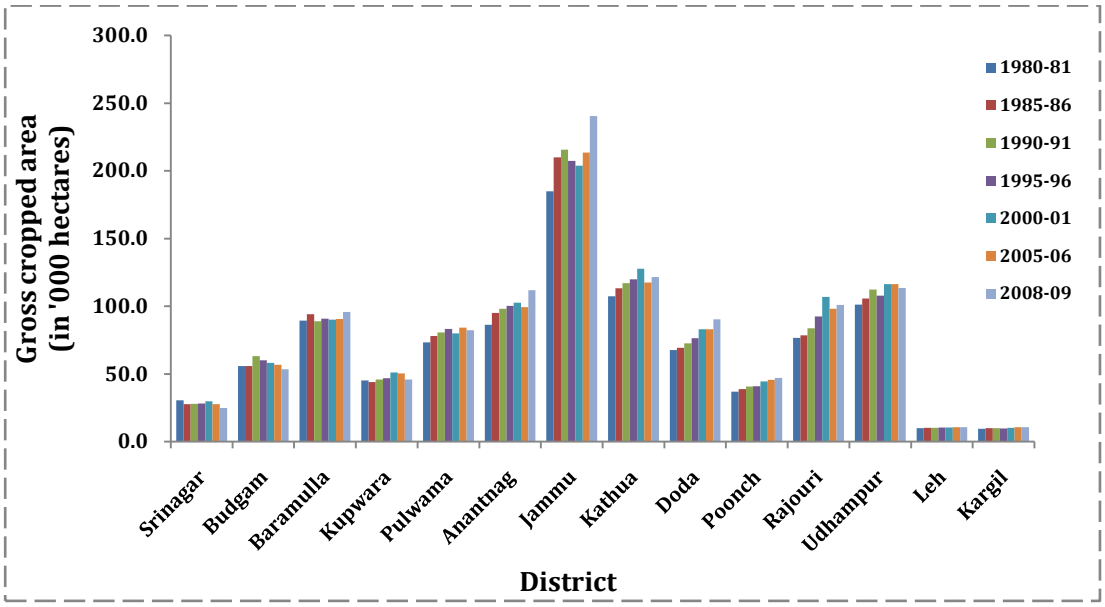


Fig. 6.2: Growth in the gross cropped area in Jammu and Kashmir (1980-2008)

It decreased in two districts of the state namely Srinagar (-18.73 percent) and Budgam (-4.34 percent) and in remaining twelve districts it has increased during this time span of twenty eight years though with different intensities. The gross cropped area has increased in the districts lying in Jammu division because the climate is favourable for double cropping, while as in Kashmir province, most of land is sown only once on account of severe winter season prevalent in the valley.

Five districts (Anantnag, Jammu, Rajouri, Poonch and Doda) in the state have recorded high growth of gross cropped area than state average, while as seven districts (Baramulla, Kupwara, Pulwama, Kathua, Udhampur, Leh and Kargil) have recorded

low growth than state average of 17.96 percent. In Jammu province only Kathua has recorded comparatively less increase (13.28 percent) than other districts [Fig. 6.3].

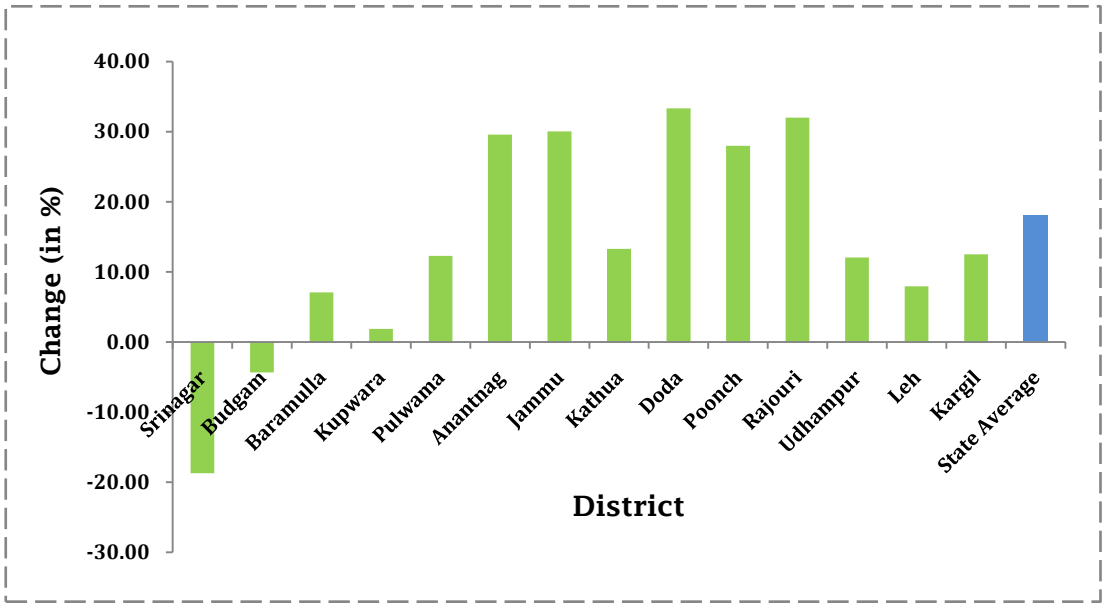


Fig. 6.3: Percent change in gross sown area in Jammu and Kashmir (1980-2008)

(III) Gross irrigated area to net sown area

Irrigation refers to the availability of water for crop cultivation. This determines to large extent what crops can be grown and where. The gross irrigated area to net sown area (in percentage) has been calculated by the formula;

$$\textit{Gross irrigated area to net sown area} = \frac{\textit{Net sown area}}{\textit{Gross irrigated area}} \times 100$$

The Fig. 6.4 reflects that on an average the Kashmir province has adequate irrigational facilities on account of its canal irrigation system than the Jammu province which is dependent on monsoon rains, while as Ladakh has irrigation available for cent percent net sown area. The gross irrigated area to net sown area has increased from 48.76 percent to 50.73 percent, though for Kashmir province it increased at a higher rate (61.65% to 64.37%) than the Jammu province (19.14% to 20.66%).

The Fig. 6.4 also shows the trends in irrigation potential of the state and its spatial variation.

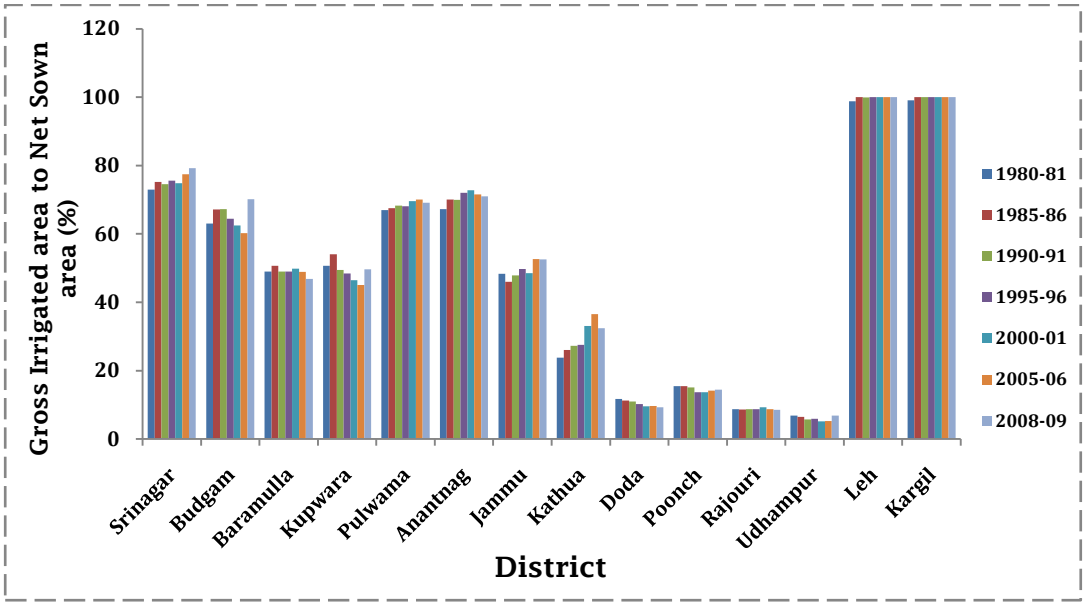


Fig. 6.4: Growth in the gross irrigated area in Jammu and Kashmir (1980-2008)

Srinagar district has maximum irrigation facilities as seventy two to eighty percent of its net sown area gets adequate irrigation, while as on contrarily Udhampur has the minimum where only six to seven percent area is irrigated properly.

The irrigation capacity has increased considerably in district Kathua (8.57 percent) followed by Budgam (7.19 percent) and Srinagar (6.28 percent), while as it has decreased in five districts (Baramulla, Kupwara, Doda, Poonch and Rajouri) during these twenty eight years. Moreover, low increase is observed in Leh and Kargil districts (1.19 and 0.85 percent respectively) of the state (Fig. 6.5).

Fig. 6.5: Percent change in gross irrigated area in Jammu and Kashmir (1980-2008)

(IV) Cropping intensity

Cropping intensity depicts the feasibility of land for cultivation more than once in a year and is calculated by using the following formula;

$$\textit{Cropping intensity} = \frac{\textit{Gross sown area}}{\textit{Net sown area}} \times 100$$

Cropping intensity is an indicator of agricultural development. The high cropping intensity reflects that all the factors affecting crop cultivation are favourable for double or triple cropping, while as low cropping intensity reflects the same in opposite direction. The cropping intensity has increased in the state from 130.27 in the year 1980 to 145.70 in 2008.

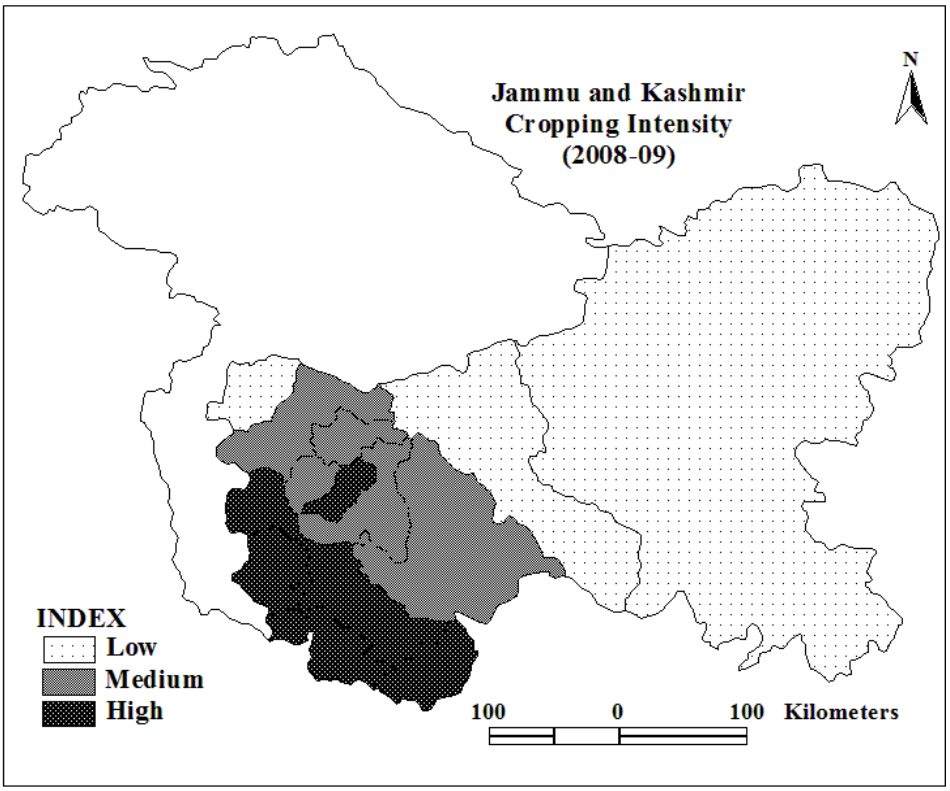


Fig. 6.6: Cropping intensity in Jammu and Kashmir (2008-09)

However, Kashmir province has less cropping intensity than Jammu province because climate is favourable for double cropping in latter than former. In Kashmir province, the cropping intensity has increased by seventeen units (110.68 to 127.42), while as in Jammu division it has increased by almost twenty units (157.68 to 177.06). The highest cropping intensity is observed in Jammu and Kathua districts and lowest in Kupwara and Leh.

The cropping intensity at state level has increased by 11.84 percent though with inter district variations. Eight out of fourteen districts (Srinagar, Budgam, Pulwama, Anantnag,

Fig. 6.7: Percent change in cropping intensity in Jammu and Kashmir (1980-2008)

Kathua, Doda, Poonch and Rajouri) have recorded more increase than state average, while as district Kargil has shown a decrease in cropping intensity (-2.40 percent). The lowest increase is observed in district Kupwara (0.53 percent) [Fig. 6.7]. The overall trend of cropping intensity in the state is increasing as shown in figure 6.8.

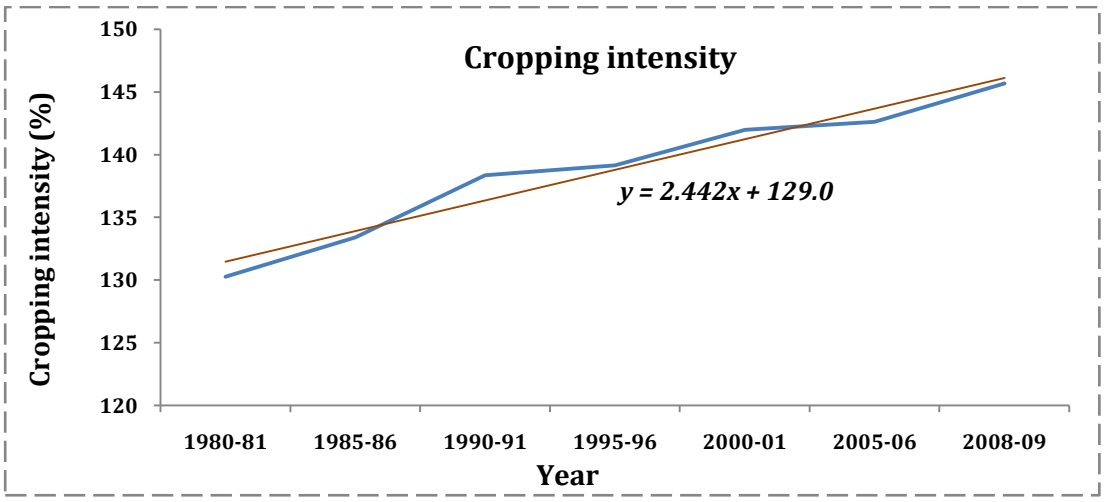


Fig. 6.8: Trend of cropping intensity in Jammu and Kashmir (1980-2008)

(V) Area under paddy

Paddy is one of the dominant crops grown in the state of Jammu and Kashmir as it staple food of more than sixty percent of the population of the state. It is a tropical crop and requires high temperature and moisture conditions (24°C to 35°C and 150-250cm). Paddy cultivation is an age old practice in the state, but with changing times the area under this crop has decreased in all the districts.

Kashmir province has lost 34.66 percent of the area under this crop, while as Jammu province has recorded 21.96 percent decline. Fig. 6.9 depicts that Srinagar and Udhampur district lost maximum area under paddy during these twenty eight years (48.95 and 46.64 percent respectively), while as Jammu district has lost the least area (13.30 percent). The cultivation of this crop is not possible in Ladakh division of the state because of the very cold climate and short growing season. On an average in absolute values the state has lost 82321 hectares (-29.92 percent) of land under paddy cultivation.

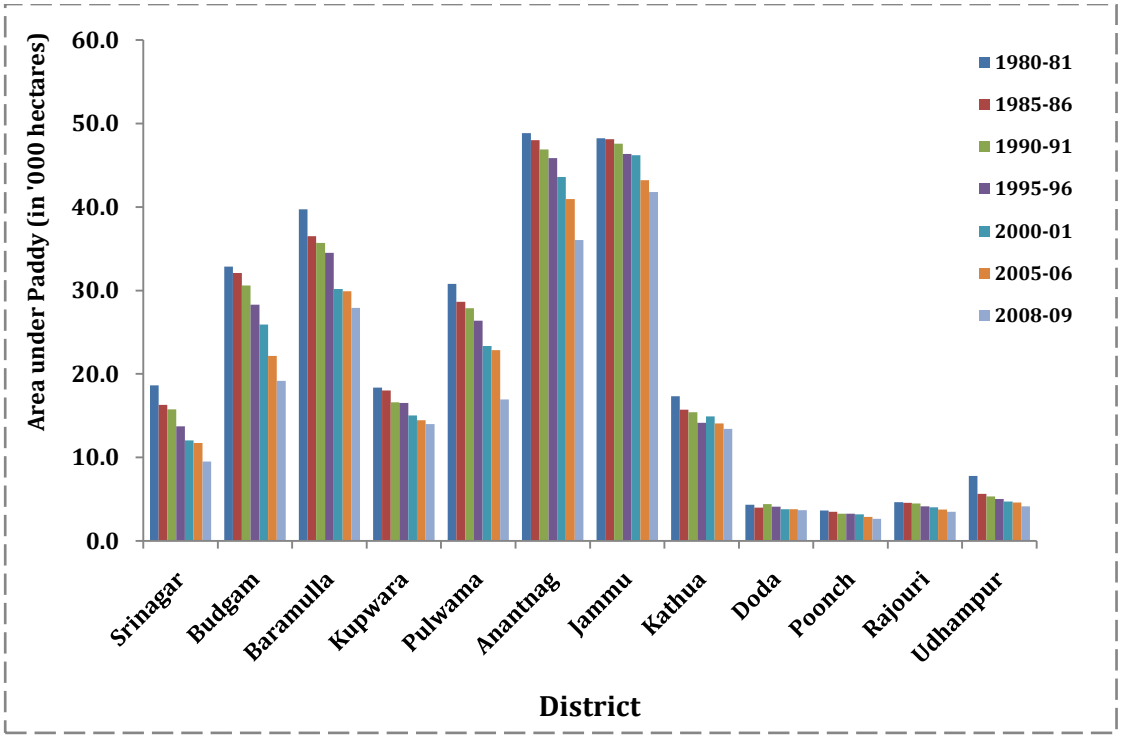


Fig. 6.9: Growth in area under paddy in Jammu and Kashmir (1980-2008)

In the state almost one third of the land under paddy (-29.92 percent) has lost during these twenty eight years though with regional variations. The maximum land loss under this crop is observed in district Srinagar (-48.95 percent) followed by Udhampur (-46.64 percent), Pulwama (-44.88 percent) and Budgam (-41.60 percent), while as least loss is recorded in district Jammu (-13.30 percent) and Doda (-15.35 percent). Four out of the twelve districts have recorded higher decrease than state average (Fig. 6.10).

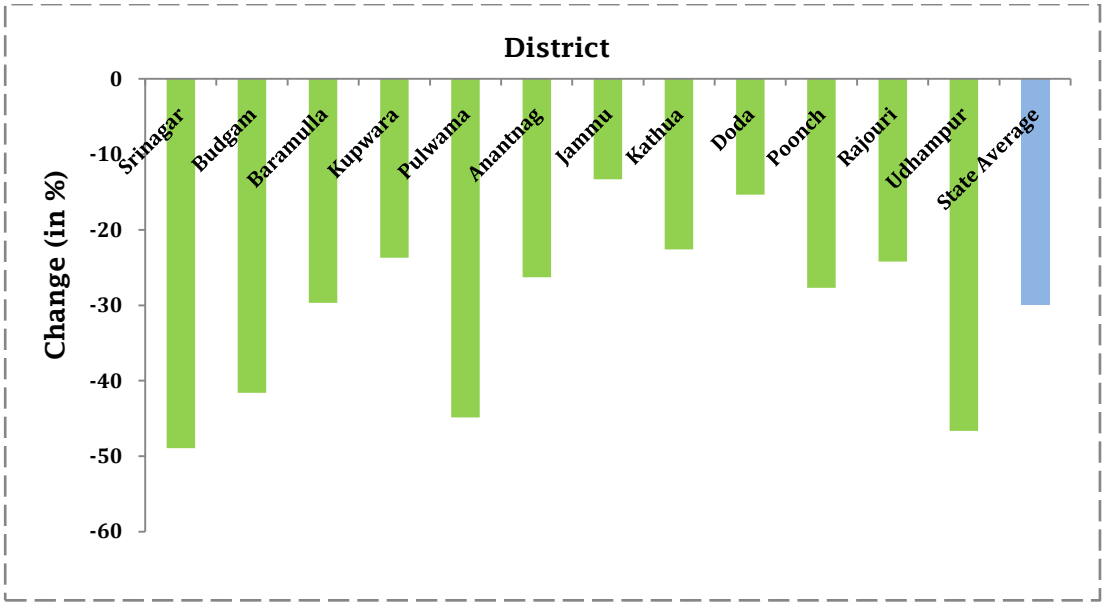


Fig. 6.10: Percent change in area under paddy in Jammu and Kashmir (1980-2008)

The overall trend of area under paddy in the state is decreasing (Fig. 6.11). It showed continuous decrease from 1980 to 2008.

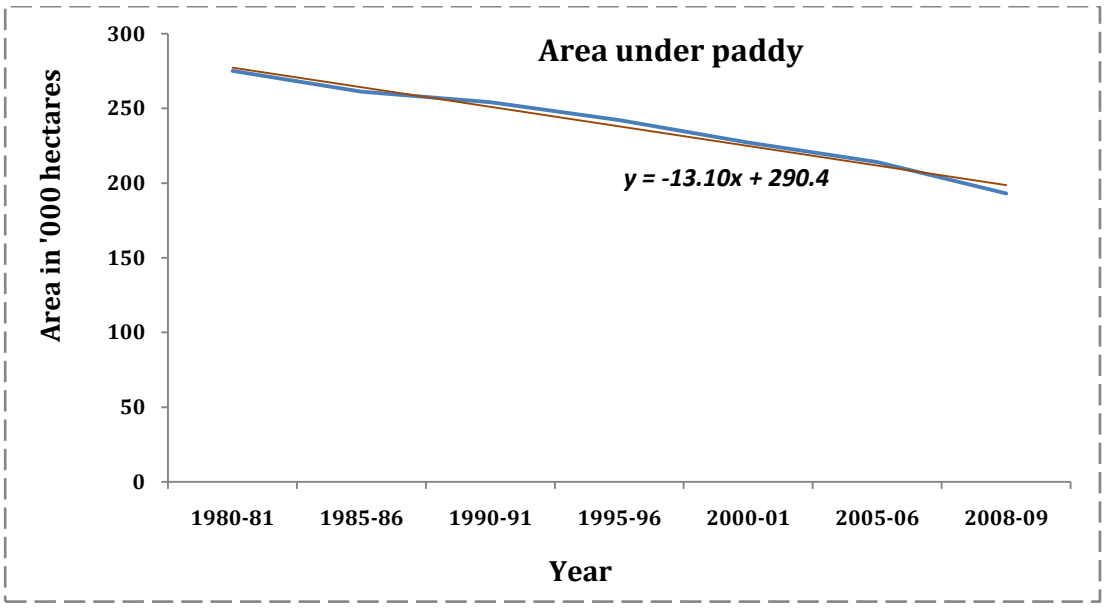


Fig. 6.11: Trend of area under paddy in Jammu and Kashmir (1980-2008)

(VI) Area under maize

Maize is also one of the prime crops grown in the state of Jammu and Kashmir as it is staple food of the Gujjars and Bakerwlas living in and around the pir panjal range consisting of more than ten to fifteen percent of the population of the state. It is a coarse grain and requires moderate temperature and less water (10°C to 25°C and 50-120cm). Though maize is cultivated in all the districts of the state, but it is a dominant crop in the hilly districts having more low lying mountainous area (*kandi belt*) than the districts which have relatively more plain area.

The area under maize has overall increased in Kashmir province by 5.14 percent though it decreased in three of its districts namely Pulwama, Anantnag, and Srinagar by 9.44, 6.52 and 4.59 percent respectively.

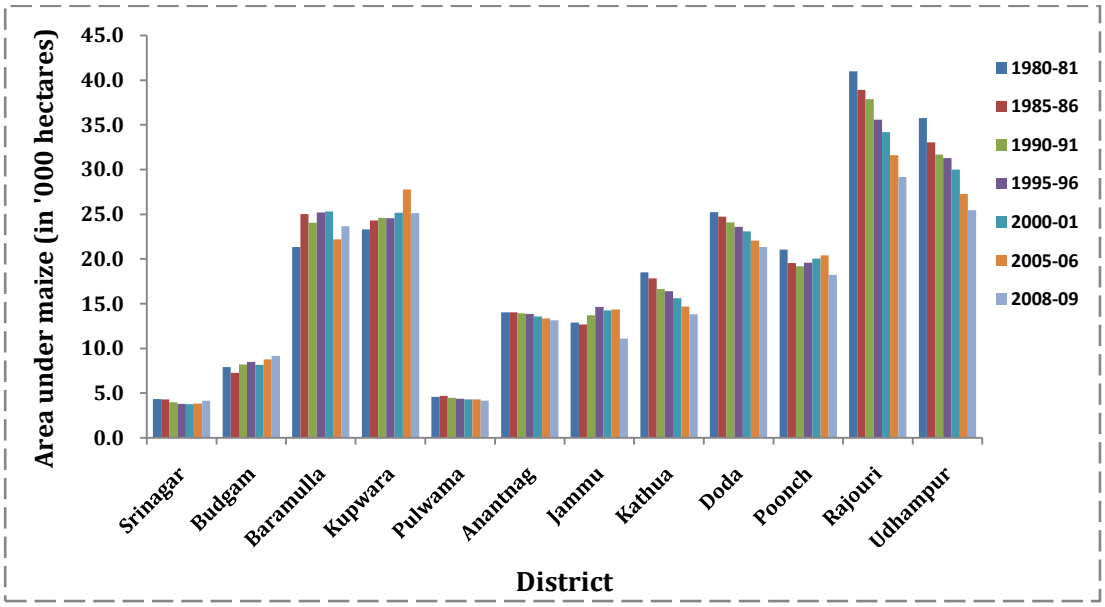


Fig. 6.12: Growth in area under maize in Jammu and Kashmir (1980-2008)

Jammu province has recorded a decline in the area under this crop by 22.88 percent, the maximum decline is observed in Rajouri and Udhampur (28.70 percent each) and minimum in Poonch (13.41 percent). In absolute terms, the area under this crop has increased by 3878 hectares in Kashmir Province, while as in Jammu province it has decreased by 35339 hectares (Fig. 6.12). The crop is not cultivated in Ladakh division because of the unfavourable geographical conditions. The crop has witnessed a decrease in its area at state level (-13.68 percent) though there has been increase in its area in

three districts namely Budgam (16.30 percent), Baramulla (10.83 percent) and Kupwara (7.83 percent). Highest decrease is observed in district Udhampur and Rajouri (-28.78 percent each) and Kathua (-25.50 percent), while as lowest decrease is evident from district Srinagar (-4.59 percent). All the districts of Jammu province have recorded a negative growth in the area under maize cultivation (Fig. 6.13).

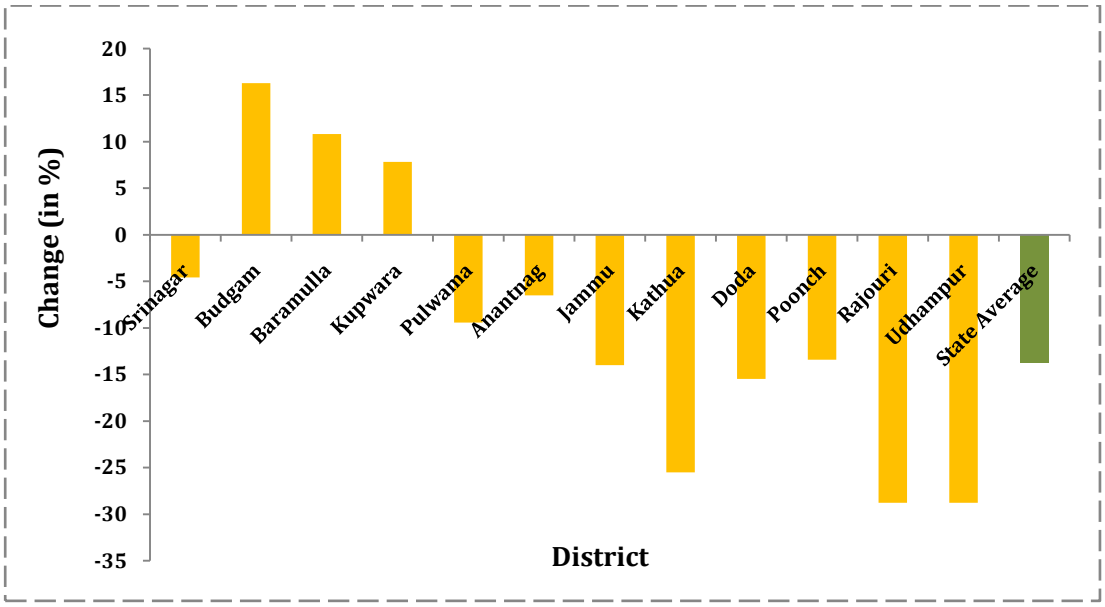


Fig. 6.13: Percent change in area under maize in Jammu and Kashmir (1980-2008)

The trend analysis depicts that area under maize in the study area has shown a continuous decline from 229 thousand hectares in 1980 to 198 thousand hectares in 2008 (Fig. 6.14).

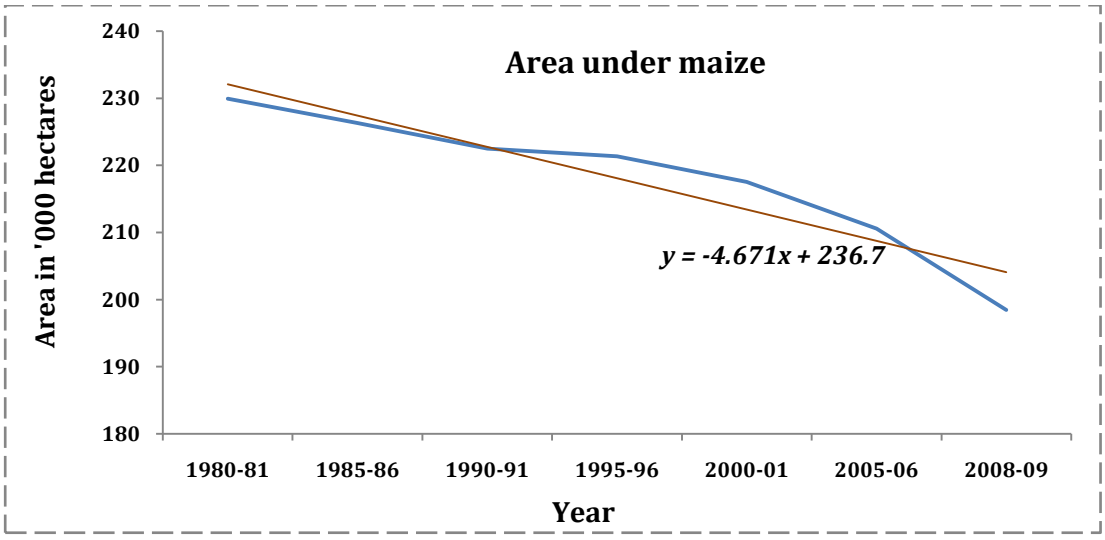


Fig. 6.14: Trend of area under maize in Jammu and Kashmir (1980-2008)

(VII) Area under wheat

Wheat is also one of the important crops grown in the state of Jammu and Kashmir as it is staple food for the people of Jammu and Ladakh province consisting of more than forty percent of the population of the state. This is a rabi crop in the state; i.e. it is grown in October-November and harvested in March-April and requires moderate temperature and less water (15^0C to 25^0C and 50-120cm). This crop is mainly cultivated in Jammu and Ladakh division and less area is under this crop in the districts of Kashmir division. In Kashmir valley wheat is grown in upper reaches and not in plain areas.

In absolute terms, the area under this crop has decreased by 23423 hectares in the state though it increased by 502 hectares in Kashmir province. In Jammu province it has decreased by 24267 hectares (Fig. 6.15) and in the two districts of Ladakh, the area under this crop has increased by 342 hectares. The maximum area under wheat is in Jammu district (31564 ha), followed by Kathua (16023 ha), while as very least area under it is in Srinagar district (5 ha). The overall growth of the crop shows a declining trend.

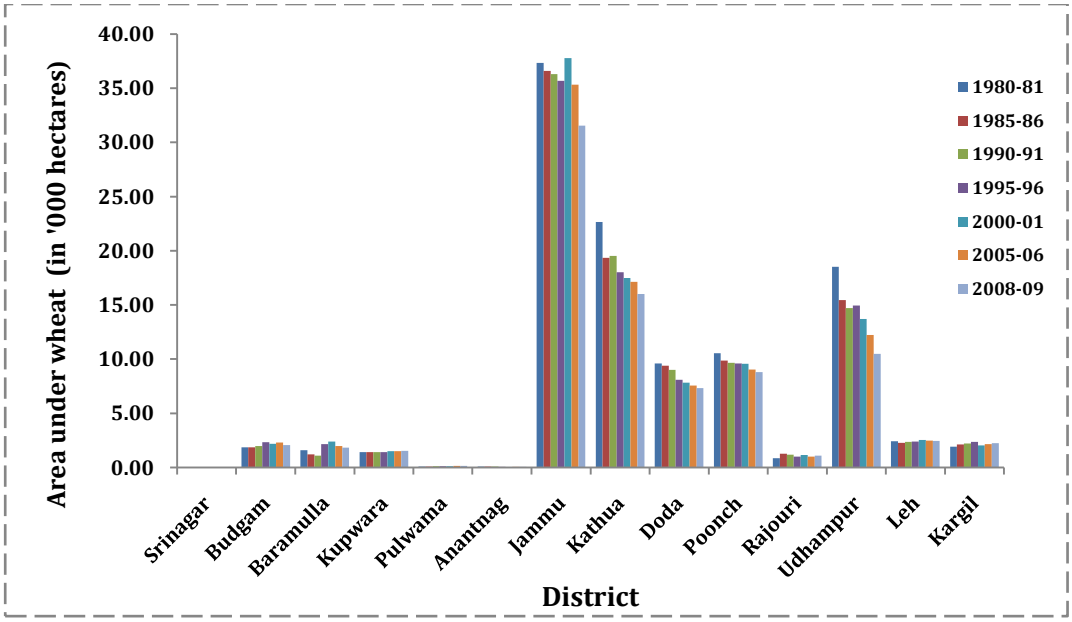


Fig. 6.15: Growth in area under wheat in Jammu and Kashmir (1980-2008)

The area under this crop has decreased at state level by 21.47 percent. In Kashmir province, it has overall increased by 9.74 percent though it decreased in two of its districts (Srinagar and Anantnag); while as in Jammu province the crop has recorded a decline by 24.36 percent. The maximum decline in Jammu province is observed in Udhampur district (43.46 percent) followed by Kathua (-29.28 percent) and minimum in Jammu district (15.50 percent) [Fig. 6.16].

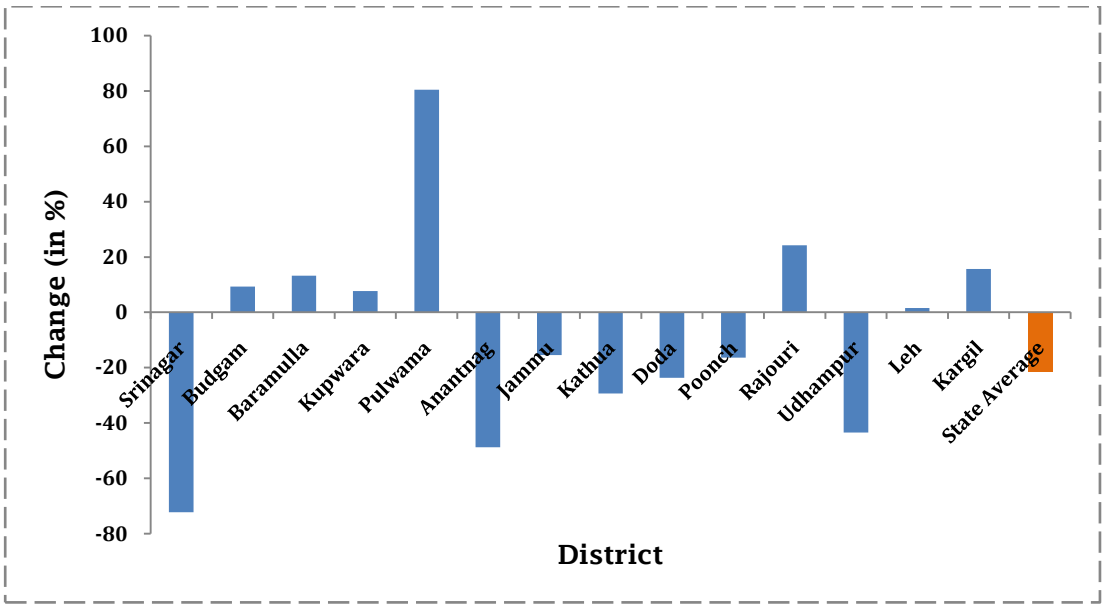


Fig. 6.20: Percent change in area under wheat in Jammu and Kashmir (1980-2008)

The total area under wheat has shown a decreasing trend from 1980 to 2008 (Fig. 6.17)

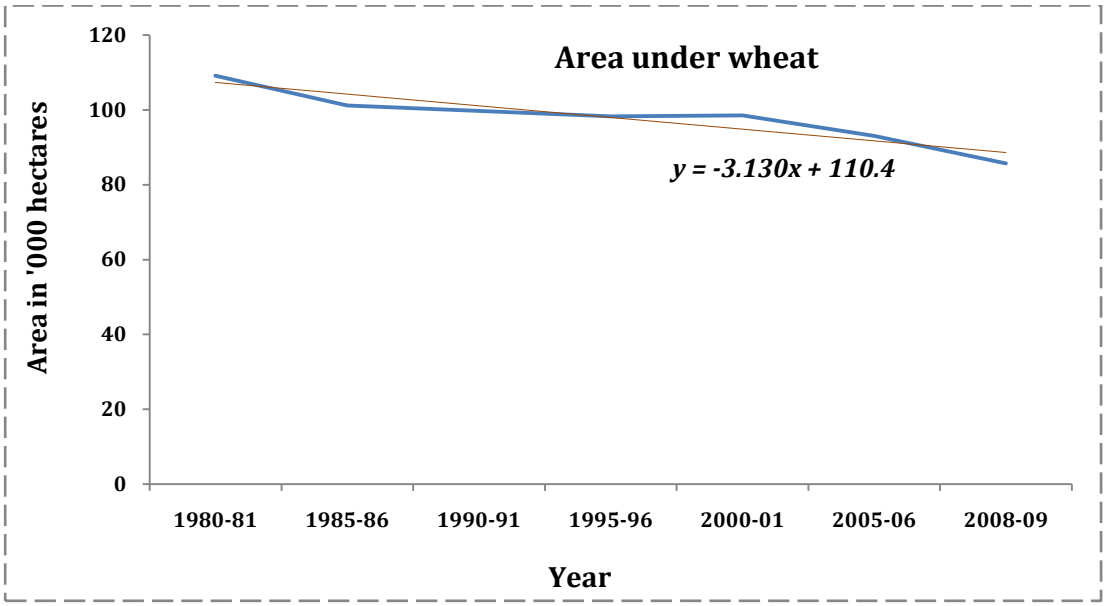


Fig. 6.17: Trend of area under wheat in Jammu and Kashmir (1980-2008)

(VIII) Area under orchards

Orchard cultivation or horticulture is an old economic activity of people of the state especially Kashmir. Kalhana, the great Kashmiri historian mentioned fruit culture in Kashmir in his famous book *'Rajtarangini'* during the reign of king Nara as back as 1000 B.C. It was however, during the period of Lalitaditya (900 A.D) that horticulture in the state received considerable patronage. The valley of Kashmir, parts of Doda, Kathua, Udhampur, Rajouri and Poonch district fall in temperate zone which is conducive for the cultivation of fruits, thus occupying substantial area under orchards.

The area under orchards has increased in all the districts of the state from the year 1980 to 2008 (Table 6.8 and Fig. 6.18).

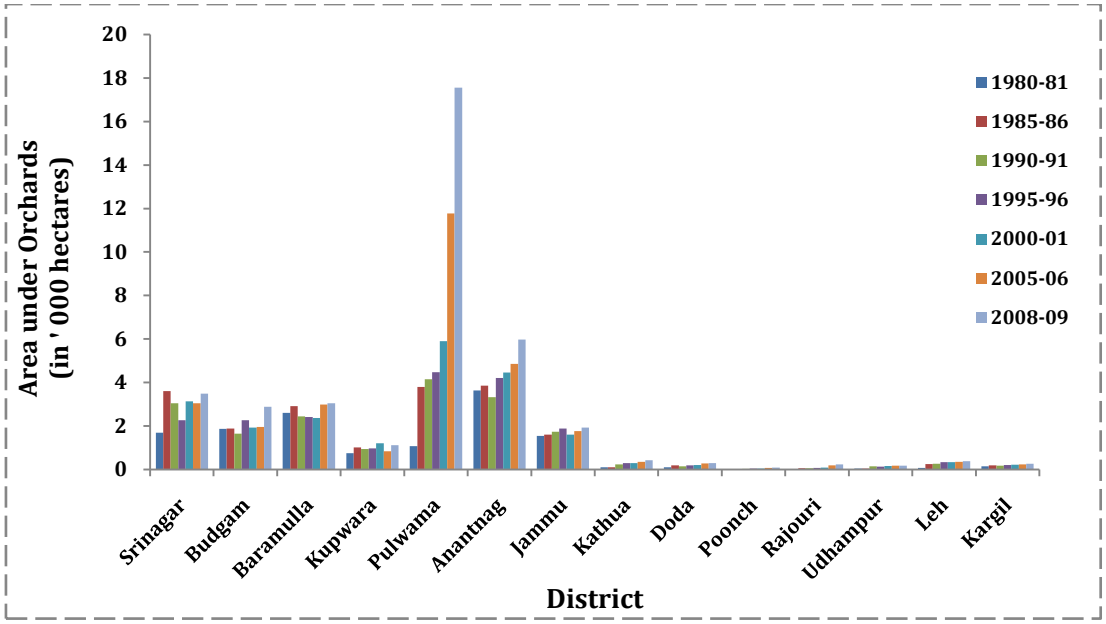


Fig. 6.18: Growth in area under orchards in Jammu and Kashmir (1980-2008)

The maximum area has increased in district Pulwama (16482 hectares), while as in district Poonch very least area has been brought under orchard cultivation (74 hectares in 28 years). Though maximum area in absolute values has increased in districts of Kashmir valley (22469 hectares), but the intensity of expansion during the time period is observed highest in Pulwama (1533.21 percent) followed by Rajouri (735.29), Leh (416.66) and Poonch (389.47) and is much higher than the state average of 176.39 percent. The districts with least intensity of expansion are; Baramulla, Jammu, Kupwara

and Anantnag (Fig. 6.18). The overall trend of area under orchards in the study area is increasing (Fig. 6.19).

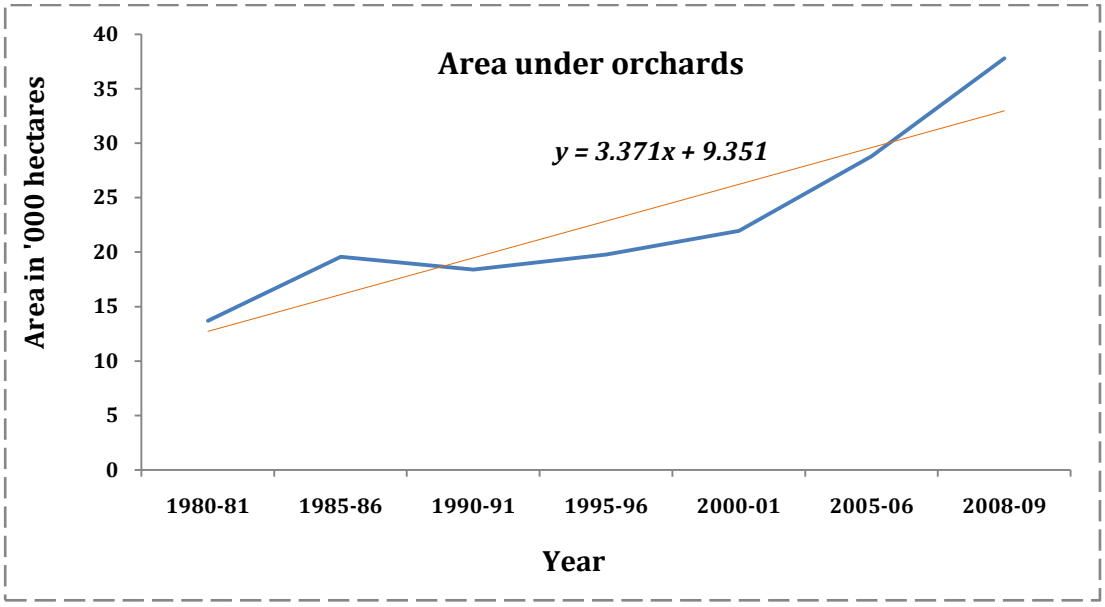


Fig. 6.19: Trend of area under orchards in Jammu and Kashmir (1980-2008)

6.2 DETERMINANTS OF THE DYNAMICS

Cropping land use is a highly dynamic process and it changes with both physical and human induced processes. The factors leading to these changes are very complex. The cropping land use of any geographical area is determined and shaped by the perception and experience of farmers about all the processes and factors which affect the cultivation of crops from sowing to harvesting. Since the analysis of data reveals that significant changes have occurred in the cropping land use, therefore both primary and secondary sources were used to ascertain the underlying causes of the change. These sources indicated the following factors responsible for cropping land use change in the study area;

(i) Economic returns: One of the major factors that influence the choice of crops and cropping pattern is the expected income from land. Commercialization has changed the consumption pattern of food in the state, thus led to greater dependence on the use of purchased goods. This change expanded the need for cash income. Therefore, the purpose of cultivation changed from production for household consumption to production for the market. The cultivators therefore chose to cultivate those crops that

yielded higher cash income in the long run. The sample survey indicates that on average respondents prefer the cultivation of the crops like pulses, orchards cultivation, vegetables etc. which are more remunerative. This sense of profit maximization has been found more in Kashmir valley than in Jammu region.

(ii) Irrigation: Irrigation is a major determinant in the cropping land use. This institutional factor has also affected the cropping land use in the state. Maximum respondents in the study area held lack of irrigation responsible for diverting the cropping land use, though its impact has been more pronounced in Jammu province than Kashmir valley where it changed more by economic considerations. At district level in Jammu province, the effect is felt more by Doda followed by Rajouri and Poonch and in Kashmir, it is Kupwara followed by Budgam and Pulwama (10 and 9 percent respectively).

(iii) Public distribution system (PDS): The establishment of strong public distribution system (PDS) in the state ensured easy availability of food items in addition to free movement of these items from one region to another. Rice at moderate prices became available in the open market. This development worked to the disadvantage of paddy cultivation. Similarly other crops have also been changed with more viable options.

(iv) Government or state forces: The government of Jammu and Kashmir has acquired land for various development projects like construction of railway line from Udhampur to Uri, road ways (widening of NH-1A, Mughal road etc), building infrastructure and military purposes etc. displaced a large number of households mostly rural farmers. Thus, this process has led to change in area under dominant crops of the state.

(v) Population dynamics: The increasing population affects the cropping land use pattern of any area as population attributes like literacy rate, sex ratio, occupational structure, and population growth etc. are intimately related with the agricultural system. The spread of literacy, enhanced level of education and the increase in communication facilities opened the rural society to outside forces. The new generation, especially the educated are after jobs outside agriculture sector and give only secondary importance to cultivation, the least being to rice cultivation.

(vi) Climate: Climate is one of the important physical factors affecting agriculture. Its elements like temperature, length of growing season, sunlight, frost, moisture conditions, and winds etc. have direct and indirect influence on the cropping pattern of a region.

(vii) Change in family structure: The breakup of the traditional joint family system in all the districts of the study area led to partitioning of households. The increase in population and partitioning of households has resulted in fragmentation of land holdings. The rise in the demand for new dwelling units, thus encroached the land under agriculture and resulted in shifting cropping pattern in the state.

(viii) Labour problems: The availability of labour is also a major constraint in the cropping pattern of a region. Labour represents all human services other than decision-making and capital. In the study area, higher labour wages are in non-agricultural sectors; therefore the preference of the workers to work in sectors other than farming shifted a sizeable proportion of the rural labour especially in Kashmir valley away from agriculture sector.

(ix) Credit facility: The credit facility is intimately linked with the cropping land use as it helps the farmers in the input phase of crop cultivation to purchase fertilizers, pesticides, herbicides, machinery etc. The credit policy adopted by the state government which provides more loans to orchard cultivators than paddy or wheat cultivators has made the paddy cultivators disinterested especially in Kashmir valley which promises better prospectus in horticulture to change the traditional cropping land use.

(x) Poor implementation of legislation: The laws regarding the prevention of land conversion from agriculture to horticulture or residential purposes like section 133 of J&K land revenue act, 1965 are very poorly implemented in the state. This poor implementation leads to easy conversion of land under food crops to cash crops or residential purpose. A vast tract of agriculture land has been converted into residential and commercial purposes especially in the adjoining areas of leading urban centers of the state.

(xi) Price factors: The fluctuations in the price of agricultural products create a state of insecurity among farmers. In order to reduce the risk, they diversify crops preferring those that are expected to give a steady income. This pattern is said to provide a

reasonable level of income from land and at the same time minimize risk due to crop failures and price fluctuations. Moreover, increase in the cost of cultivation is attributed to be one of the reasons for the shifting of agricultural land use from paddy to other crops. For example, the expenditure on one canal of agricultural land in a year is around five thousand rupees when the returns amount to six or seven thousand rupees only.

(xii) Competition for market: The shrinkage of rice cultivation and other seasonal crops has displaced agricultural labour especially women from the farm sector. Moreover, in the context of globalization of the economy and trade liberalization, cash crops will have to face severe competition in the global as well as international markets. As the emerging crop-pattern is dominated by export-oriented cash crops spread over thousands of small holdings, getting effective control over the market forces will be a difficult problem for the cultivators. The lack of fixed price for apple production in Kashmir is an example in this context. Moreover, to maintain quality of the fruits, vegetables and other products (pulses, mangoes etc.) is difficult and needs heavy capital.

6.3 WORKING POPULATION IN AGRICULTURE AND CROPPING LAND USE CHANGE

The ratio of working population in agriculture is decreasing day by day because of urbanization, modernization and diversification of occupation of the people. The percentage of people working in agriculture sector in the state has decreased from 72.43 percent in 1980 to 44.77 percent in 2008, thus implies a negative growth of -27.66 percent during these twenty eight years in the state.

The decrease in working population in agriculture is not uniform across the spatial units (districts) of the state. The districts which observed highest negative growth are Kargil (-50.84 percent), Budgam (-38.37 percent), Baramulla (-34.65 percent), Jammu (-34.12 percent) and Leh (-33.54 percent). However, lowest negative growth is recorded in Doda (-15.25 percent), Srinagar (-17.45 percent) and Rajouri (-18.72 percent).

Six districts of the state have recorded much decline in the proportion of working population in agriculture than state average rate, while as in the other districts, the rate of decline of population engaged in agriculture is lower than the state average as is depicted in Fig. 6.20.

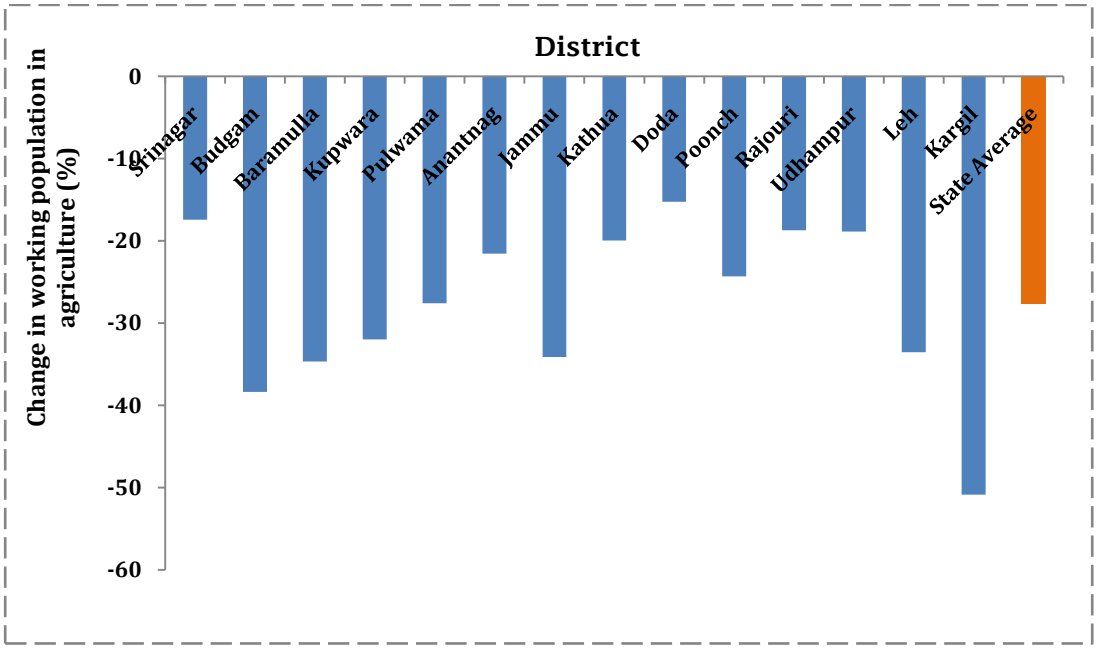


Fig. 6.20: Percent change in working population in agriculture in J & K (1980-2008)

The overall trend of working population in agriculture in the study area is decreasing (Fig. 6.21).

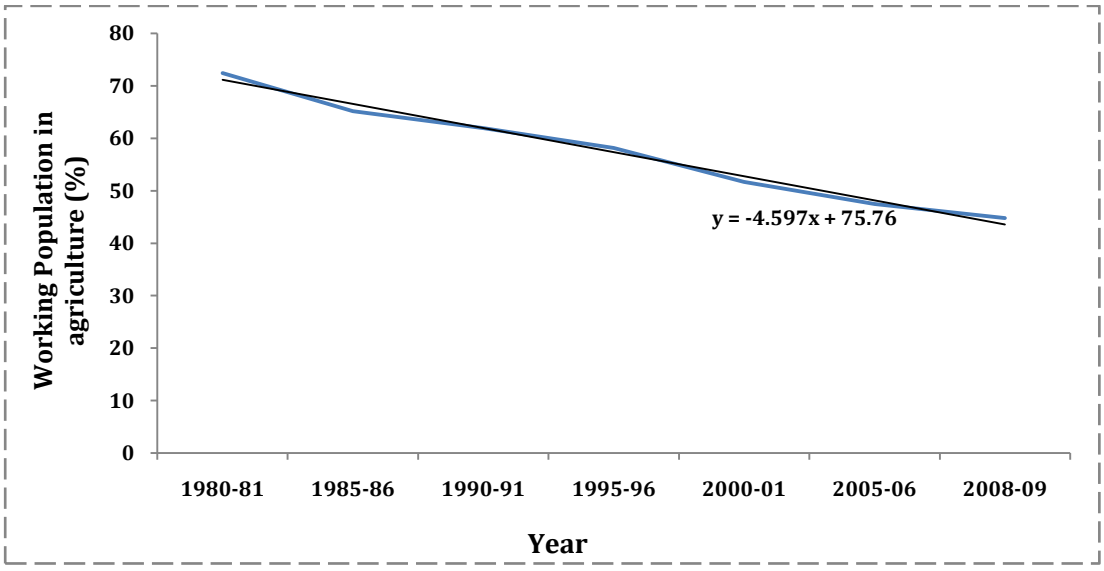


Fig. 6.21: Trend of working population in agriculture in J & K (1980-2008)

6.4 SPATIAL VARIATION IN THE CROPPING LAND USE DYNAMICS

The cropping land use has not changed uniformly in the state but exhibit greater variations. In order to quantify the spatial variation in the cropping land use, four variables have been taken for analysis, *viz*, area under paddy, wheat, rice and orchards.

Since wheat occupies miniscule area in Kashmir valley and orchards do not occupy substantial area in districts of Jammu division, therefore for the respective divisions, they have not been taken into account for analysis.

The percent change in different crops grown in the state has been subjected to ranking method. The first rank was given to the district which showed highest decrease or increase in the cropping land use under any crop taken for the study and last rank or highest value was assigned to the district with lowest change in area under different crops. The ranks of all the crops have been added to get composite index and finally a choropleth map has been prepared to highlight the spatial variation in the cropping land use of the state (Fig. 6.22).

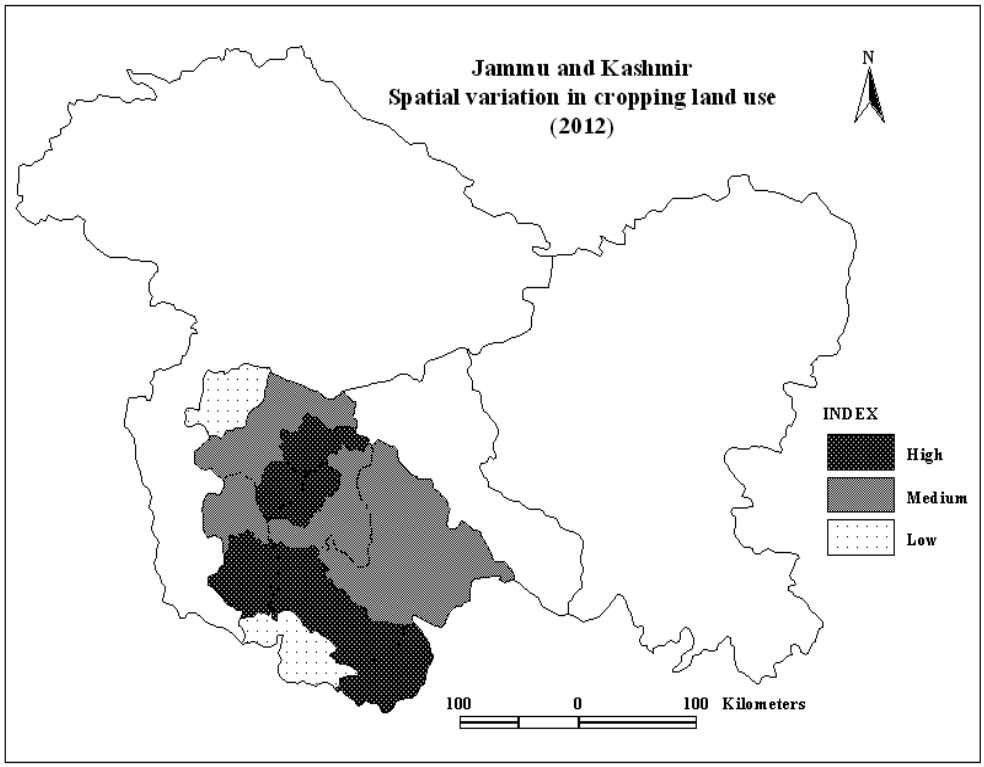


Fig. 6.22: Cropping land use change in Jammu and Kashmir

From the figure, it is clear that six districts (Srinagar, Budgam, Pulwama, Kathua, Rajouri and Udhampur) have shown high level of spatial dynamics in the cropping land use during the time period taken for the study. The reasons for higher level of cropping land use change in Srinagar and Budgam is urban expansion of the Srinagar city and cultivation of more remunerative and market oriented crops like vegetables and fruits. In Pulwama district, the agricultural land has been directly transformed into orchard

cultivation. Medium level of dynamics is observed in four districts (Baramulla, Anantnag, Doda and Poonch) as the rate of change in these districts is comparatively lower than those mentioned above and two districts (Jammu and Kupwara) have shown low change in cropping land use. Jammu district has substantial plain area which is productive, therefore has less chance for cropping land use shifting and Kupwara district have more mountainous low lying area (*kandi area*) devoted to maize cultivation, therefore has less scope for orchard cultivation and hence shows less change in cropping land use dynamics. Leh and Kargil districts have not been taken into consideration as the cropping land use increased under all the crops grown in these districts on account of efficient land reclamation processes.

7.1 CROPPING LAND USE CHANGE AND FOOD BUDGET

The food budget may be defined as the balance between the food production and food requirements. The gap between these two aspects reflects the food deficit level in any geographical area. The food production of any spatial unit is directly related with the cropping land use scenario of that region. The cropping pattern change in the state of Jammu and Kashmir especially the shift from food crops to cash crops has led to widening the gap between food production and requirement. In order to understand the effect of the changing cropping land use on food budget of the state, the dynamics in population growth, food productivity and production in a spatio-temporal manner need to be analysed. These factors or dimensions are discussed in detail below;

7.1.1 Population dynamics

Human population may be defined as the total number of men, women and children living in an area at a particular point of time. Population growth is simply the change in population between the two given points of time. It includes natural increase as well as migration. Population change and population growth rate is calculated by using the following formulas;

- $\mathbf{P_2 = P_1 (x)^n}$
- $\mathbf{Pgr = \frac{Pt2 - Pt1}{Pt1} \times 100}$

Where 'P_1' is population of preceding year, 'P_2' is Population of succeeding year, 'x' is rate of growth, 'n' is number of years, 'Pgr' is Population growth rate, and Pt_1 and Pt_2 is population at time t_1 and t_2

The population in absolute values in the state has increased from 5808929 persons in 1980 to 11704596 in 2008 (102.46 percent increase) as is depicted in fig. 7.1 with an overall growth rate of 102.46 percent. The trend of population growth across the districts of the state is shown in figure 7.1.

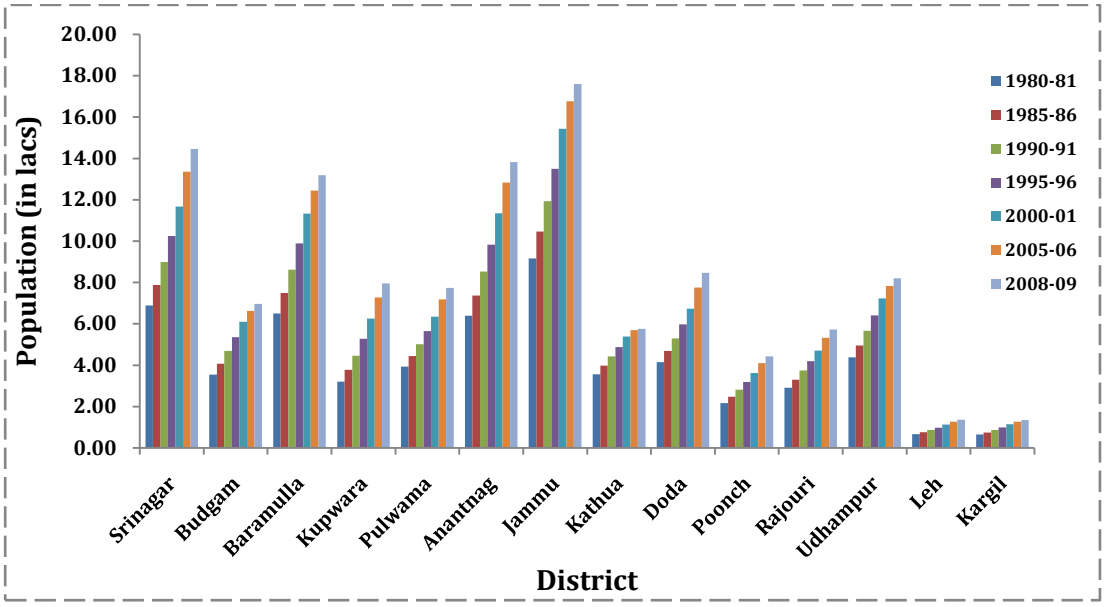


Fig. 7.1: Growth of population in Jammu and Kashmir (1980-2008)

The population increased at a faster rate from 1980 to 2000; however it started dwindling after 2000. The highest growth is observed in Kupwara district (148.94 percent) followed by Anantnag (116.36 percent) and Srinagar (109.84 percent), while as lowest growth is observed in Kathua (61.67 percent). The districts with growth rate less than state average are Udhampur (87.35 percent), Rajouri (97.35 percent), Jammu (92.05 percent), Pulwama (97.26 percent) and Budgam (96.87 percent) [Fig. 7.2].

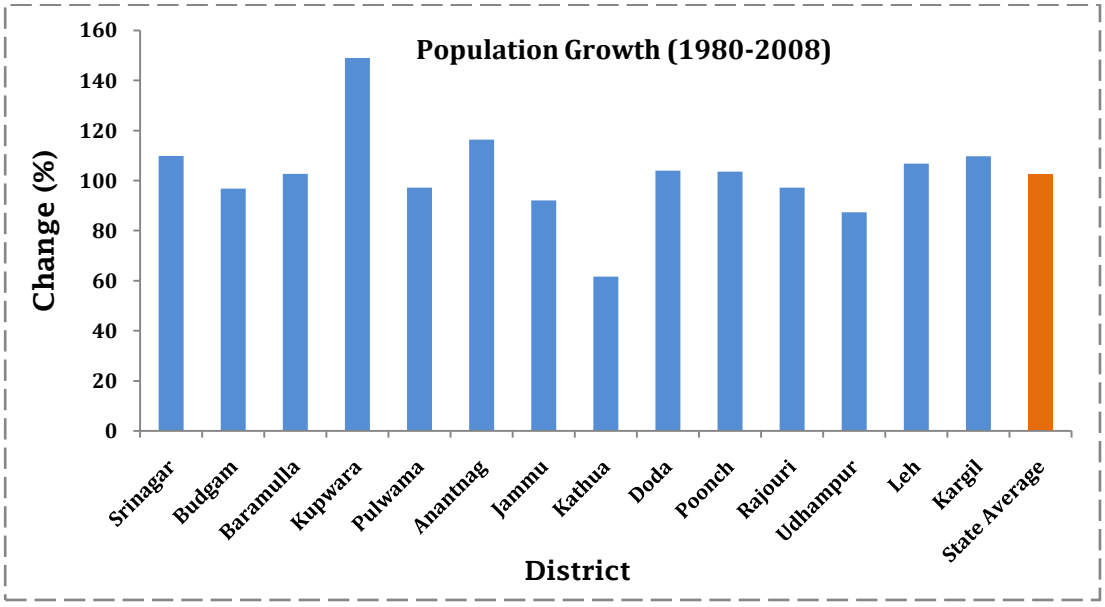


Fig. 7.2: Percent change in population growth in Jammu and Kashmir (1980-2008)

7.1.2 Food requirement

Food requirement means the total food needed to support the population for ensuring food security. The food requirement has been calculated by using the standard consumption intake of rice, wheat or maize per capita/head (400grams/head/day) fixed by food and agricultural organization (FAO, 1988 & 1998) and world health organization (WHO, 1978 & 2000). The significant increase in population (36.59% per decade) has increased the food demand in the state. The formula used to calculate food requirement is;

The food requirement has increased by 860768 metric tonnes during these twenty eight years, *i.e.*, more than what was needed in 1980. The average rate of increase per annum is 3.62 percent. The food requirements in the different districts of the study area have increased in consonance with the rate of population growth in the respective districts. The highest requirement in absolute values is in Jammu (Fig. 7.3) district (256880 metric tonnes) followed by Srinagar (211194 metric tonnes) and Anantnag (201778 metric tonnes), while as lowest requirement is in Kargil (19730 metric tonnes). However, the intensity of requirement is more in Kupwara district (148.94 percent) followed by Anantnag (116.36), and Srinagar (109.84 percent), while as lowest growth is observed in Kathua (61.67 percent). The districts with growth rate less than state average are Udhampur (87.35 percent), Rajouri (97.35 percent), Jammu (92.05 percent), Pulwama (97.26 percent) and Budgam (96.87 percent) [Fig. 7.4].

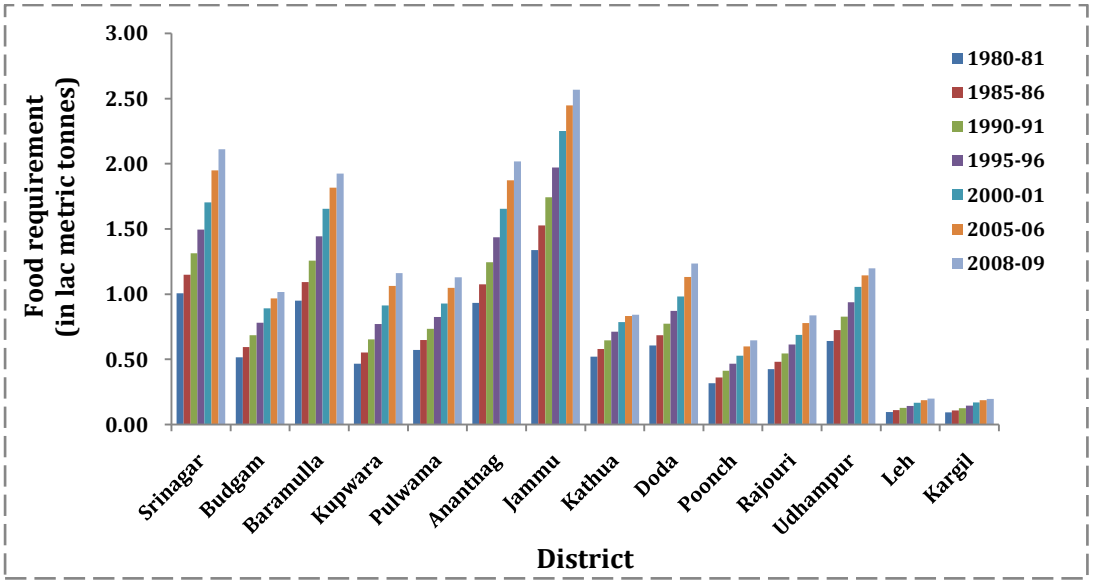


Fig. 7.3: Growth of food requirement in Jammu and Kashmir from 1980 to 2008

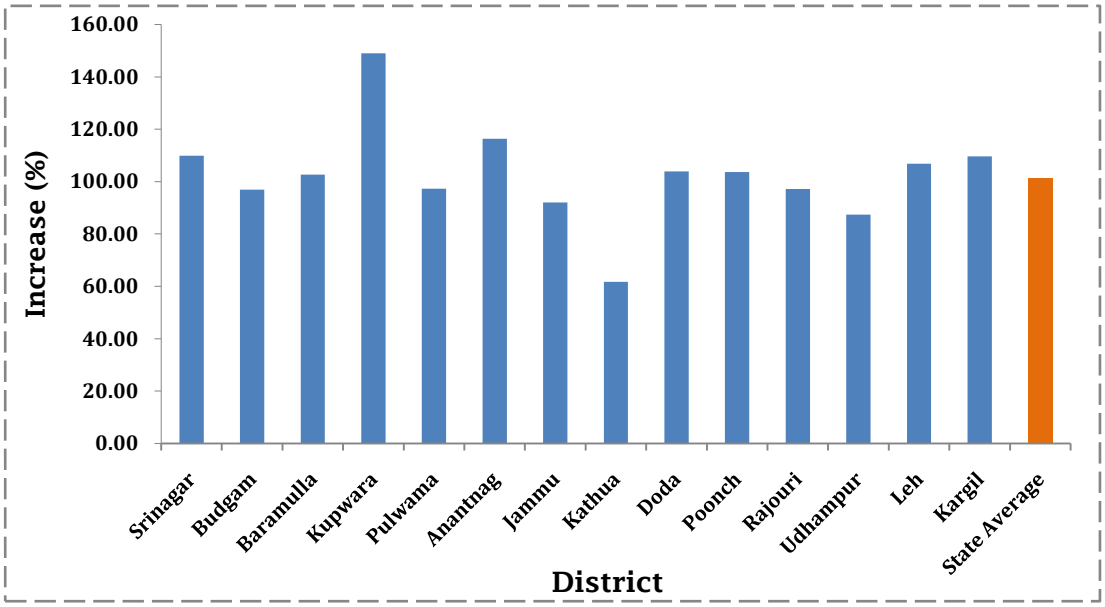


Fig. 7.4: Percent increase in food requirement from 1980 to 2008

The spatial variation in the food requirement across the districts of the state is highlighted in Fig. 7.5.

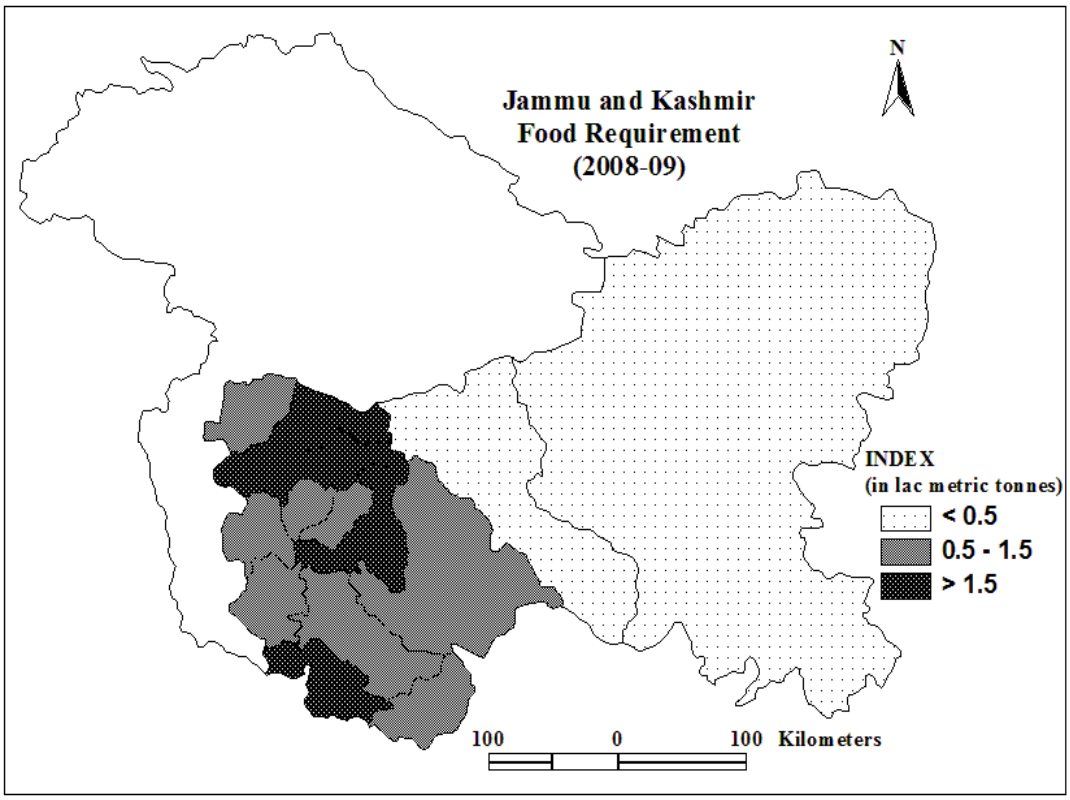


Fig. 7.5: Food requirement in Jammu and Kashmir (2008-09)

The trend of food requirement is increasing in the study area as is depicted in figure 7.6.

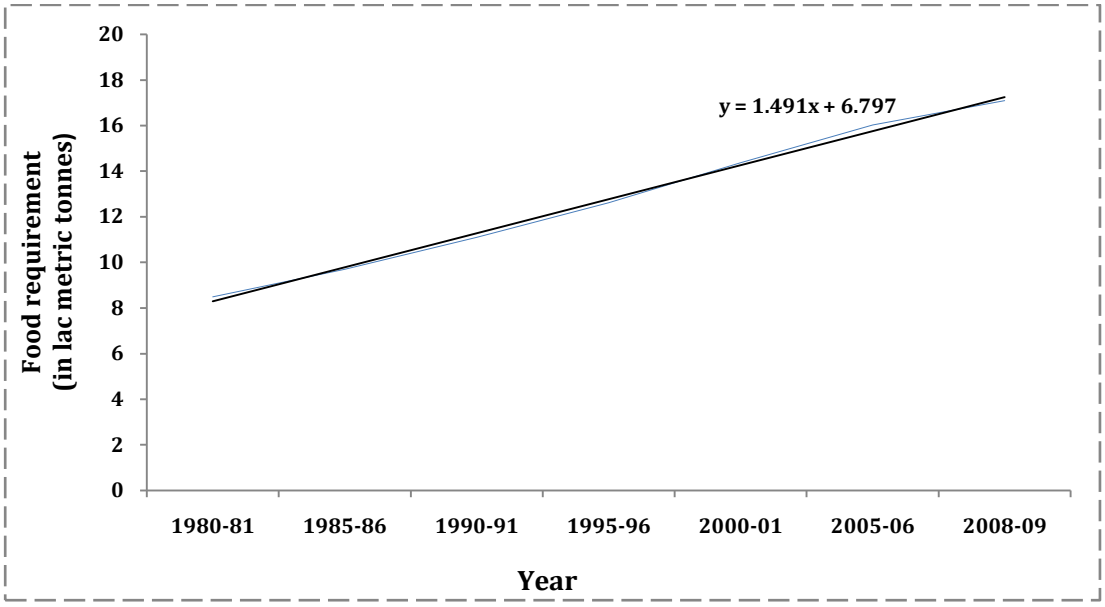


Fig. 7.6: Trend of food requirement in Jammu and Kashmir (1980- 2008)

7.1.3 Agricultural productivity and production

Agricultural productivity may be defined as the yield per unit of land. It is a vital indicator of agricultural development. It depends both on the physical as well as socio-economic factors, *viz*, climate, soil, per capita income, literacy, sex ratio, occupational structure etc. The overall agricultural productivity in the state is low as compared to other states of India like Punjab, Haryana, Chhattisgarh and West Bengal. The low productivity in the state is on account of climatic constraints, lack of easy advance borrowings, irrigation, credit facilities, and agricultural policy etc. The productivity trend of the major crops grown in the state is given below:

The paddy productivity in the state of Jammu and Kashmir has increased over the period of time. It has increased from 8.75 quintals/hectare to 19.31 quintals/hectare, thus implies a total increase of 10.56 quintals/hectare during these twenty eight years. The productivity has increased at a slower rate in the first fifteen years (1980-1995) and in the last thirteen years (1995-2008), it increased at a considerable rate (Fig. 7.7). The productivity increase is more pronounced in Kashmir province (13.48 quintals/ha) than Jammu province (11.16 quintals/ha).

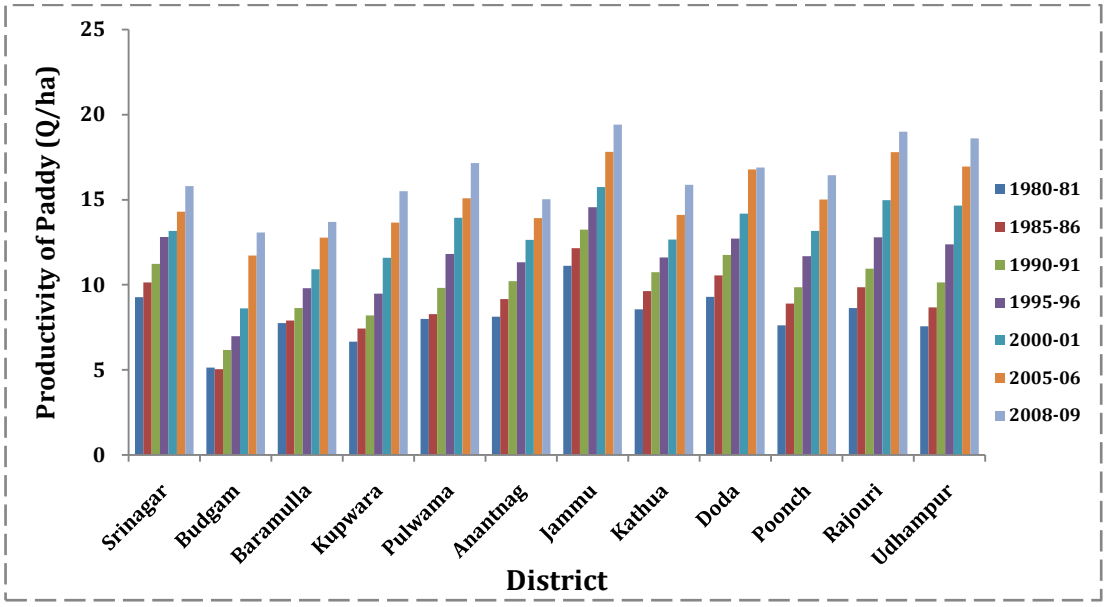


Fig. 7.7: Growth of paddy productivity in Jammu and Kashmir (1980-2008)

Five districts out of six in Kashmir province have more productivity increase than state average (12.31 q/ha), while as in Jammu province, only Jammu district has productivity more than the state average (Fig. 7.8).

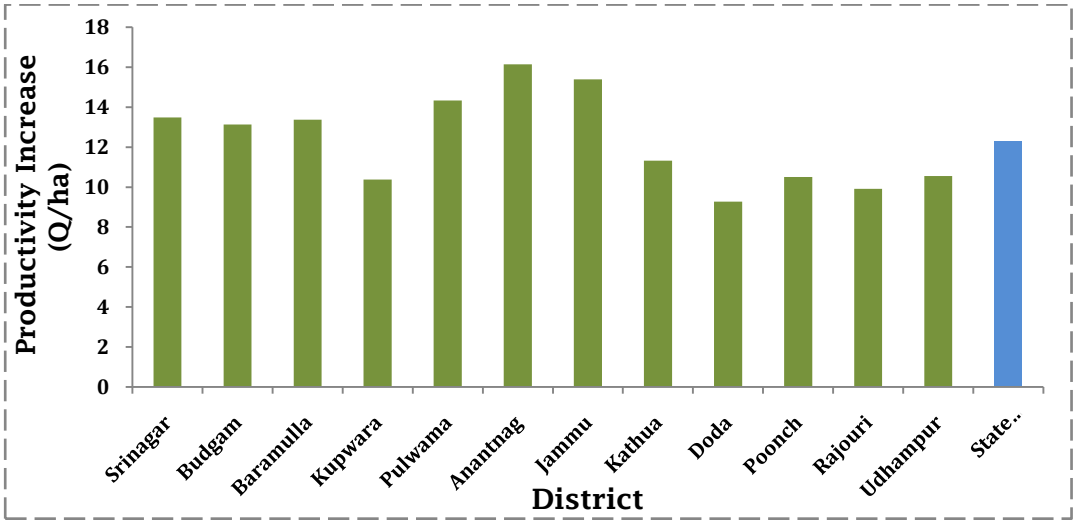


Fig. 7.8: Productivity increase in paddy in Jammu and Kashmir (1980-2008)

The productivity of maize in all the districts of the state has increased during these twenty eight years taken for the study. It has increased from 8.14 quintals/hectare to 16.38 quintals/hectare, thus implies a total increase of 8.23 quintals/hectare. The productivity has increased at a slower rate in the first fifteen years (1980-1995) and in the last thirteen years (1995-2008), it increased at a considerable rate (Fig 7.9). The

productivity has increased more in Jammu province (8.91 q/ha) than Kashmir province (7.55 q/ha).

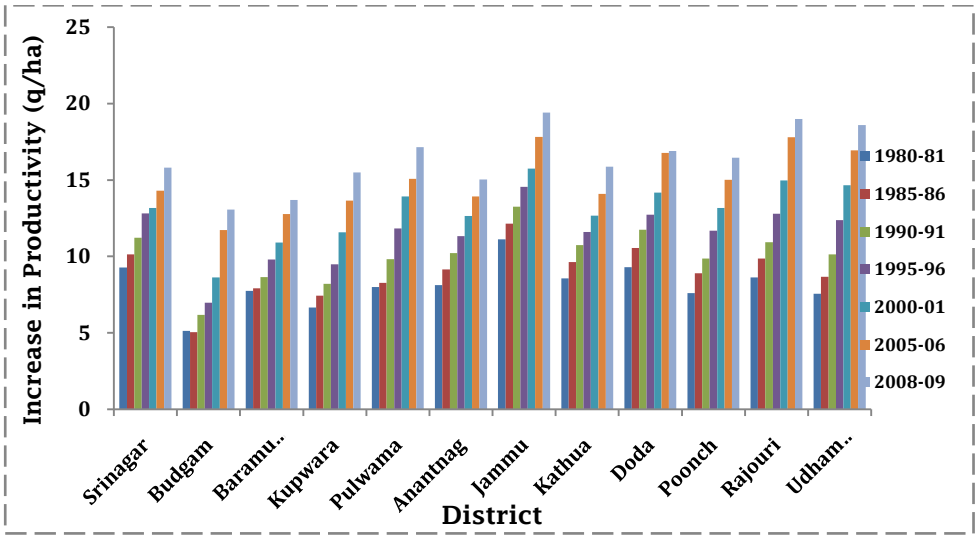


Fig. 7.9: Growth of maize productivity in Jammu and Kashmir (1980-2008)

The highest growth is recorded in Udhampur district (11.04 percent) followed by Rajouri (10.37 percent) and Pulwama (9.16 percent), while the lowest is observed in Baramulla (5.94 percent). In Jammu province, Doda and Kathua produce yields below state average, while as in Kashmir province, only Pulwama and Kupwara are above state average and rest are below it (Fig. 7.10).

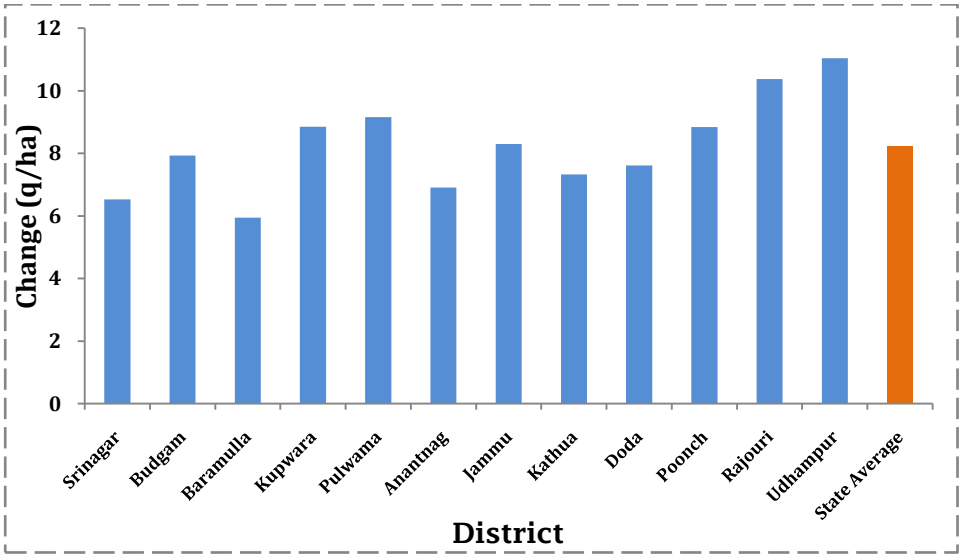


Fig. 7.10: Maize productivity increase in Jammu and Kashmir (1980-2008)

The wheat has also shown significant increase in productivity in all the districts of the state. It has increased from 6.15 quintals/hectare to 13.58 quintals/hectare, thus implies a total increase of 7.43 quintals/hectare (Fig7.11).

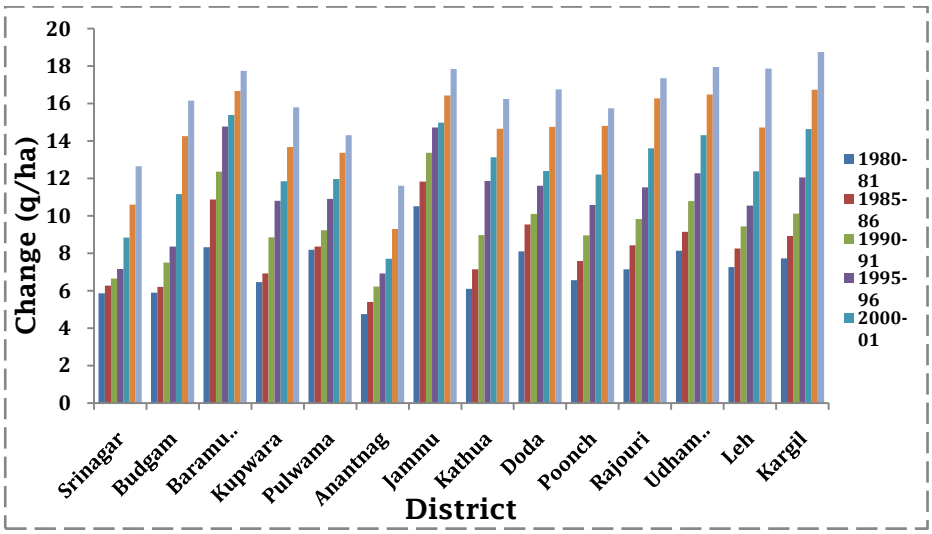


Fig. 7.11: Trends in the wheat productivity in Jammu and Kashmir (1980-2008)

Like in case of paddy and maize, the productivity of wheat has also increased at a slower rate in the first fifteen years (1980-1995) than the last thirteen years (1995-2008) The productivity has generally increased more in Kashmir province (9.22 q/ha) than Jammu province (8.13 q/ha). The highest growth is recorded in district Kargil (11.03 q/ha) followed by Leh (10.60 q/ha) and Budgam (10.25 q/ha), while the lowest is observed in Pulwama (6.12 q/ha). Four districts out of fourteen namely Srinagar, Jammu, Anantnag and Pulwama recorded increase less than state average (Fig. 7.12).

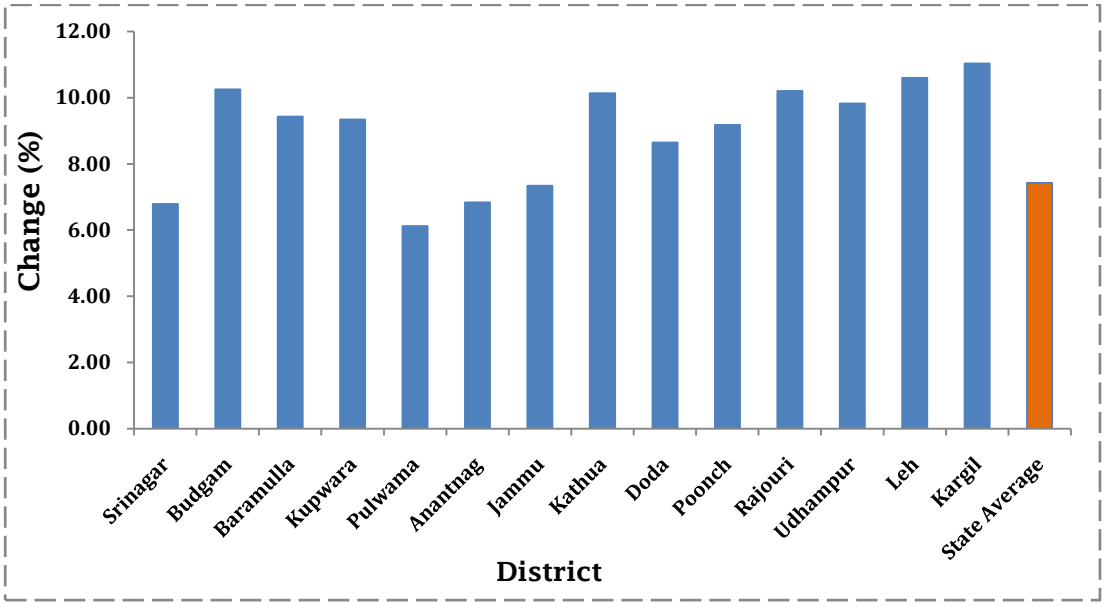


Fig. 7.12: Growth of wheat productivity in Jammu and Kashmir (1980-2008)

The production has increased over the period of time not because of increase in area under these crops, but on account of increase in productivity. The production would have been more than what it is observed in the tables and figures provided the area under these crops would have remained same or increased from the year 1980 to 2008. But the cropping land use analysis revealed that the area under these crops have decreased over the period of time.

The production of rice in absolute figures has increased by 172662 metric tonnes and in percentage by 56.74 percent during these twenty eight years. The production has increased more in Jammu district followed by Anantnag and Baramulla, while as Doda, Poonch and Rajouri has recorded lowest increase (Fig. 7.13).

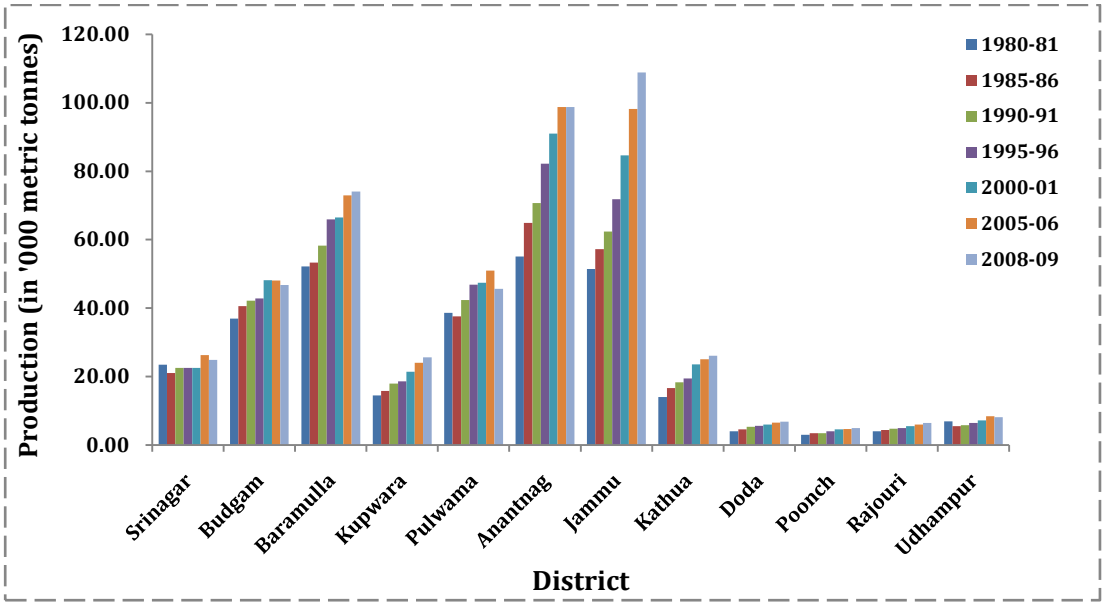


Fig. 7.13: Growth in production of Paddy (1980-2008)

The maize production has increased from 187225 metric tonnes in the year 1980 to 328996 metric tonnes in 2008 with the net increase of 141771 metric tonnes. The overall rate of increase is 75.72 percent.

The highest increase is observed in district Kupwara (23439 metric tonnes) followed by Udhampur (20332 metric tonnes) and Rajouri (20086 metric tonnes), while as lowest increase is observed in Srinagar (2517 metric tonnes) and Pulwama (3453 metric tonnes) [Fig. 7.14].

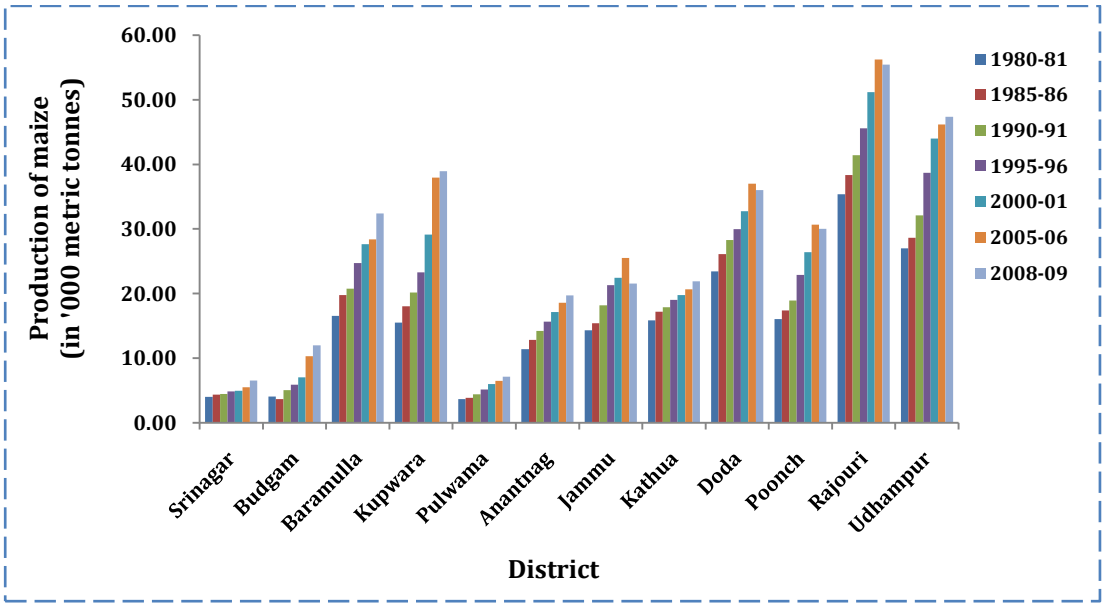


Fig. 7.12: Growth in production of maize in metric tonnes (1980-2008)

Like paddy and maize, wheat production has also increased from 87055 metric tonnes in the year 1980 to 138630 metric tonnes in 2008 with the total increase of 51575 metric tonnes. The overall rate of increase is 59.24 percent. Since wheat is a dominant crop in Jammu province, therefore production has increased in all the districts of the province with highest increase in Jammu (17084 metric tonnes) followed by Kathua (12178 metric tonnes) and Poonch (6961 metric tonnes).

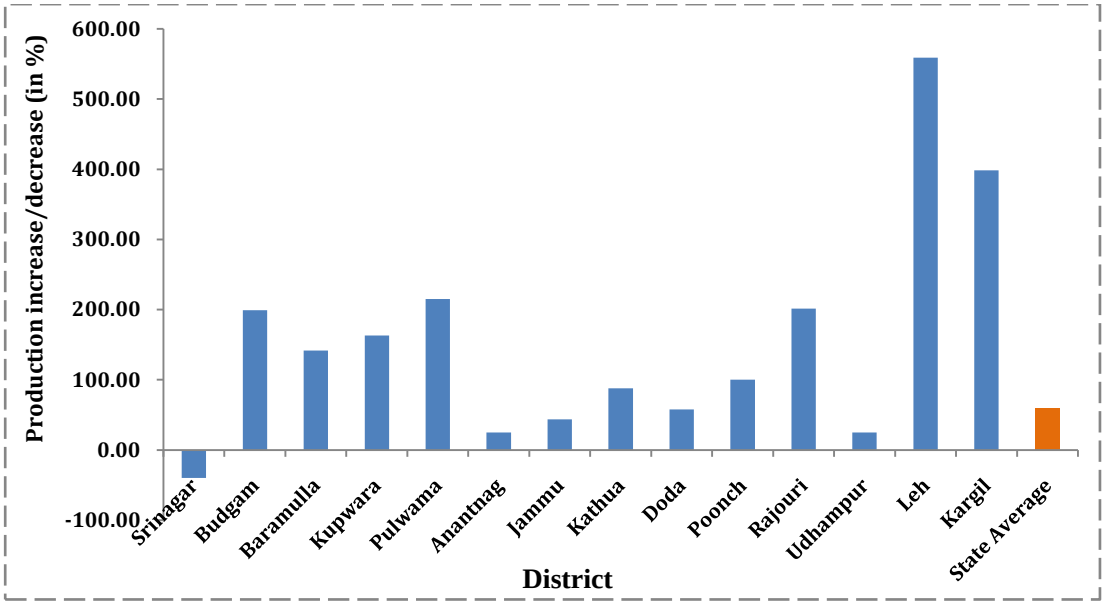


Fig. 7.15: Percent change in wheat production (1980-2008)

The production has increased in districts of Kashmir province also except district Srinagar which has recorded decline in production. The percentage increase or decrease is shown in Fig. 7.15. Though Leh and Kargil has recorded highest rate of increase, but in absolute values all the districts except Srinagar have more production than Leh and Kargil. Leh and Kargil have least production not because of low productivity, but because of less area under these crops.

7.1.4 Food deficit analysis

Food deficit of any geographic area may be defined as a gap between the food requirements minus the domestic production of that area. The domestic production in the study area has been calculated by addition of production of the three crops discussed above grown in the state.

The overall domestic production has increased from 581803 metric tonnes in 1980 to 953118 metric tonnes in 2008, thus recorded an absolute increase of 371315 metric

tonnes. The highest increase in absolute values is observed in Jammu (81786 metric tonnes) followed by Anantnag (52020 metric tonnes) and Baramulla (39598 metric tonnes), while the lowest is observed in Leh (2639 metric tonnes). In terms of percentage increase, highest change is observed in Kargil (180.72 percent), Leh (149.56 percent) and Kupwara (116.60 Percent) because more area has been brought under cultivation in these districts. The lowest increase is recorded in Pulwama (25.10 percent), Budgam (47.41 percent) and Udhampur (51.40 percent). The district wise increase in production in percentage is shown in Fig. 7.16.

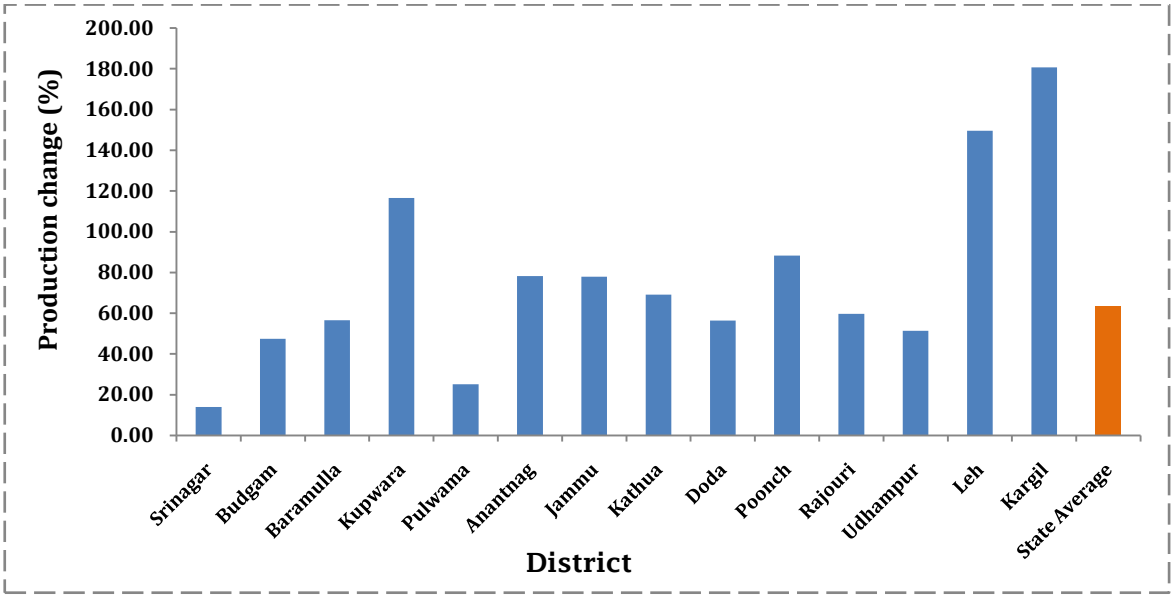


Fig. 7.16: Percent change in domestic production in Jammu and Kashmir (1980-2008)

The overall trend of domestic production is increasing in the state (Fig. 7.17) on account of increasing productivity, but it does not increase in consonance with increasing population.

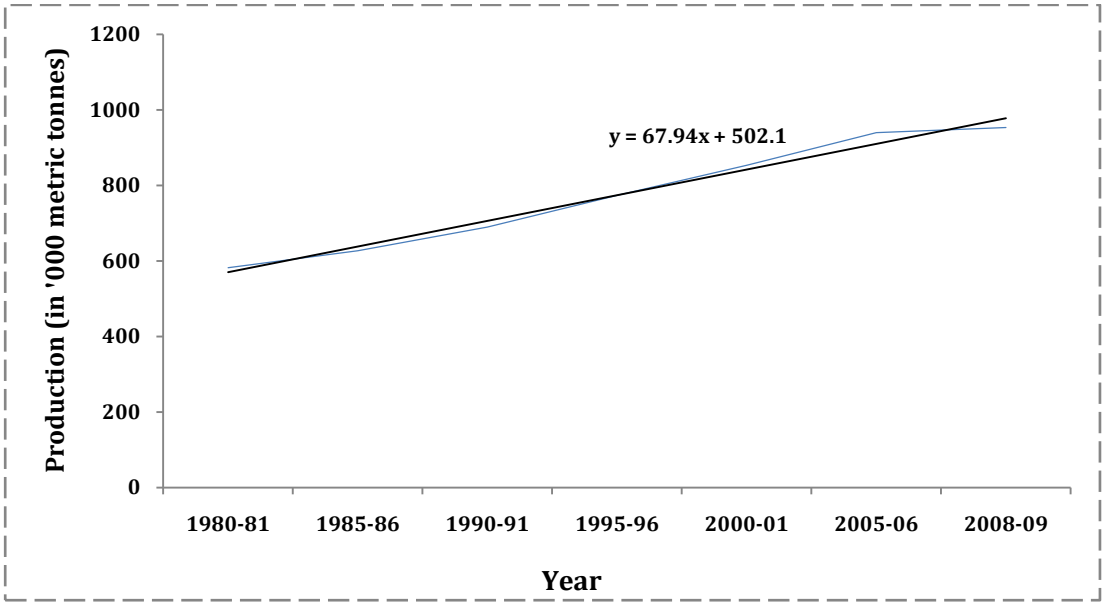


Fig. 7.17: Trend of domestic production in Jammu and Kashmir (1980-2008)

The food deficit in the state has increased from 33.96 percent to 43.29 percent (9.33 percent increase) during the time period taken for the study. The district wise deficit over the period of time is shown in the Fig. 7.18.

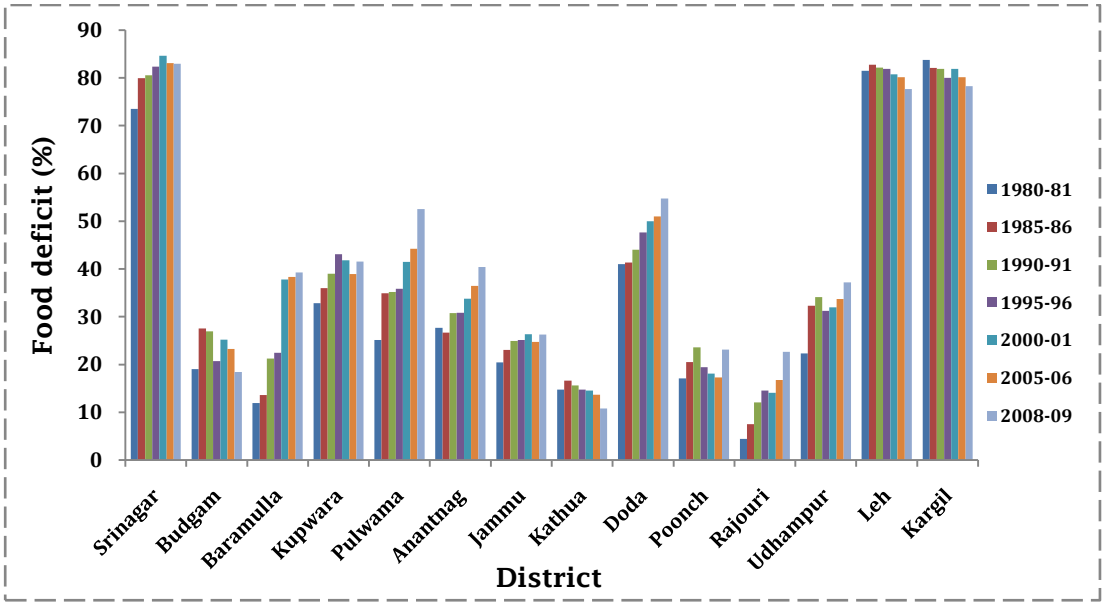


Fig. 7.18: Growth in food deficit in Jammu and Kashmir (1980-2008)

The food deficit has increased more for Kashmir province (14.18 percent) than Jammu province where it increased bit slower (9.15 percent). In the Ladakh sector including the Leh and Kargil district, the food deficit has decreased by 4.66 percent (Fig. 7.19).

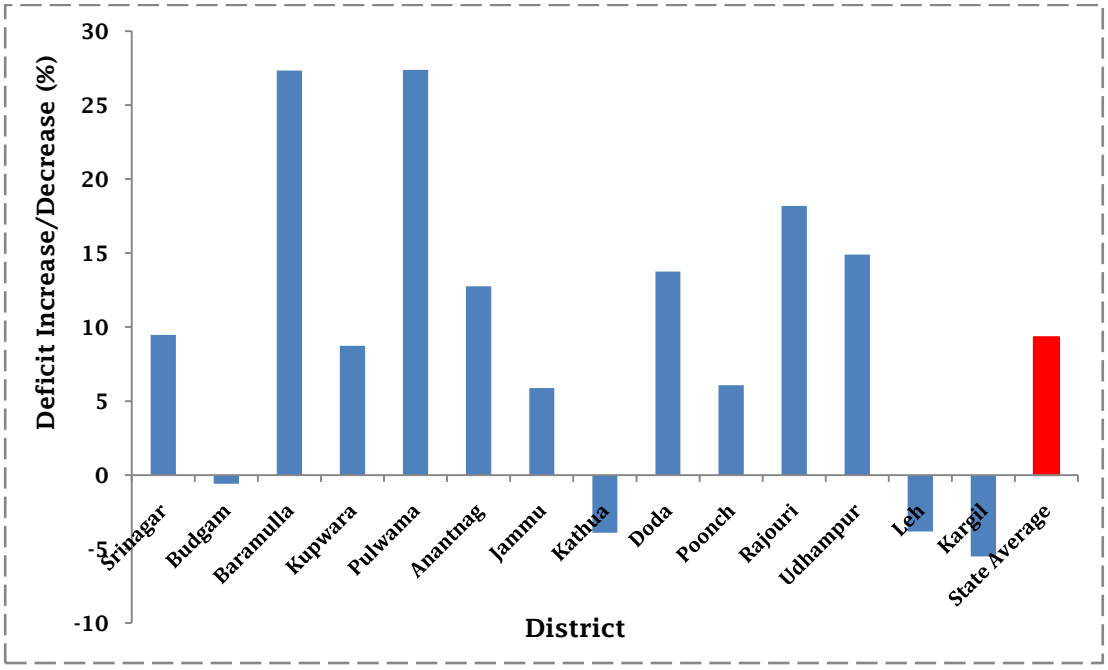


Fig. 7.19: Percent change in food deficit in Jammu and Kashmir (1980-2008)

The other districts which observed lowering of the food deficit are Kathua (3.9 percent) and Budgam (0.66 percent). The highest food district is observed in district Srinagar (82.97 percent) followed by Kargil (78.30 percent), Leh (77.67 percent), Doda (54.76 percent) and Pulwama (52.21 percent), while as lowest food deficit is observed in Kathua (10.81), Rajouri (22.64 percent) and Poonch (23.15 percent).

The food deficit at provincial level in the state has been presented in Fig. 7.20. It is evident from the figure that Ladakh has maximum food deficit, but it improved its domestic production over the period of time due to which its food deficit decreased from 82.64 percent in 1980 to 77.98 percent in 2008 (-4.66 percent). Though Jammu province had lower level of food deficit in 1980, but it shows an increasing trend and it increased from 19.99 percent in 1980 to 29.14 percent in 2008. In the Kashmir province, the food deficit increased at a higher rate (14.18 percent) from 31.69 percent in 1980 to 45.87 percent in 2008.

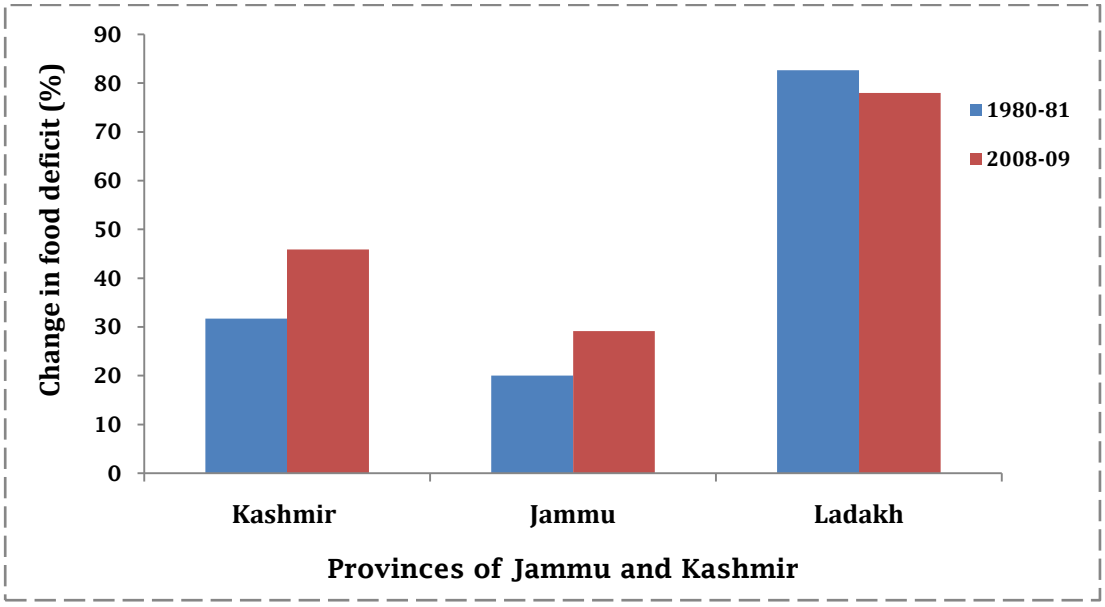


Fig. 7.20: Percent change in food deficit in provinces of Jammu and Kashmir (1980-2008)

7.1.5 Levels of food deficit

In order to determine the levels of food deficit across the districts of the state, the food deficit calculated above has been divided into five levels, *viz*, very high (80-100 percent), high (60-80 percent), medium (40-60 percent), low (20-40 percent) and very low (below 20 percent) [Fig. 7.21]. From the figure, it is clear that only Srinagar district has very high food deficit (82.97 percent) because of being home to more urban people, while as high level of deficit on account of paucity of suitable agricultural land is observed in two districts of Ladakh division of the state namely Leh (77.67 percent) and Kargil (78.30 percent); Four districts (Kupwara, Doda, Anantnag and Pulwama) have medium level of deficit and five districts (Baramulla, Poonch, Rajouri, Jammu and Udhampur) have low level of deficit and the remaining two districts (Budgam and Kathua) have very low food deficit (18.46 percent and 10.81 percent respectively).

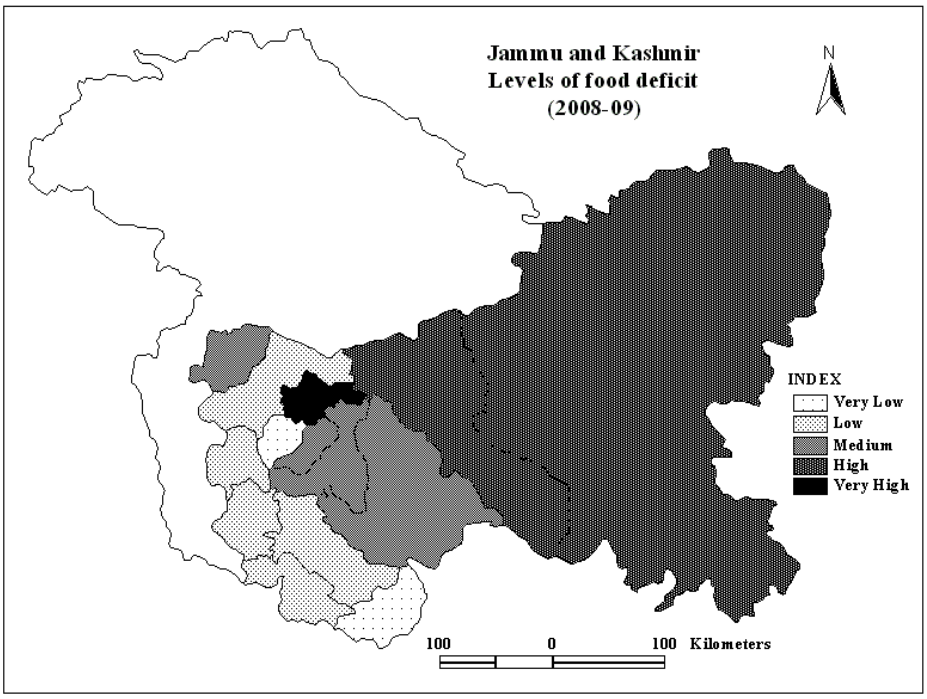
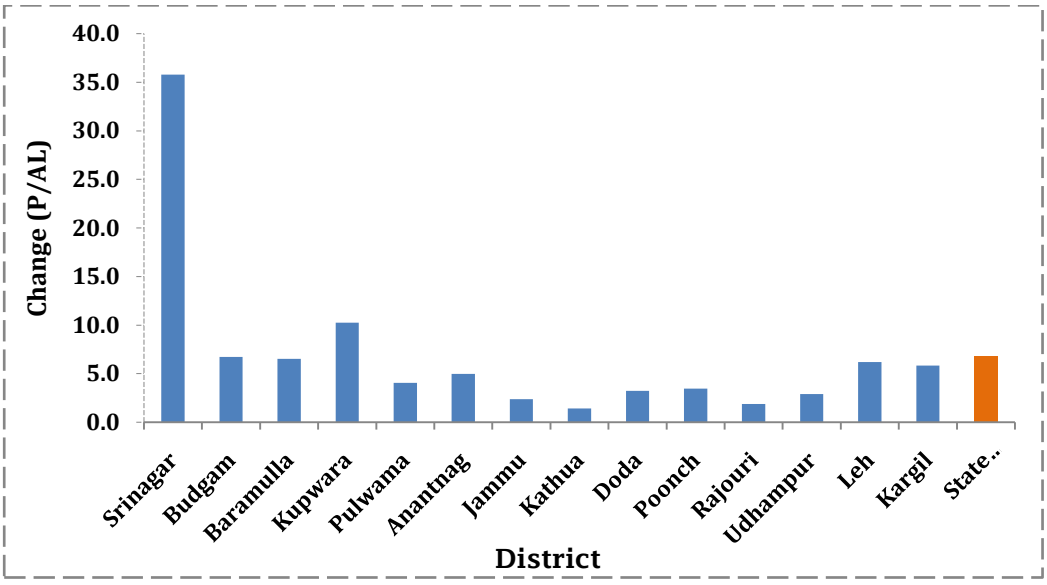


Fig. 7.21: Levels of food deficit in Jammu and Kashmir (2008-09)

7.2 CROPPING LAND USE DYNAMICS AND MAN-LAND RATIO

The increasing population and the shrinkage of agricultural land due to the shifting process have led to the increasing man-land ratio i.e. the number of people per unit of agricultural land increased. On an average, the physiological density increased from 7 persons per unit of agricultural land to 13.8, thus implies a net increase of 6.8 persons/unit of agricultural land during these twenty eight years.



Note: P/AL means '*persons per unit of agricultural land*'

Fig 7.22: Change in Physiological density in Jammu and Kashmir (1980-2008)

The highest increase has been recorded in Srinagar district (35.8 p/unit of agricultural land), followed by Kupwara (10.2) and Budgam (6.7). The lowest change is found in Kathua (1.4) and Rajouri (1.9). Most of the districts have received comparatively less change than a few districts in which the change is pronounced (Fig. 7.22).

The man-land ratio increased at a higher rate in Srinagar and Budgam because of urban sprawl of Srinagar city. The total area of Srinagar city increased from 208.09 Km^2 in 1980-81 to 291.8 Km^2 in 2011. The other districts of Kashmir valley also show pronounced increase in man-land ratio because of the fact that agricultural land is limited due to mountainous topography and so addition of population leads to increasing man-land ratio. Similarly, Ladakh region has also very least agricultural land, therefore the man-land ratio increase at a higher rate. The man-land ratio in Jammu province increased at a slower rate because of more net sown area.

The change in the man-land ratio across the provinces of the state is shown in Fig. 7.23. It is clear from the figure that man-land ratio increased at a higher rate in Kashmir province followed by Ladakh. In Jammu province, the man-land ratio increased at a very slow pace in comparison with the other provinces of the state.

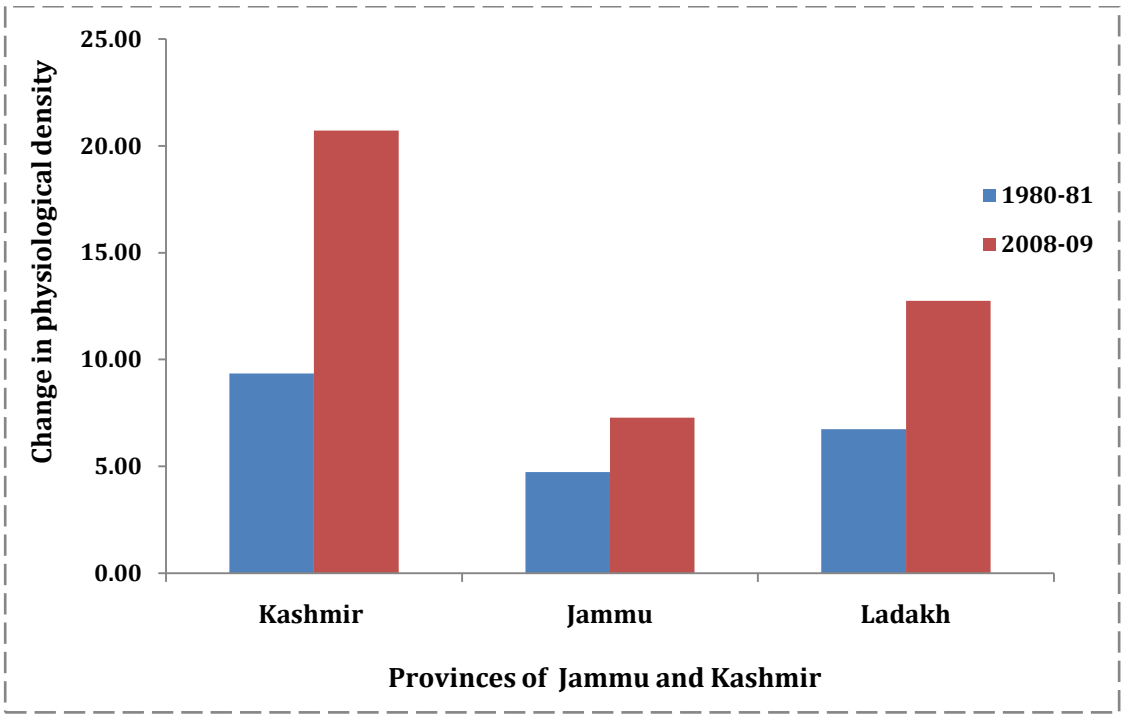


Fig. 7.19: Change in Physiological density in provinces of Jammu and Kashmir (1980-2008)

7.3 FOOD IMPORT ANALYSIS

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Since food deficit exists in the study area, therefore in order to ensure food security, the import of food grains becomes an indispensable process. The government supplies the food through public distribution system at the outlets of consumer affairs and public distribution department (commonly known as *'ration ghats'*) established in every locality of the state. Since the food deficit increased in the state over the period of time, therefore naturally the food imports increased over time. The people meet the food requirements by purchasing food from private dealers as well in addition to the food received per month from ration outlets.

The wheat imports in the study area have increased from 77086 metric tonnes in 1980 to 181885 metric tonnes in 2008, thus an absolute increase of 104799 metric tonnes with the percentage increase of 135.95 percent. Since wheat is staple food of Jammu province, therefore the imports have increased much in Jammu district (26669 metric tonnes) followed by Udhampur (23710 metric tonnes) and Doda (22991 metric tonnes), while as the imports are recorded least in Kathua (851 metric tonnes) and Pulwama (514 metric tonnes) [Fig. 7.24].

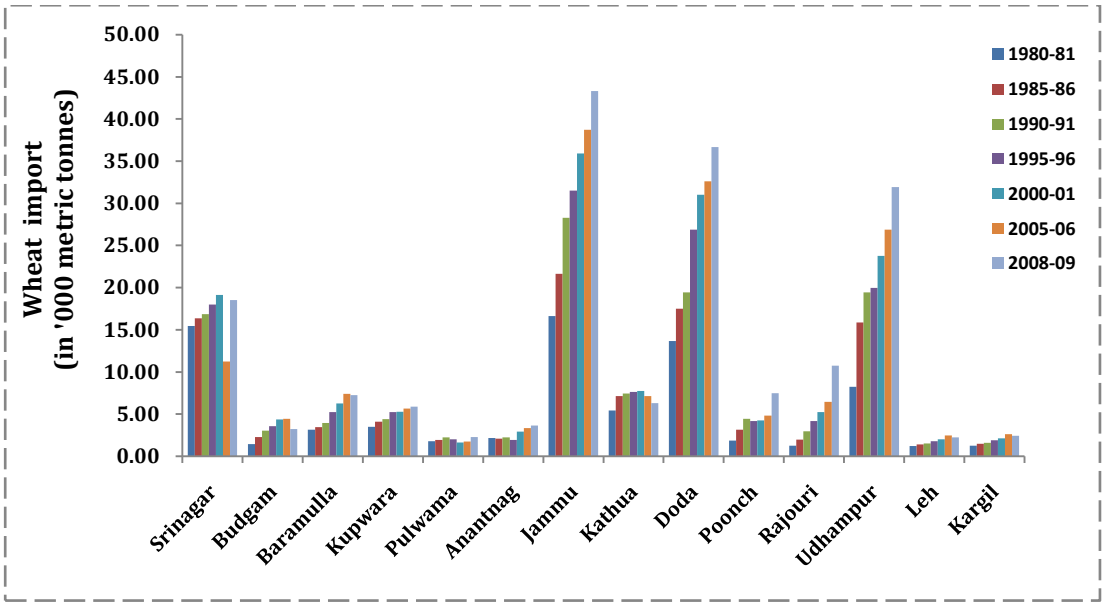


Fig. 7.24: Growth in wheat import in Jammu and Kashmir (1980-2008)

The percentage increase in imports is observed more in Rajouri (744.57 percent), followed by Poonch (300.78 percent) and Udhampur (288.09 percent), while as least is observed in Srinagar (19.76 percent) and Kathua (15.66 percent) [Fig. 7.25].

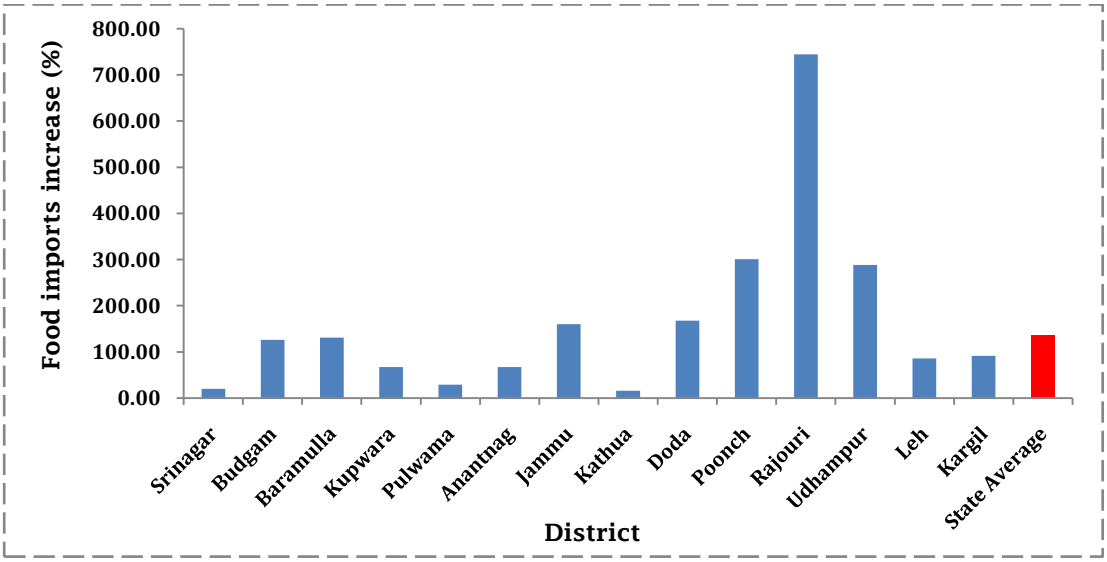


Fig. 7.25: Percent change in wheat imports in Jammu and Kashmir (1980-2008)

The import of rice is more than wheat in the study area because being staple food of more people with less domestic production. It has more demand than wheat and like wheat it has increased from 150262 metric tonnes in 1980 to 481038 metric tonnes in 2008, thus an absolute increase of 330776 metric tonnes with the percentage increase of 220.13 percent.

Since rice is a staple food of Kashmir province, therefore the imports have increased much in Srinagar district (67997 metric tonnes) followed by Anantnag (52304 metric tonnes) and Baramulla (50089 metric tonnes), while as the imports are recorded least in Kupwara (29117 metric tonnes) and Budgam (26440 metric tonnes) [Fig. 7.26].

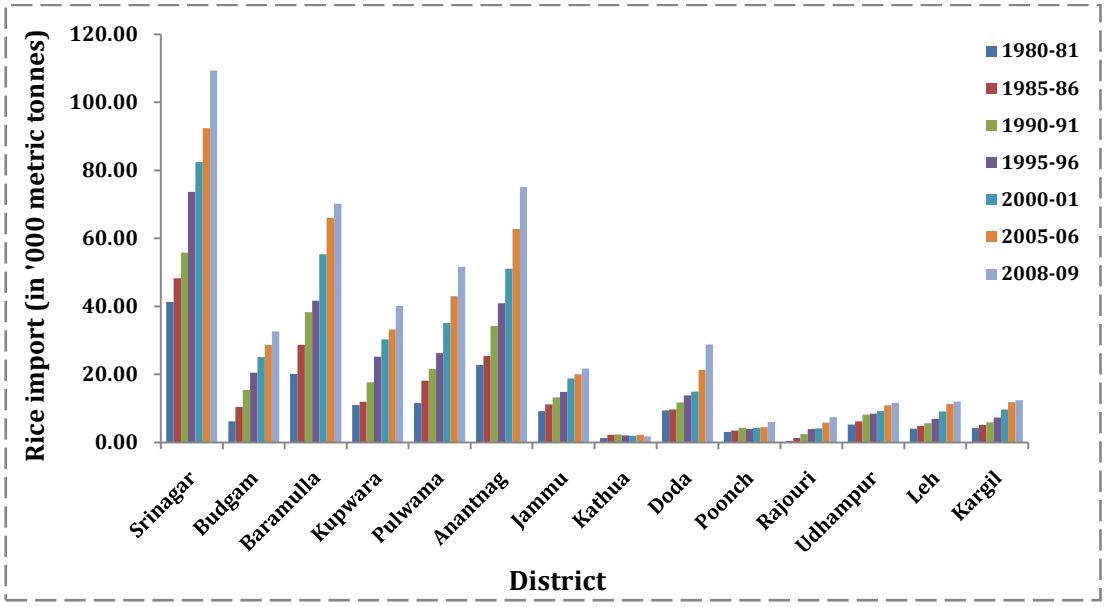


Fig. 7.26: Growth in rice import in Jammu and Kashmir (1980-2008)

The percentage increase in imports is observed more in Rajouri (1506.50 percent), followed by Poonch (426.26 percent) and Pulwama (347.96 percent), while as least is observed in Poonch (93.38 percent) and Kathua (31.57 percent) [Fig. 7.27].

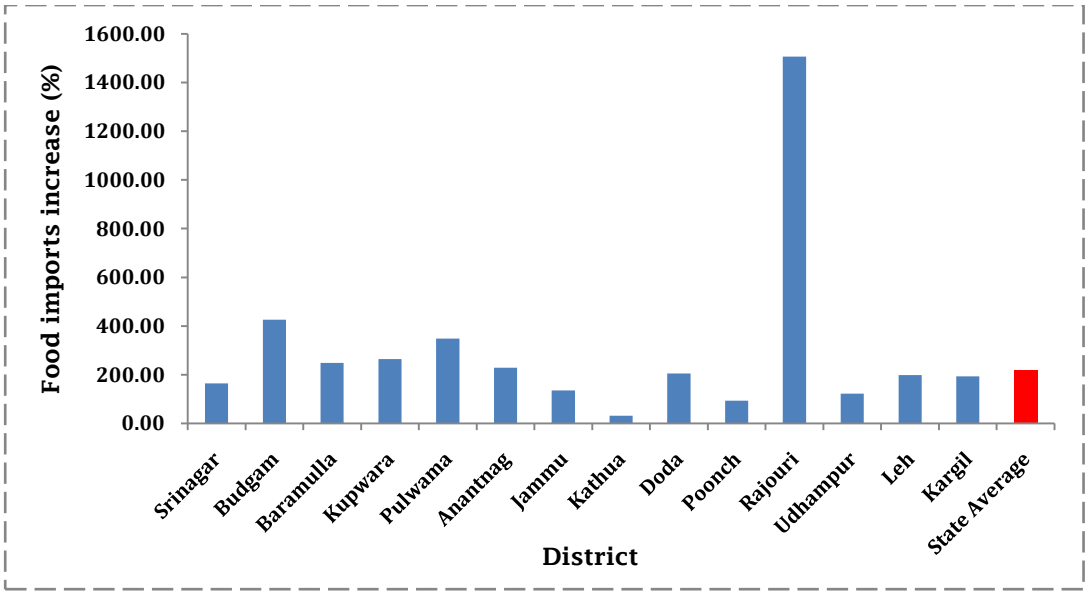


Fig. 7.27: Percent change in rice import in Jammu and Kashmir (1980-2008)

The food import at provincial level in the state has been presented in Fig. 7.28. It is evident from the figure that Kashmir province imports more followed by Jammu province. Ladakh province has minimum food imports because it has only two districts with the total population of 287492 (Census of India, 2011). The food imports increased

at a higher rate in Kashmir province because its food deficit widened more than other two provinces of the state.

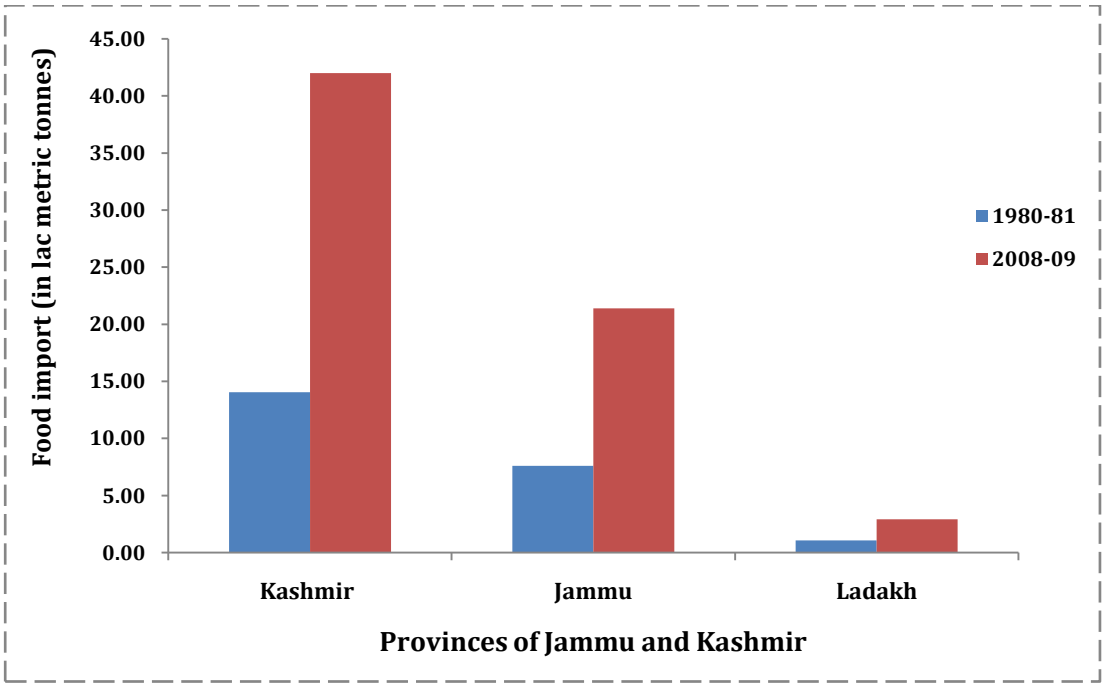


Fig. 7.28: Change in total food imports in provinces of Jammu and Kashmir (1980-2008)

7.3.1 Levels of food import

In order to determine the levels of food import across the districts of the state, Z-score has been computed for both rice and wheat imports for the year 1980 and 2008 (Table 7.14). Then composite z-score has been calculated and three groups have been identified, *viz*, high, medium and low (Fig. 7.29 and 7.30).

Table 7.14: Standardized scores of food imports in Jammu and Kashmir, 2011

District	Z-Score (1980)		Composite Score (1980)	Z-Score (2008)		Composite Score (2008)
	Rice	Wheat		Rice	Wheat	
Srinagar	2.79	1.76	**4.55**	0.39	2.36	**2.75**
Budgam	-0.41	-0.72	**-1.13**	-0.69	-0.05	**-0.75**
Baramulla	0.86	-0.42	**0.44**	-0.41	1.13	**0.72**
Kupwara	0.03	-0.35	**-0.32**	-0.51	0.18	**-0.33**
Pulwama	0.07	-0.66	**-0.59**	-0.76	0.54	**-0.22**
Anantnag	1.10	-0.59	**0.51**	-0.67	1.28	**0.61**
Jammu	-0.14	1.97	**1.83**	2.16	-0.40	**1.76**
Kathua	-0.85	-0.01	**-0.87**	-0.48	-1.02	**-1.50**
Doda	-0.12	1.44	**1.33**	1.69	-0.17	**1.51**
Poonch	-0.69	-0.64	**-1.34**	-0.39	-0.89	**-1.28**
Rajouri	-0.94	-0.75	**-1.68**	-0.16	-0.85	**-1.01**

Udhampur	-0.50	0.48	**-0.02**	1.35	-0.71	**0.64**
Leh	-0.61	-0.76	**-1.37**	-0.77	-0.70	**-1.47**
Kargil	-0.59	-0.75	**-1.34**	-0.75	-0.69	**-1.44**

Source: *Compiled by using table 7.13*

From the figure 7.29, it is clear that three districts namely Srinagar, Jammu, and Doda have high levels of food imports; while as five districts (Leh, Kargil, Rajouri, Poonch and Budgam) have low food imports and six districts of the state (Kupwara, Baramulla, Anantnag, Pulwama, Udhampur and Kathua) fall in the medium level of food imports.

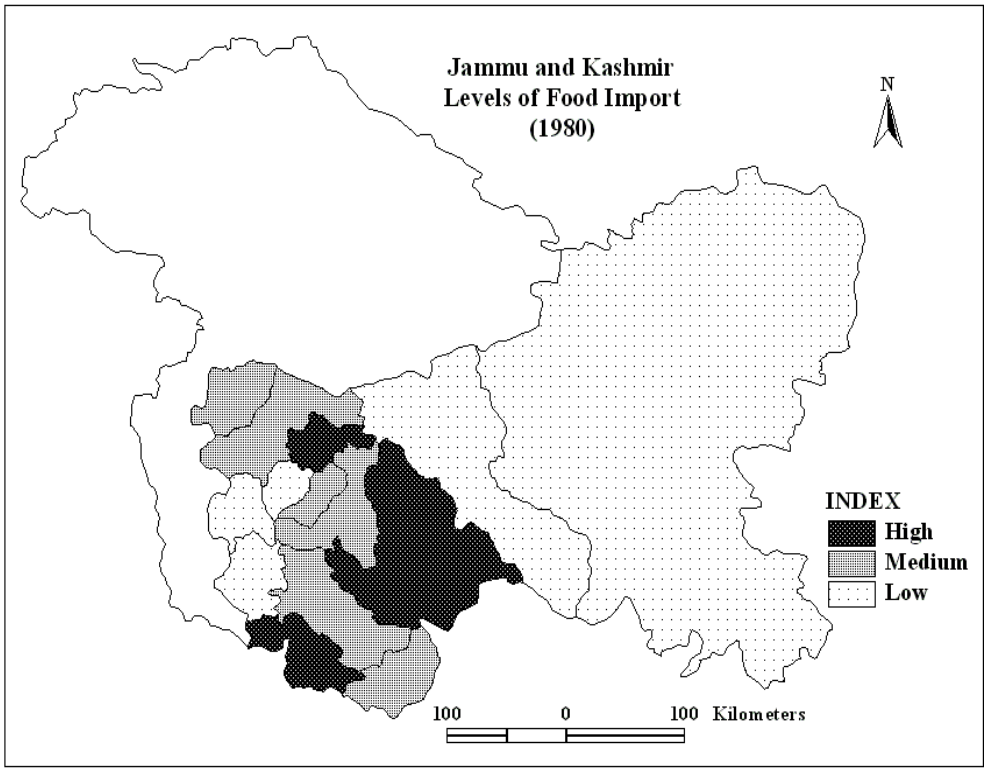


Fig. 7.29

The figure 7.30 shows that the three districts namely Srinagar, Jammu, and Doda have again high levels of food imports; while as five districts (Leh, Kargil, Rajouri, Poonch and Kathua) have low food imports and six districts of the state (Kupwara, Baramulla, Anantnag, Pulwama, Budgam and Udhampur) fall in the medium level of food imports. Form these two figures, district Kathua has improved in its domestic food production, thus it changed from medium to low food importer; while as Budgam district moved from low to moderate level in food imports.

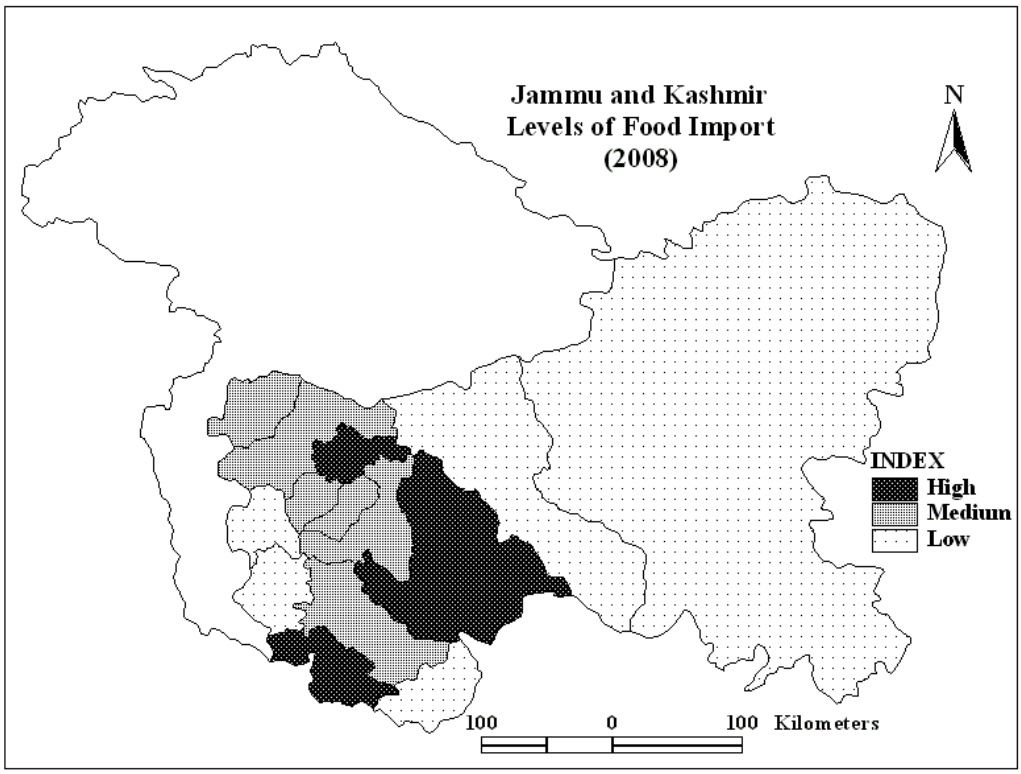

Jammu and Kashmir
Levels of Food Import
(2008)
N
INDEX
High
Medium
Low
100 0 100 Kilometers

Fig. 7.30

8.1 CROPPING LAND USE STATUS

Jammu and Kashmir State has the feasible climate for the growth of three major food crops, *viz*, paddy, maize, wheat and orchards where plenty of fruits are grown. The cropping land use has undergone substantial changes during the past thirty years. The area under food crops has changed into cash crops especially horticulture.

Since the three regions of the state have clear distinctions in the climatic regimes, therefore different crops thrive in the regions depending upon the climatic, soil and irrigation suitability besides other geographical factors. Paddy is a tropical crop which needs high temperature and water, therefore is grown both in Jammu and Kashmir region. The Ladakh region is agriculturally very backward owing to its harsh climatic conditions plus the barren soil. The Jammu region is mainly devoted to the cultivation of wheat as it is staple food there, while as Kashmir possessing the Mediterranean climate is feasible for both rice and orchard cultivation.

It is evident that in Kashmir province, the area under paddy is more in Budgam (18760 ha) followed by Anantnag (18680 ha) and Baramulla (18346 ha). The lowest area is observed in Shopian district (512 ha). In Jammu province, the highest area under paddy is in Jammu (31430 ha), followed by Kathua (13112 ha) and Udhampur (7406 ha), while as district Ramban (680 ha) has the lowest area under paddy. Similarly maize is mainly grown mostly in districts having more mountainous low lying area (*kandi belt*). The maize cultivation is very low in Srinagar district only (102 ha) and all other districts of the state have substantial area under maize. The maximum area under maize among the districts is in Rajouri (27112 ha), followed by Kupwara (23112 ha), Baramulla (18490 ha) and Poonch (17212 ha), while as Kulgam, Pulwama and Shopian have comparatively less area under maize cultivation (2912, 2662 and 1384 hectares respectively) [Fig. 8.1].

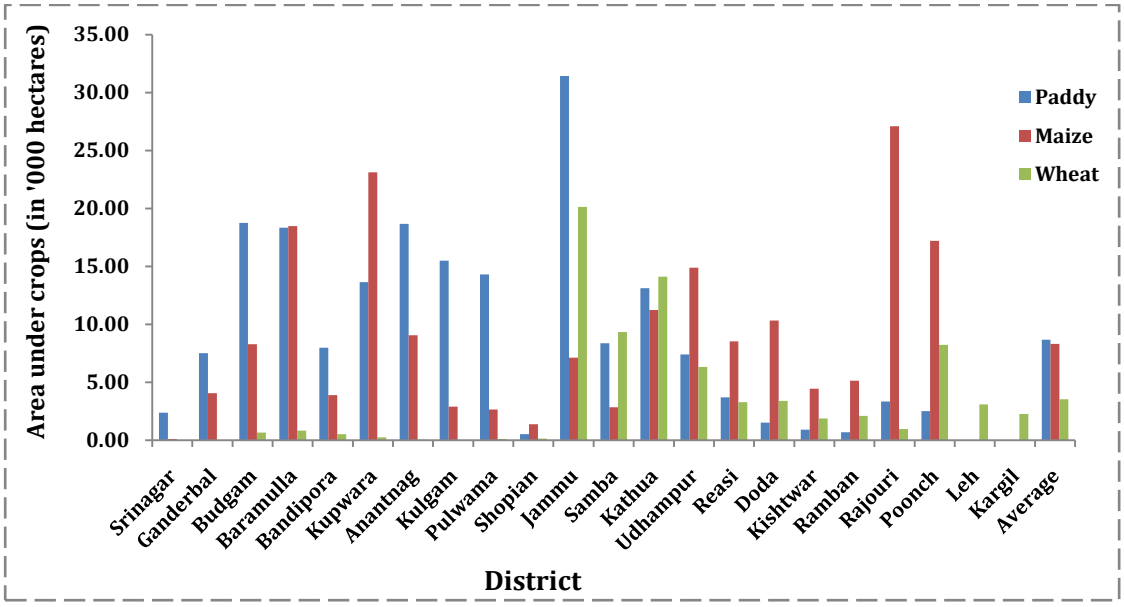


Fig. 8.1: Cropping land use of Jammu and Kashmir (2011-12)

Wheat is mainly grown in Jammu province and very little area is under this crop in Kashmir province. The districts which have more area under wheat are; Jammu (20136 ha) followed by Kathua (14112 ha), Samba (9342 ha), Poonch (8244 ha), Udhampur (6344 ha), Doda (3405 ha), Reasi (3292 ha), Ramban (2112 ha), Kishtwar (1876 ha) and Rajouri (986 ha). In Kashmir province, the maximum area under wheat is in Baramulla district (849 ha), followed by Budgam (679 ha) and Bandipora (548 ha). Kashmir being favourable for orchard cultivation, therefore maximum area under orchards is observed in Kashmir province (34329 ha) and very less area is under orchards in Jammu province (2359 ha). The highest area under orchards is found in district Shopian (13511 ha), followed by Anantnag (4777 ha) and Pulwama (4055 ha). In Jammu province, only Jammu district has comparatively substantial area under orchards (879 ha).

8.2 PRODUCTIVITY AND PRODUCTION

The agriculture productivity has increased in the state in the last thirty years on account of improved use of seeds and fertilizers, mechanization, improved irrigation etc. The productivity per hectare is more in paddy than wheat and maize. The paddy productivity per hectare is more in Pulwama (29.54 q/ha) followed by Anantnag (29.43 q/ha), Srinagar (29.21 q/ha), Kulgam (28.89 q/ha), Baramulla (28.72 q/ha), Budgam (27.42

q/ha), Jammu (27.10 q/ha), Bandipora (27.03 q/ha), Ganderbal (26.61 q/ha), Samba (24.42 q/ha) and Kupwara (24.04 q/ha) etc. The Maize thrives well in the '*kandi belt'* (mountainous low lying areas). This crop has more productivity in the Jammu province than Kashmir. It is observed from the table 8.2 that the productivity per hectare is more in district Jammu (21.56 q/ha), followed by Rajouri (21.42 q/ha), Samba (21.25 q/ha) and Shopian (20.12 q/ha), while as the lowest productivity is found in Budgam (15.43 q/ha), Bandipora (15.47 q/ha) and Ramban (15.67 q/ha). In case of wheat, the highest productivity is observed in Leh (19.46 q/ha) and Kargil (19.32 q/ha) followed mainly by districts of Jammu division than Kashmir (Fig. 8.2).

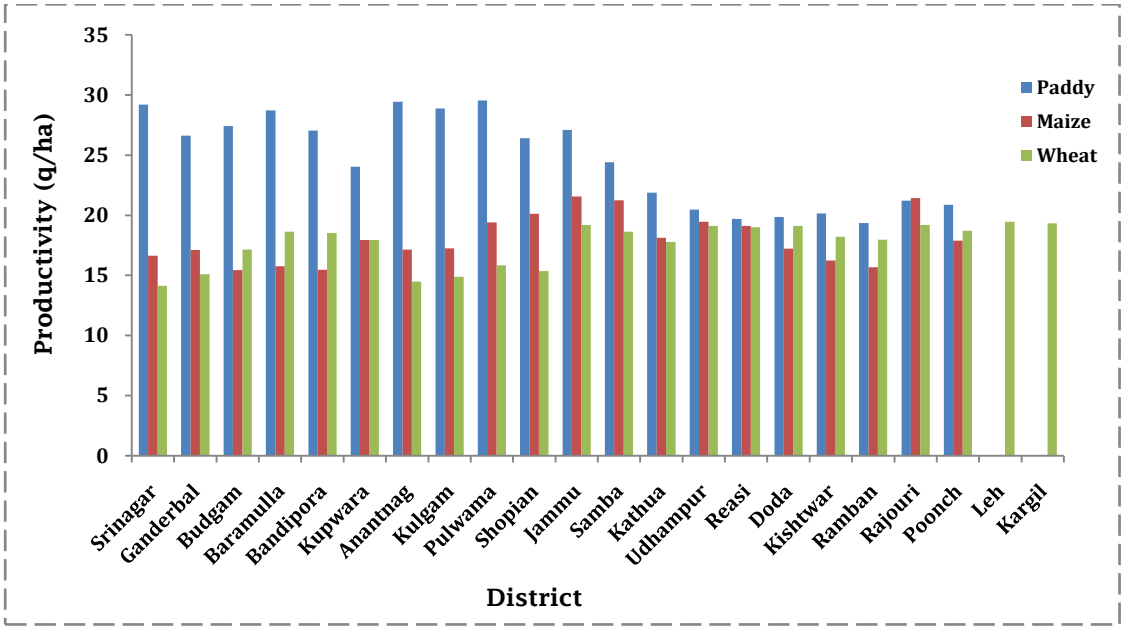


Fig. 8.2: Productivity of paddy, maize and wheat in Jammu and Kashmir (2011)

The production is observed more in the districts having good productivity as well as more area under food crops. It is evident from the table 8.2 that in absolute values, the production of paddy is more in Jammu district (85175 metric tonnes) followed by Anantnag (54975 metric tonnes) and Baramulla (52690 metric tonnes), while as in case of maize, the production is more in Rajouri (58074 metric tonnes) followed by Kupwara (41440 metric tonnes) and Poonch (30775 metric tonnes). The production of wheat is more in Jammu (38661 metric tonnes) followed by Kathua (25091 metric tonnes) and Samba (17395 metric tonnes) [Fig. 8.3].

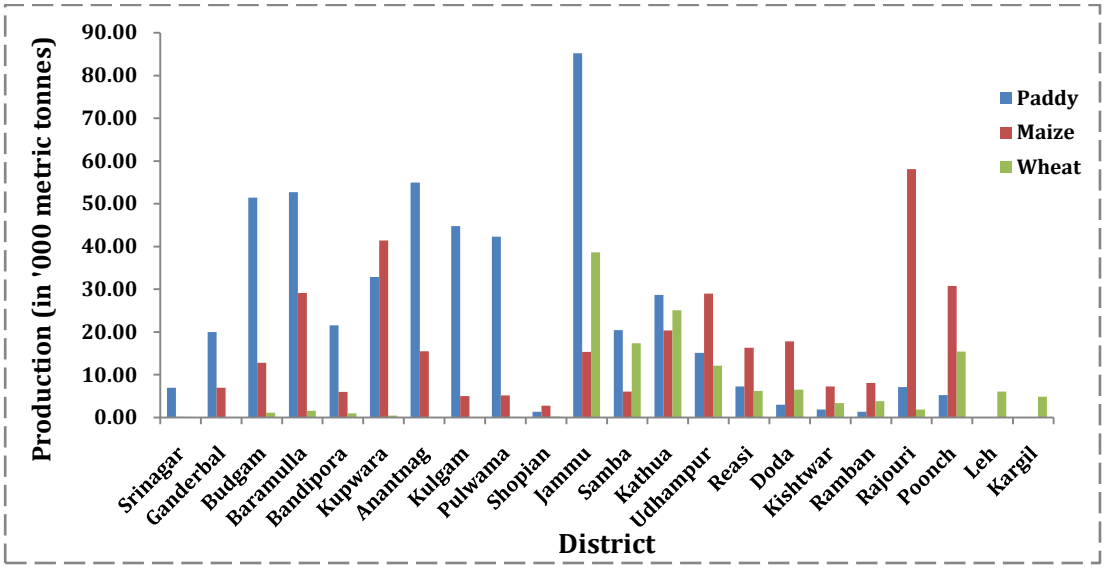


Fig. 8.3: Crop production in metric tonnes (2011-12)

8.3 FOOD REQUIREMENT AND DEFICIT

The food requirement increase is a natural phenomenon because of rising population. The comparison of population increase at provincial level has been depicted in fig. 8.4. The figure 8.4 shows that Kashmir province has more population followed by Jammu province. Ladakh province has only around two percent of the state population. The population of the state increased from 58.08 lac in 1980 to 125.48 lac in 2011 (116 percent). In Kashmir province, it increased from 30.44 lac to 69.07 lac (126 percent increase) during these thirty years, while as in Jammu province the population increased from 26.33 lac to 53. 50 lac (103 percent increase).

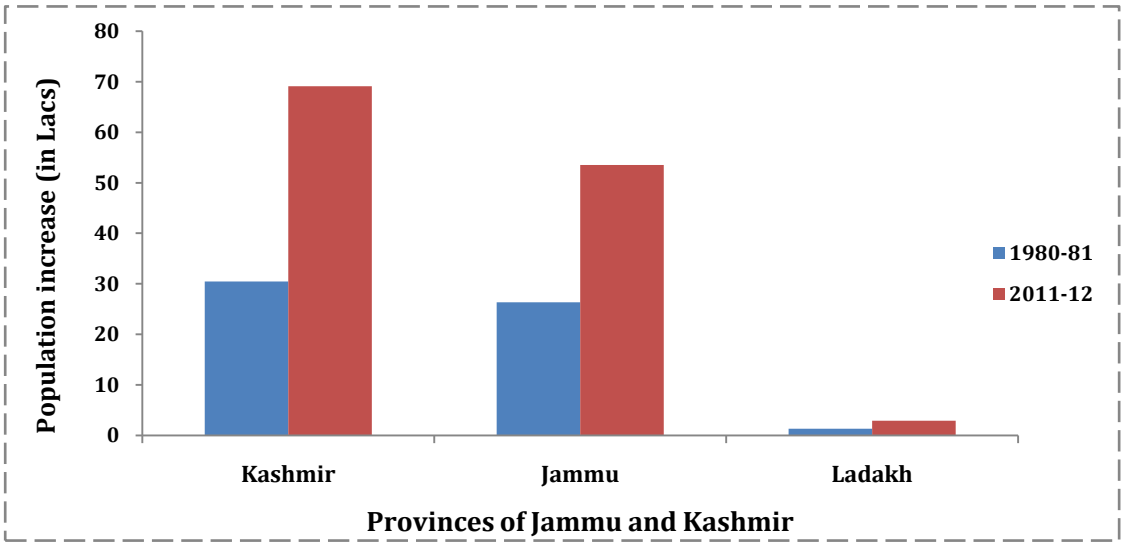


Fig. 8.4: Population increase in Jammu and Kashmir (1980-2011)

The total food requirement in the state is 1832143 metric tonnes. However, it is more in district Jammu (222855 metric tonnes) on account of its more population (15.26 lac). The requirement in absolute values is low in district Kargil (20935 metric tonnes) and Leh (21477 metric tonnes) because of being less populated. The growth in the food requirement across the provinces of the state has been depicted in fig 8.5. The overall food requirement in all the provinces increases with the passage of time. In absolute values, Kashmir province has more requirements followed by Jammu and Ladakh.

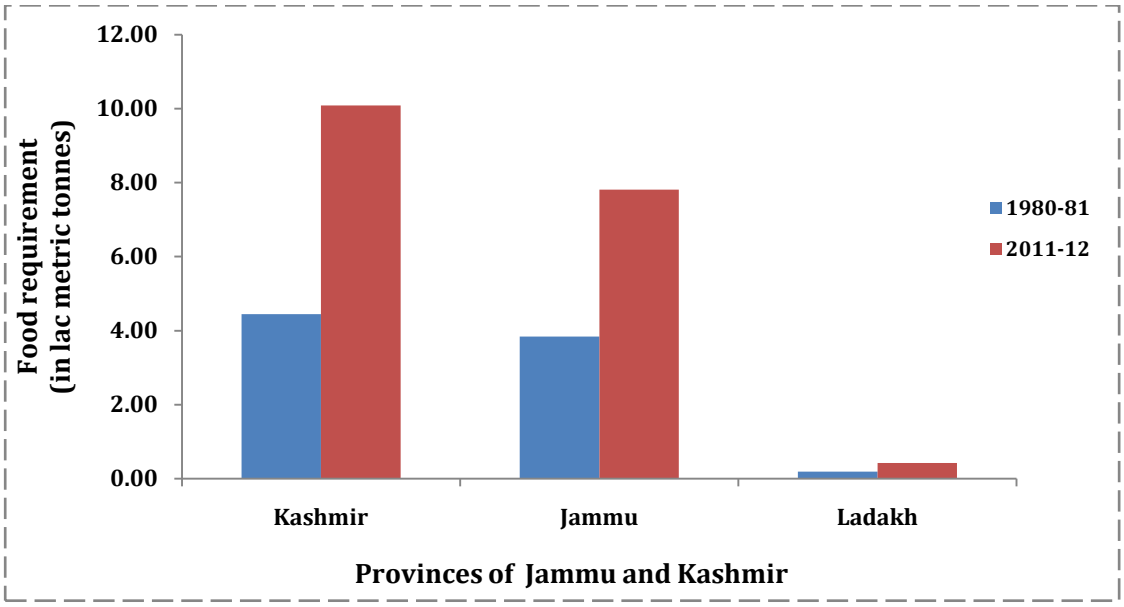


Fig. 8.5: Food requirement in Jammu and Kashmir (1980-2011)

The total domestic production is equivalent to fifty three percent (984462 metric tonnes) of the requirement. The leading districts in production in absolute figures are; Jammu (139217 metric tonnes), Baramulla (83411 metric tonnes), Kupwara (74727 metric tonnes) and Kathua (74158 metric tonnes).

The comparison of domestic production across the three provinces of the state has been drawn (Fig. 8.6). The figure 8.6 indicates that Jammu province leads in the domestic production. Kashmir province lags in the domestic production not because of less productivity than Jammu, but because of losing the agricultural land to other land uses. Ladakh province has very little net sown area and therefore has least domestic production.

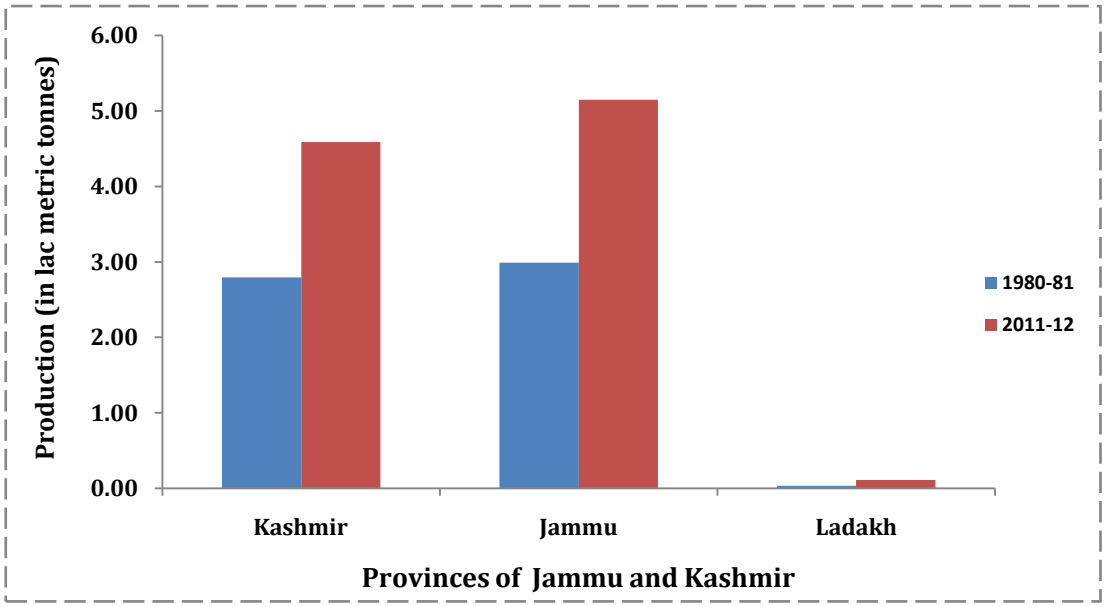


Fig 8.6: Domestic production in Jammu and Kashmir (1980-2011)

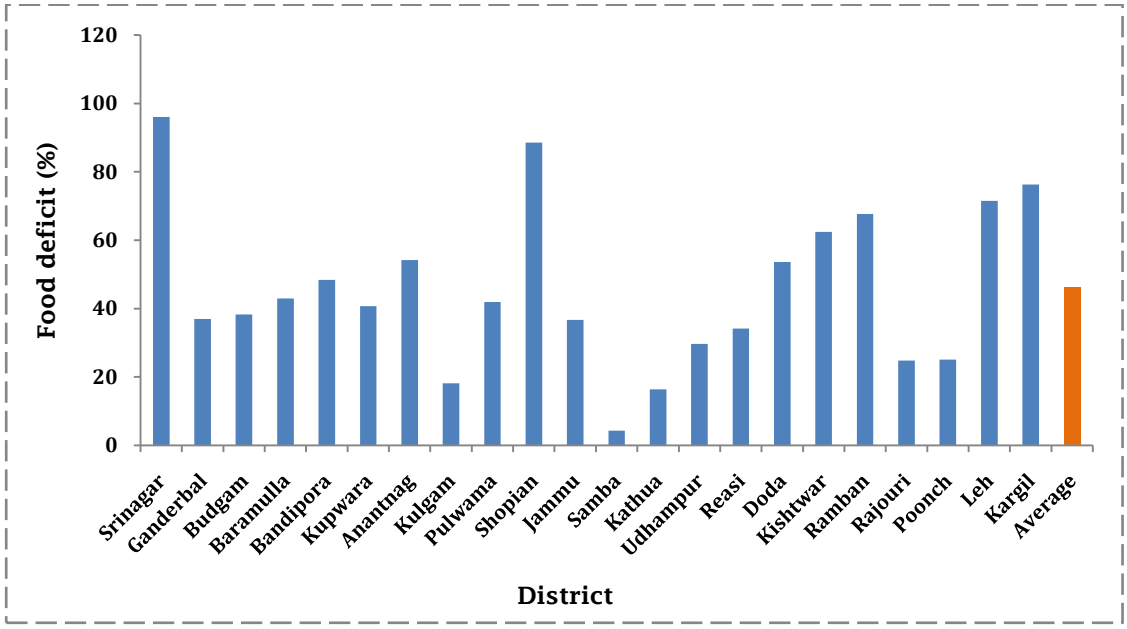


Fig. 8.7: Food deficit in Jammu and Kashmir (2011-12)

The average food deficit in the state stands at 46.26 percent. However, there is spatial variation in the deficit levels across the different districts. The highest deficit is observed in Srinagar (96.08 percent) followed by Shopian (88.58 percent), Kargil (76.27 percent), Leh (71.47 percent), Ramban (67.7 percent) and Kishtwar (62.47 percent). The lowest deficit is observed in Samba (4.35 percent) and Kathua (16.36 percent). Eight districts in the state have more food deficit than the state average (Fig.

8.7). The food deficit at the provincial level has been highlighted in figure 8.8. Ladakh province has the maximum food deficit (73.87 percent in 2011) though it improved its domestic production and lowered its food deficit by 8.77 percent from 82.64 percent in 1980. The food deficit increased at a higher rate in Kashmir province (31.69 percent in 1980 to 50.63 percent in 2011), while as in Jammu province the food deficit increased by 15.50 percent over these thirty years of time.

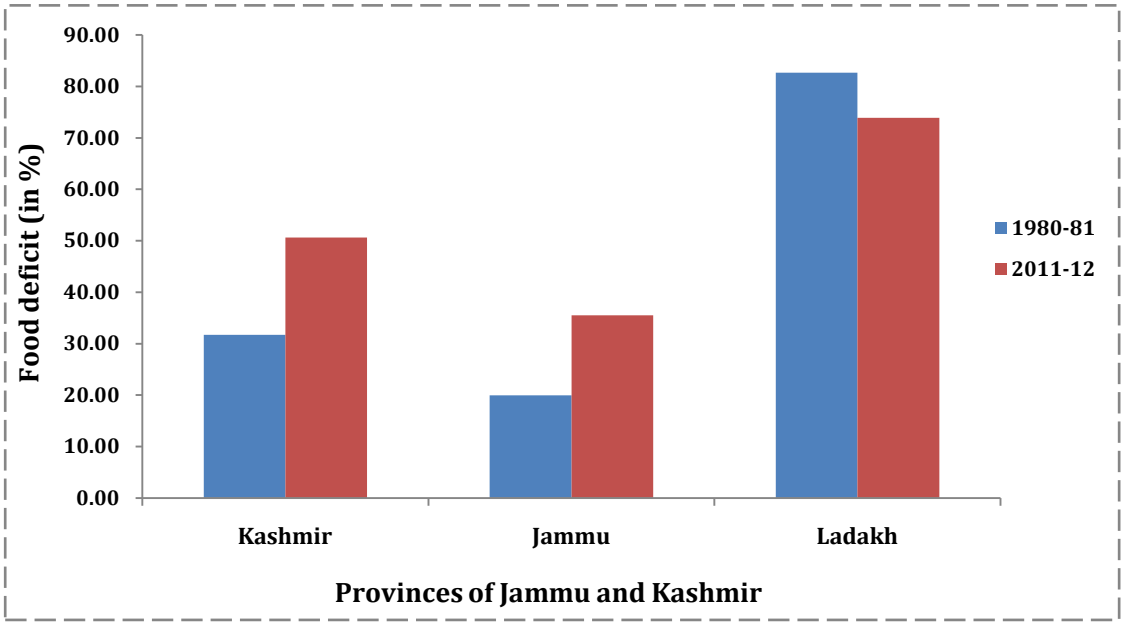


Fig. 8.8: Food deficit in Jammu and Kashmir (1980-2011)

8.4 LEVELS OF FOOD DEFICIT

In order to determine the levels of food deficit across the spatial territories of the state, the food deficit calculated above (table 8.3) has been divided into five levels /zones, *viz*, very high (80-100 percent), high (60-80 percent), medium (40-60 percent), low (20-40 percent) and very low (below 20 percent) [Fig. 8.9]. From the figure, it is clear that two districts, *viz*, Srinagar and Shopian have very high level of food deficit (96.08 percent and 88.58 percent respectively), while as very low food deficit is observed in Samba, Kathua and Kulgam (4.35 percent, 16.36 percent and 18.14 percent respectively). High level of deficit is observed in four districts namely Leh, Kargil, Ramban and Kishtwar (71.47 percent, 76.27 percent, 67.70 percent, and 62.47 percent respectively). Six districts (Doda, Kupwara, Baramulla, Bandipora, Anantnag, and Pulwama) have

medium level of deficit and seven districts (Ganderbal, Budgam, Poonch, Rajouri, Jammu, Udhampur and Reasi) posses' low level of deficit.

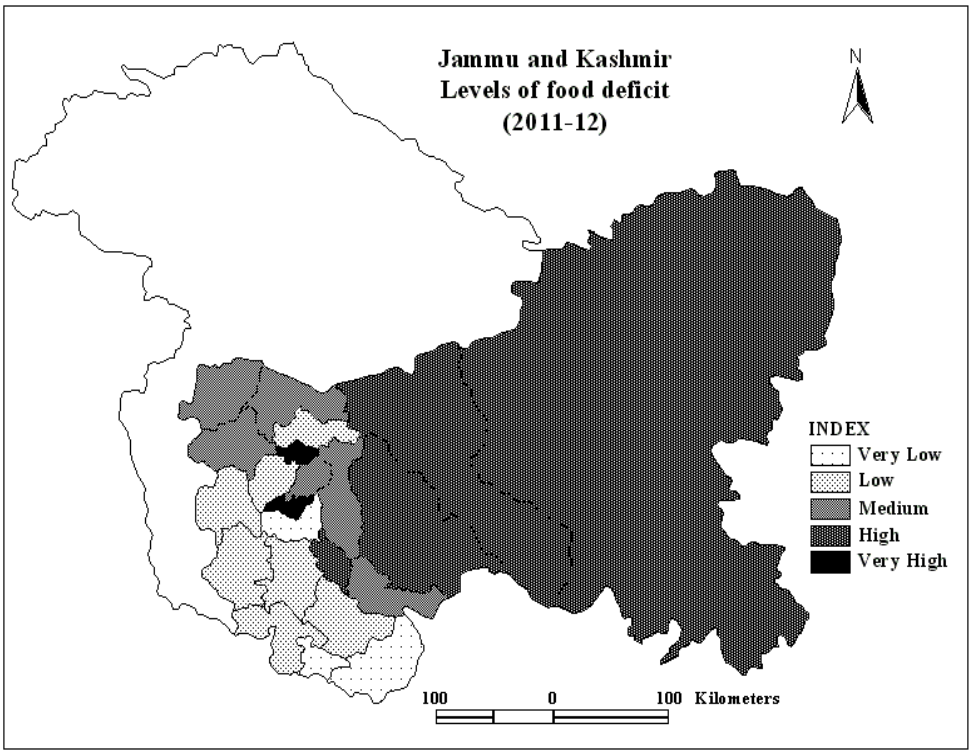


Fig. 8.9: Levels of food deficit in Jammu and Kashmir (2011-12)

8.5 FOOD IMPORTS

The food imports have increased and are increasing with increasing population. Since food deficit exists in the study area, therefore in order to ensure food security, the import of food grains becomes all the more important. The food imports in the state consist mainly of wheat and rice shown in the table 8.4 below;

The import of rice is higher in Kashmir than Jammu as it is main staple food of the people of valley.

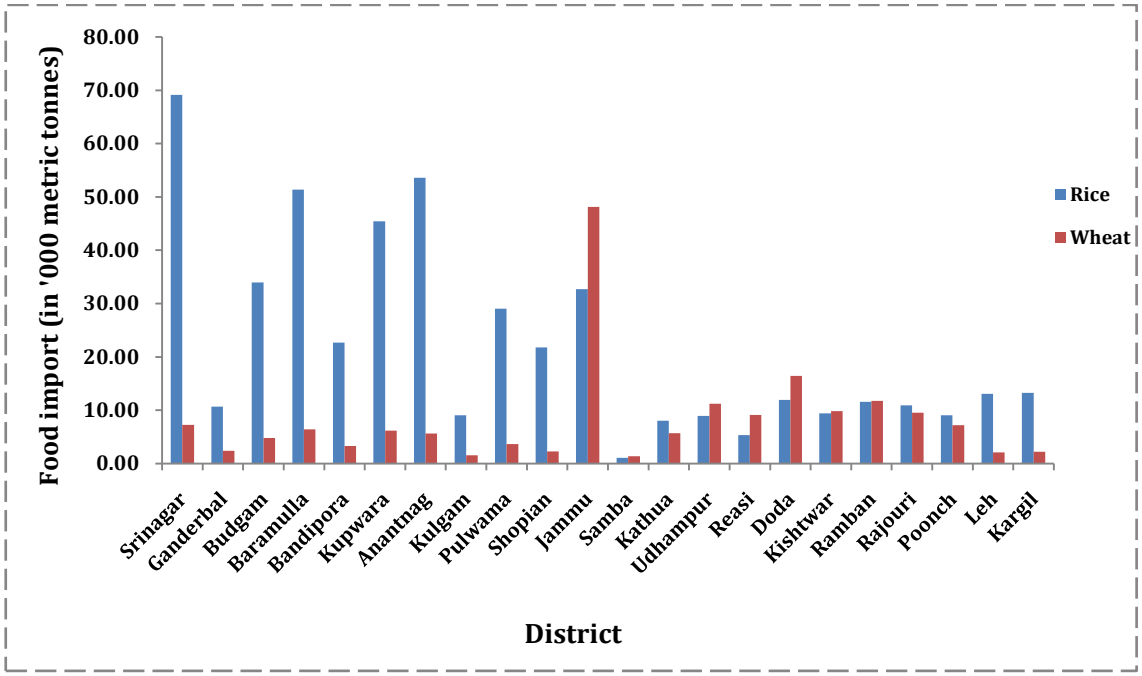


Fig. 8.10: Food imports in Jammu and Kashmir (2011-12)

Similarly, Jammu has more demand for wheat than rice. In absolute values district Srinagar has more rice import (69133 metric tonnes) followed by Anantnag (53611 metric tonnes), Baramulla (51365 metric tonnes), Kupwara (45453 metric tonnes), Budgam (33977 metric tonnes), Jammu (32730 metric tonnes), Pulwama (29054 metric tonnes) and Bandipora (22689 metric tonnes) etc. In case of wheat, Jammu district has maximum imports (48111 metric tonnes) followed by Doda (16472 metric tonnes), Ramban (11747 metric tonnes), Udhampur (11216 metric tonnes) and Kishtwar (9856 metric tonnes) [Fig. 8.10].

8.5.1 Levels of food import

In order to determine the levels of food import across the districts of the state, Z-score has been worked out for both rice and wheat imports. Then composite z-score has been calculated (table 8.5) and three groups have been identified, *viz,* high, medium and low (Fig 8.7). From the figure, it is clear that five districts namely Srinagar, Jammu, Kupwara, Baramulla and Anantnag have very high levels of food imports; while as six districts (Leh, Kargil, Kathua, Samba and Kulgam) have low food imports and the remaining eleven districts of the state fall in the medium level of food imports.

Table 8.5: Standardized scores of food imports in Jammu and Kashmir, 2011

District	Z-Score		Composite Z-Score
	Rice	Wheat	
Srinagar	2.56	-0.09	2.48
Ganderbal	-0.61	-0.59	-1.20
Budgam	0.65	-0.34	0.32
Baramulla	1.60	-0.17	1.43
Bandipora	0.04	-0.49	-0.45
Kupwara	1.28	-0.20	1.08
Anantnag	1.72	-0.25	1.47
Kulgam	-0.70	-0.67	-1.37
Pulwama	0.39	-0.45	-0.07
Shopian	-0.01	-0.60	-0.60
Jammu	0.59	4.10	4.69
Samba	-1.13	-0.69	-1.82
Kathua	-0.75	-0.25	-1.00
Udhampur	-0.70	0.32	-0.38
Reasi	-0.90	0.11	-0.79
Doda	-0.54	0.86	0.32
Kishtwar	-0.68	0.18	-0.50
Ramban	-0.56	0.37	-0.19
Rajouri	-0.60	0.15	-0.45
Poonch	-0.70	-0.10	-0.79
Leh	-0.48	-0.61	-1.09
Kargil	-0.47	-0.60	-1.07

Source: *Compiled from table 8.4*

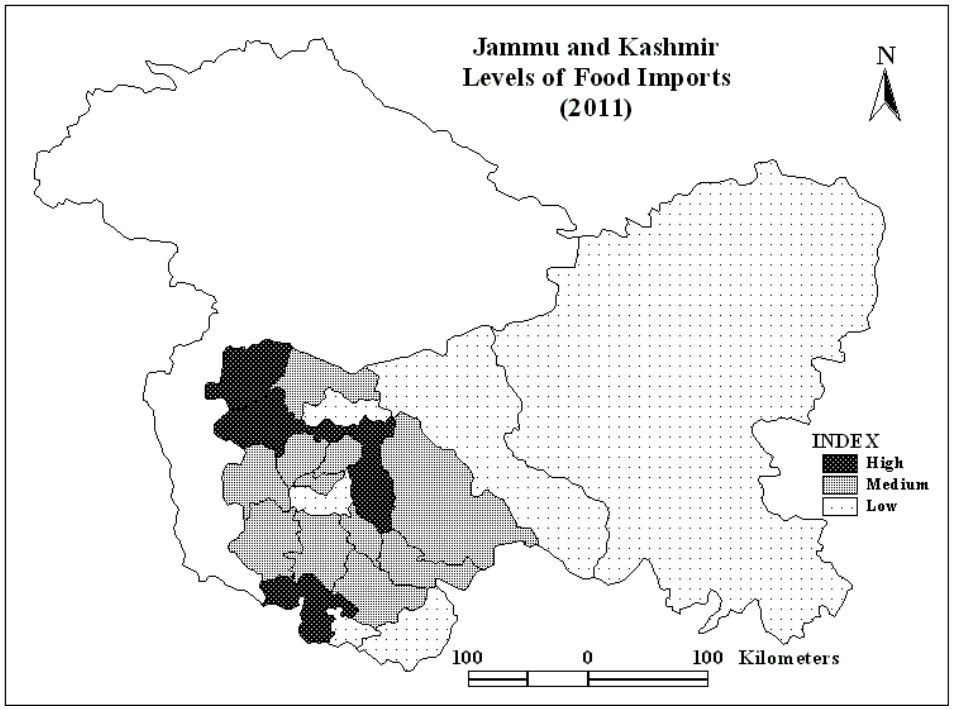


Fig. 8.11

8.6 MAN-LAND RATIO

The man-land ratio (physiological density) is simply the ratio of population and agricultural land in any geographical area. It has increased in the state on account of increasing population which means that the land available per person has decreased over the period of time.

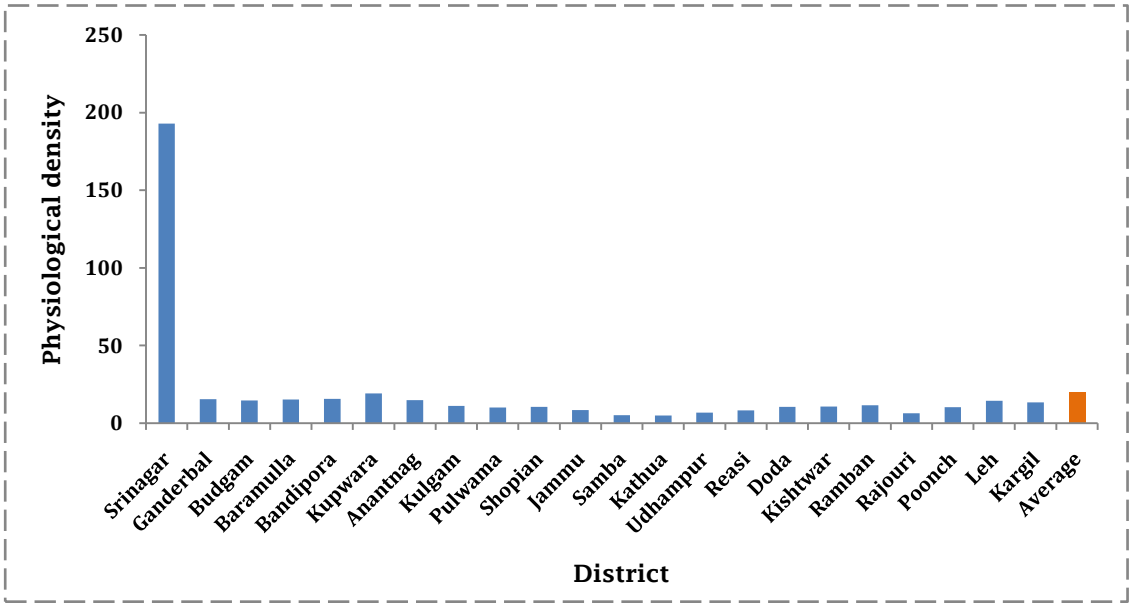


Fig. 8.12

The man-land ratio is highest in Srinagar (192.91) on account of its more urban population and least agricultural area followed by Kupwara (19.08), Bandipora (15.59), Ganderbal (15.36) and Baramulla (15.32). The physiological density is more in Kupwara, Ganderbal and Bandipora not because of more population but due to low agricultural land available. The physiological density is more in districts of Kashmir than Jammu province (Table 8.4 and Fig. 8.12).

8.7 WORKING POPULATION IN AGRICULTURE

The sum total of the people working in agriculture from a group of people residing in a geographical area is called '*working population in agriculture*'. This proportion of population is linked with the socio-economic development of any country or region. The ratio of this population to total population is decreasing day by day because of urbanization, modernization and diversification of occupation of the people. The

percentage of people working with agriculture in Jammu and Kashmir is shown in the table 8.4. The state average is 46.95 percent which indicates that 53.05 percent population is engaged in activities other than agriculture. The working population with agriculture is not same throughout but exhibit regional variations which are visible across the districts of the state. The districts with more percentage of population engaged in agriculture are Doda (62.12 percent), Ramban (61.5 percent), Rajouri (61.45 percent) and Kishtwar (59.64percent) etc. while as district Srinagar (5.15 percent), Jammu (15.12 percent) and Leh (34.42 percent) have low percentage of people engaged in agriculture sector (Fig. 8.13).

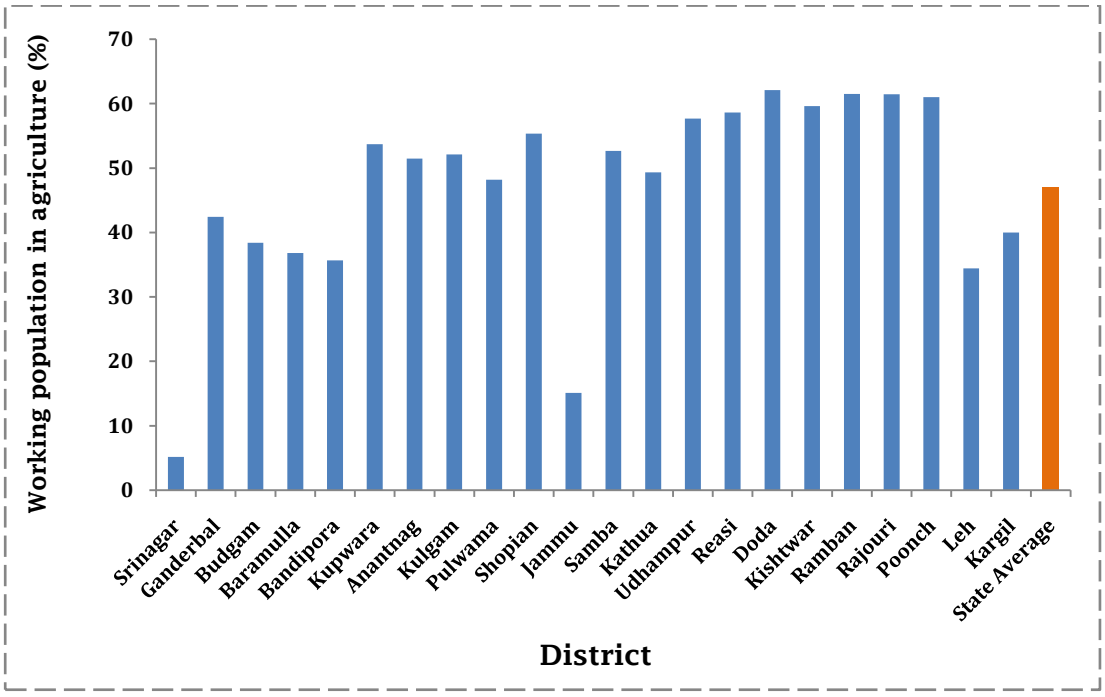


Fig. 8.13

9.1 CONCLUSION

The causes and consequences of the changes in crop pattern are so complex and inter-related that it is difficult to classify and isolate individual factors. The pursuit of increased productivity and economic returns has led to modernization of agriculture and acceleration of the transformation of rural communities. Modernization of agriculture has produced benefits and improvements in the form of better resource utilization, larger food availability and higher quality of life. These improvements look so good that one might forget that there have been losers as well as winners in this game. All sectors of the rural community have been affected by transformation. Decline in the number of persons engaged in farm-related activities, shift of economic opportunity away from women to men, increasing specialization in livelihoods, migration of rural labour in search of work, withering away of traditional, local institutions - are all features of this transformation. Agriculture has increasingly substituted external inputs and resources for internal ones, reduced the range of skills needed for farming, displaced traditional varieties of seeds and breeds of livestock and reduced biodiversity. The social and environmental costs of the change have cut deep into the structure of the rural society. The drive for agricultural efficiency, though not the sole cause, is evidently a major factor underlying the transformation.

9.2 MAIN FINDINGS

- The state of Jammu and Kashmir constitutes northern most extremity of India and is situated between 32^{o} 17′ to 37^{o} 05′ N latitude and 73^{o} 26′ to 80^{o} 30′ E longitude. The state is 640 km in length from north to south and 480 km from east to west. The total area of the State is 2, 22, 236 km^2 comprising 6.93 per cent of the total area of the Indian territory including 78,114 km^2 under the occupation of Pakistan and 42,685 km^2 under China.
- The state ranks 6^{th} in area and 17^{th} in population among states and union territories of India while it is the most populated state of Indian Himalayan Region constituting 25.33 per cent of its total population.

- The State of Jammu and Kashmir has many Himalayan rivers flowing through it; the most significant among these are the Indus, Jhelum and Chenab. The state is also home to the mighty glaciers like the Siachen and Baltoro.
- The state has two divisions (Jammu and Kashmir) and twenty two districts. Jammu division has ten districts and Kashmir division has twelve districts. The Ladakh province comes under Kashmir division.
- The state of Jammu and Kashmir has regional variations in climate as it is sub-tropical type in Jammu, temperate type in Kashmir and cold desert type in Ladakh.
- The state of Jammu and Kashmir has been divided into nine micro agro-climatic zones and five climatic zones. Among these zones, highest area is under zone L (93531 km^2) and lowest under zone 5J (376.01 km^2).
- The agro-climatic zones exhibit great variations in productivity of different crops. The high productive zones are 1J, 2J, 2'J and 3J (all are located in Jammu province), followed by medium productive zones (3'J and 4J) and low productive zones (1K and 2K). Ladakh division (zone L) is having very low productivity.
- At agro-climatic zone level, the productivity of paddy is more in 1J (25.76 q /ha) followed by 2K (23.58 q/ha), while as lowest is observed in 4J (20.05 q/ha). Similarly, productivity of maize is highest in 1J (21.41 q/ha) followed by 2J (18.97 q/ha) and 2' J (17.03 q/ha) and lowest in 3'J (12.35 q/ha). Productivity of wheat is more in L (19.39 q/ha) and least in 1K (12.37 q/ha).
- There is variation in the precipitation and temperature across the different agro-climatic and climatic zones of the state. For example, zone 5'J receives an annual rainfall of 1642mm/year, while as on contrarily, zone L receives only 157 mm/year. Similarly, mean maximum temperature is more in zone 3J (30.19˚C) and low in zone L (11.11˚C), while as mean minimum is recorded low in L (-2.53˚C) and high in 2'J (17.50˚C).
- The cropping land use pattern is different between the agro-climatic zones of Jammu province and Kashmir valley. In former, wheat and maize occupy a considerable

area, while as in latter very least area under wheat and maize is grown only in *kandi belt* (mountainous low lying area).

- In the study area, the average net sown area has increased from 7.05 percent of the total geographical area in 1980 to 7.29 percent in 2008, though with spatial variations across the districts. For example, four districts (Srinagar, Budgam, Pulwama and Kathua) have received negative growth in the net sown area. The highest increase is recorded by Jammu, Doda, Rajouri and Kargil, while as least increase has been recorded from Kupwara and Baramulla districts.
- There are wide variations in the irrigation capacity across the districts of the state. Srinagar district has maximum irrigation facilities as seventy two to eighty percent of its net sown area gets adequate irrigation, while as on contrarily Udhampur has the minimum where only six to seven percent area is irrigated properly.
- The cropping intensity has increased over the period of time in the state by 11.84 percent though with spatial variations. For example, in Kashmir valley, it has increased by seventeen units (110.68 to 127.42), while as in Jammu division it has increased by almost twenty units (157.68 to 177.06). The highest cropping intensity is observed in Jammu and Kathua districts and lowest in Kupwara and Leh. Eight out of fourteen the districts (Srinagar, Budgam, Pulwama, Anantnag, Kathua, Doda, Poonch and Rajouri) have recorded more increase than state average, while as district Kargil has shown a decrease in cropping intensity (-2.40 percent). The lowest increase is observed in district Kupwara (0.53 percent).
- Paddy cultivation is an age old practice in the state, but with changing times the area under this crop has decreased in all the districts. In the state almost one third of the land under paddy (-29.92 percent) has lost during the twenty eight years (1980-2008) though with regional variations. Kashmir province has lost 34.66 percent of the area under this crop, while as Jammu province has recorded 21.96 percent decline. The maximum land loss under this crop is observed in district Srinagar (-48.95 percent) followed by Udhampur (-46.64 percent) and Pulwama (-44.88 percent), while as least loss is recorded in district Jammu (-13.30 percent) and Doda (-15.30 percent).

- The area under maize has overall witnessed a decrease in its area at state level (-13.68 percent) though there has been increase in its area in three districts namely Budgam (16.30 percent), Baramulla (10.83 percent) and Kupwara (7.83 percent). Highest decrease is observed in district Udhampur and Rajouri (-28.78 percent each), while as lowest decrease is observed in district Srinagar (-4.59 percent). All the districts of Jammu province have recorded a negative growth in the area under maize cultivation.
- The area under wheat in absolute values has decreased by 23423 hectares in the state though it increased by 502 hectares in Kashmir province. In Jammu province it has decreased by 24267 hectares and in the two districts of Ladakh, the area under this crop has increased by 342 hectares. The overall growth of the crop showed a declining trend. The area under this crop has decreased at state level by 21.47 percent. The maximum decline in Jammu province is observed in Udhampur district (43.46 percent) followed by Kathua (-29.28 percent) and minimum in Jammu district (15.50 percent).
- The area under orchards has increased in all the districts of the state from the year 1980 to 2008. The maximum area has increased in district Pulwama (16482 hectares), while as in district Poonch very least area has been brought under orchard cultivation (74 hectares in 28 years). Though maximum area in absolute values has increased in districts of Kashmir valley (22469 hectares), but the intensity of expansion during the time period is observed highest in Pulwama (1533.21 percent) followed by Rajouri (735.29), Leh (416.66) and Poonch (389.47).
- The cropping land use in the state has changed on account of both physical or natural and socio-economic factors, *viz,* climate, economic returns, availability of agricultural products at reasonable cost, easy advance borrowings, lack of Irrigation, lack of credit facilities, developmental projects etc.
- The analysis of the spatial variation in the cropping land use dynamics have shown that six districts (Srinagar, Budgam, Pulwama, Kathua, Rajouri and Udhampur) have undergone highest cropping land use changes, while as medium level of dynamics is observed in four districts (Baramulla, Anantnag, Doda and Poonch) and two districts

(Jammu and Kupwara) have shown low change in cropping land use. Leh and Kargil districts have not been taken into consideration as the cropping land use has increased under all the crops grown in these districts.

- The population in absolute values in the state has increased from 5808929 persons in 1980 to 11704596 in 2008 with an overall growth rate of 102.46 percent (3.65 percent/annum). The population increased at a faster rate from 1980 to 2000; however it started dwindling after 2000. The highest growth for these twenty eight years is observed in Kupwara district (148.94 percent) followed by Anantnag (116.36 percent) and Srinagar (109.84 percent), while as lowest growth is observed in Kathua (61.67 percent). The districts with growth rate less than state average are Udhampur (87.35 percent), Rajouri (97.35 percent), Jammu (92.05 percent), Pulwama (97.26 percent) and Budgam (96.87 percent).
- The food requirement in the state has increased by 860768 metric tonnes during these twenty eight years. The average rate of increase per annum is 3.62 percent. The food requirements in the different districts of the study area have increased in consonance with the rate of population growth in the respective districts. The highest requirement in absolute values is in Jammu district (256880 metric tonnes) followed by Srinagar (211194 metric tonnes) and Anantnag (201778 metric tonnes), while as lowest requirement is in Kargil (19730 metric tonnes). However, the intensity of requirement is more in Kupwara district (148.94 percent) followed by Anantnag (116.36 percent) and Srinagar (109.84 percent), while as lowest growth is observed in Kathua (61.67 percent).
- The paddy productivity in the state of Jammu and Kashmir has increased over the period of time. It has increased from 8.75 quintals/hectare to 19.31 quintals/hectare, thus implies a total increase of 10.56 quintals/hectare during these twenty eight years. The productivity has generally increased more in Kashmir province (13.48 quintals/ha) than Jammu province (11.16 quintals/ha). Five districts out of six in Kashmir province have more productivity increase than state average (12.31 q/ha),

while as in Jammu province, only Jammu district has productivity more than the state average.

- The productivity of maize in all the districts of the state has increased during these twenty eight years taken for the study. It has increased from 8.14 quintals/hectare to 16.38 quintals/hectare, thus implies a total increase of 8.23 quintals/hectare. The productivity has increased more in Jammu province (8.91 q/ha) than Kashmir province (7.55 q/ha). The highest growth is recorded in Udhampur district (11.04 percent) followed by Rajouri (10.37 percent) and Pulwama (9.16 percent), while the lowest is observed in Baramulla (5.94 percent). In Jammu province, Doda and Kathua produce yields below state average, while as in Kashmir province, only Pulwama and Kupwara are above state average and rest are below it.
- The wheat has also shown significant increase in productivity in all the districts of the state. It has increased from 6.15 quintals/hectare to 13.58 quintals/hectare, thus implies a total increase of 7.43 quintals/hectare. The productivity has generally increased more in Kashmir province (9.22 q/ha) than Jammu province (8.13 q/ha). The highest growth is recorded in district Kargil (11.03 q/ha) followed by Leh (10.60 q/ha) and Budgam (10.25 q/ha), while the lowest is observed in Pulwama (6.12 q/ha).
- The production of rice in absolute figures has increased by 172662 metric tonnes and in percentage by 56.74 percent during these twenty eight years. The production has increased more in Jammu district followed by Anantnag and Baramulla, while as Doda, Poonch and Rajouri has recorded lowest increase.
- The maize production has increased from 187225 metric tonnes in the year 1980 to 328997 metric tonnes in 2008 with the net increase of 141772 metric tonnes. The overall rate of increase is 75.72 percent. The highest increase is observed in district Kupwara (234388 quintals) followed by Udhampur (203316 quintals) and Rajouri (200858 quintals), while as lowest increase is observed in Srinagar (25168 quintals) and Pulwama (34526).
- Like paddy and maize, wheat production has also increased from 87055 metric tonnes in the year 1980 to 138630 metric tonnes in 2008 with the total increase of 51575 metric tonnes. The overall rate of increase is 59.24 percent. Since wheat is a

dominant crop in Jammu province, therefore production has increased in all the districts of the province with highest increase in Jammu (17084 metric tonnes) followed by Kathua (12178 metric tonnes) and Poonch (6960 metric tonnes). Leh and Kargil districts have least production not because of low productivity, but because of less area under these crops.

- The overall domestic production has increased from 581802 metric tonnes in 1980 to 953118 metric tonnes in 2008, thus recorded an absolute increase of 371316 metric tonnes. The highest increase in absolute values is observed in Jammu (81786 metric tonnes) followed by Anantnag (52020 metric tonnes) and Baramulla (39510 metric tonnes), while the lowest is observed in Leh (2634 metric tonnes). In terms of percentage increase, highest change is observed in Kargil (180.72 percent), Leh (149.56 percent) and Kupwara (116.60 Percent) because more area has been brought under cultivation in these districts. The lowest increase is recorded in Pulwama (25.10 percent), Budgam (47.41 percent) and Udhampur (51.40 percent).
- The food deficit in the state has increased from 33.96 percent to 43.29 percent (9.33 percent increase) during the time period taken for the study. The food deficit has increased more for Kashmir province (14.18 percent) than Jammu province where it increased at a slow rate (9.15 percent). In the Ladakh sector including the Leh and Kargil district, the food deficit has decreased by 4.66 percent. The other districts which observed lowering of the food deficit are Kathua (3.9 percent) and Budgam (0.66 percent). The highest food deficit is observed in district Srinagar (82.97 percent) followed by Kargil (78.30 percent) and Leh (77.67 percent), while as lowest food deficit is observed in Kathua (10.81), Rajouri (22.64 percent) and Poonch (23.15 percent).
- Srinagar district has very highest food deficit (82.97 percent) because of being home to more urban people, while as high level of deficit on account of paucity of suitable agricultural land is observed in two districts of Ladakh division of the state namely Leh (77.67 percent) and Kargil (78.30 percent); Four districts (Kupwara, Doda, Anantnag and Pulwama) have medium level of deficit and five districts (Baramulla, Poonch, Rajouri, Jammu and Udhampur) have low level of deficit and the remaining

two districts (Budgam and Kathua) have very low food deficit (18.46 percent and 10.81 percent respectively).

- The physiological density (man-land ratio) increased from 7 persons per unit of agricultural land to 13.8, thus implies a net increase of 6.8 persons/unit of agricultural land during these twenty eight years. The highest increase has been recorded in Srinagar district (35.8 persons/unit of agricultural land), followed by Kupwara (10.2) and Budgam (6.7). The lowest change is found in Kathua (1.4) and Rajouri (1.9).
- The food imports in the state consist mainly of wheat and rice. The wheat imports in the study area have increased from 77086 metric tonnes in 1980 to 181885 metric tonnes in 2008, thus an absolute increase of 104799 metric tonnes with the percentage increase of 135.95 percent. Since wheat is staple food of Jammu province, therefore the imports have increased much in Jammu district (26669 metric tonnes) followed by Udhampur (23710 metric tonnes) and Doda (22991 metric tonnes), while as the imports are recorded least in Kathua (851 metric tonnes) and Pulwama (514 metric tonnes). The percentage increase in imports is observed more in Rajouri (744.57 percent), followed by Poonch (300.78 percent) and Udhampur (288.09 percent), while as least is observed in Srinagar (19.76 percent) and Kathua (15.66 percent).
- The import of rice is more than wheat in the study area because being staple food of more people with less domestic production. It has more demand than wheat and like wheat it has increased from 150262 metric tonnes in 1980 to 481038 metric tonnes in 2008, thus an absolute increase of 330776 metric tonnes with the percentage increase of 220.13 percent. Since rice is a staple food of Kashmir province, therefore the imports have increased much in Srinagar district (67997 metric tonnes) followed by Anantnag (52304 metric tonnes) and Baramulla (50089 metric tonnes), while as the imports are recorded least in Kupwara (29116 metric tonnes) and Budgam (26440 metric tonnes). The percentage increase in imports is observed more in Rajouri (1506.50 percent), followed by Poonch (426.26 percent) and Pulwama (347.96 percent), while as least is observed in Poonch (93.38 percent) and Kathua (31.57 percent).

- The agriculture productivity has increased in the state in the last thirty years on account of improved use of seeds and fertilizers, mechanization, improved irrigation etc. The productivity per hectare is more in paddy than wheat and maize. The paddy productivity per hectare in 2011 is observed more in Pulwama (29.54 q/ha) followed by Anantnag (29.43 q/ha) and Srinagar (29.21 q/ha) etc.
- The maize productivity in the year 2011 is observed more in the Jammu province than Kashmir. The productivity per hectare is more in district Jammu (21.56 q/ha), followed by Rajouri (21.42 q/ha), Samba (21.25 q/ha) and Shopian (20.12 q/ha), while as the lowest productivity is found in Budgam (15.43 q/ha), Bandipora (15.47 q/ha) and Ramban (15.67 q/ha). In case of wheat, the highest productivity is observed in Leh (19.46 q/ha) and Kargil (19.32 q/ha) followed mainly by districts of Jammu division than Kashmir.
- The average food deficit in the state in 2011 stands at 46.26 percent. However, there is spatial variation in the deficit levels across the different districts. The highest deficit is observed in Srinagar (96.08 percent) followed by Shopian (88.58 percent), Kargil (76.27 percent), Leh (71.47 percent), Ramban (67.7 percent) and Kishtwar (62.47 percent). The lowest deficit is observed in Samba (4.35 percent) and Kathua (16.36 percent). Eight districts in the state have more food deficit than the state average.
- The average physiological density in the state in 2011 is 19.57 persons/unit of agricultural land. The food imports have increased over the period of time and in 2011, the total food imports stand at 6606161 quintals (rice- 4822979 quintals and wheat- 1783182 quintals).

9.3 SUGGESTIONS

- The present growth in crop production has to be sustained considering ecological and economic factors. The existing as well as emerging frontiers must be examined to enhance agricultural growth on a sustainable basis.

- The understanding of agro-climatic relationship through crop-weather conditions, soil fertility, water use efficiency, rain water management, and appropriate cropping pattern based on regional resource potential must be emphasized.
- The area under wastelands and barren land must be brought into productive use by using resource inventorying so that the domestic production could be raised.
- The legislations pertaining to the prohibition of encroachment of agricultural land must be implemented in letter and spirit to avoid the wanton conversion of productive agricultural land into other land uses.
- The government should frame a coherent *'agricultural land use policy'* for the sustainable agricultural development of the state.
- The fixed price control mechanism for agricultural products must be ensured in order to boost the economy of the farmers and to provide them motivation for doing agricultural activities.
- The experts must be involved in the execution of developmental projects especially where agricultural land is needed so as to minimize the loss of land as far as possible.
- There must be efficient and simple credit facility system available to the farmers practicing paddy cultivation so that they don't face any problem of capital during the agricultural year.
- The irrigation capacity of all the districts must be enhanced especially in those of Jammu division which face acute shortage of water for the cultivation of crops.
- The farmers practicing paddy cultivation should be given some remuneration to keep their interest with the paddy cultivation and restrain them from changing the cropping land use.
- The existing system of food supply through public distribution system should be modified (subsidy should be given only to BPL holders and rates must be increased especially in rural areas) in such a way so that interest will be aroused in people to develop paddy culture.
- The establishment of some agro-based industrial units is need of the hour as it will help in increasing the demand of agricultural goods.

- All the problems of paddy cultivators and labourers must be addressed so as to retain as well as increase the area under this crop.
- The market for agricultural goods must be made readily available in order to minimize the risks the farmers are facing in post harvesting season.
- Agro-forestry, integrated crop management, biotechnology, and use of renewable energy must be emphasized for use in environmentally harmonious agriculture. Moreover, training of farmers has to be managed in consonance with the changing technological environment.

REFERENCES AND BIBLIOGRAPHY

Adrian C. Newton, Scott N. Johnson, and Peter J. Gregory (2010), "Implications of Climate Change for Diseases, Crop Yields and Food Security" Scottish Crop Research Institute (SCRI), Invergowrie, Dundee, DD2 5DA, U.K.

Adhikari B., Bag M. K., Bhowmick M. K and Kundu, C. (2005), "Status Paper on Rice in West Bengal". Rice Research Station, Govt. of West Bengal Chinsurah – 712102.

Agrawal A.N. (1981), "Indian agriculture problems progress and prospects". Vikas Publishing House, New Delhi, pp. 226-240.Ainsworth E.A., Leakey A.D.B., Ort D.R., Long S.P. (2008), "Facing the facts: inconsistencies and interdependence among field, chamber and modeling studies of elevated [CO2] impacts on crop yield and food supply. *New Phytol*. 179, 2008 b 5–9.

Ahmad, N. (1969), "Role of Co-operative Credit in Agricultural development of Jammu and Kashmir", P.G. Dissertation, P.G. Department of Economics, University of Kashmir.

Ali, N. (1985), "Agricultural Development and Income Distribution", Rima Publishing House, New Delhi, pp. 39-75.

Ali, N. (1992), "Panorama of Agriculture in Jammu and Kashmir". Rima Publications, New Delhi. Pp. 1-7.

Bamzai, P. N. K. (1962), "A History of Kashmir" Delhi Metropolitan Publications.

Balaguru, T. (2010), "Agro-ecological Regions in India", National Academy of agricultural Research, New Delhi

Bazaz, N.H. (2010), "A Comparative Study of Trends in Production and Productivity of major food crops in Jammu and Kashmir, Punjab and Himachal Pradesh". M.Phil Dissertation, P.G. Department of Economics, University of Kashmir, pp. 1-4, 88-98.

Bedini F and Haq S (2008), "Pakistan: Baseline Survey of National Program for Food Security and Agricultural Productivity Enhancement in Pakistan" (Crop Maximization Project – Phase II) December, 2008., United Nations World Food Programme Pakistan (UNWFP).

Bednarz, R. (2005), "Understanding land use patterns". A & M, University College station, Texas USA.

Bera, B.K. (2008), "Change in cropping pattern and present status of horticultural crops in West Bengal". *Indian Journal of Agricultural Economics*, July1, 2008.

Bhat, M. S. (2008), "Urban System in Himalayas" Arina Publishers and Distributers, New Delhi.

Brinkman, R. (1987), "Agro ecological characterization, classification and mapping: different approaches by the International Agricultural Research Centers". In *Agricultural environments: characterization, classification and mapping* (ed. A. Bunting), pp. 31-42. Wallingford, UK: CAB International.

Butt, T. A. (2002), "The Economic and Food Security Implications of Population, Climate Change and Technology - A Case Study for Mali", Ph.D Dissertation, Department of Agricultural Economics, Texas A&M University, College Station, Texas, U.S.A. (unpublished).

Chandna, R. C. (1992), "A Geography of Population" Kalyani Publications, Ludhiana.

Chapman, L.J and D.M. Brown (1978), "The Climates of Canada for Agriculture". The Canada Land Inventory Report 3, Ministry of Supply and Services, Ottawa.

Chattopadhyay N.(2008), "International Symposium on Climate Change and Food Security in South Asia (2008)".Climate Change and Food Security in India, August 25-30, 2008, Dhaka, Bangladesh.

Corbett, J.D., (1996), "The changing face of agro ecosystem characterization: Models and Spatial data, the basis for robust agro ecosystem characterization. Proceedings of the Third International Conference on the Integration of GIS and Environmental Modelling, Santa Fe, New Mexico, January 1996.

Dar, M. S. (1995), "Food Management Economy in Jammu and Kashmir State", Ph.D thesis, Department of Economics, University of Kashmir. Pp. 180-190.

Das, P. (2004), "Cropping Pattern (Agricultural and horticultural) in different zones, their average yields in comparison to National average/ Critical Gaps/ Reasons Identified and Yield Potential, ICAR, New Delhi.

Denham, Tim P.; et al. (2003). "Origins of Agriculture at Kuk Swamp in the Highlands of New Guinea". Science 301 (5630): 189–193.

Department of Census and Statistics, Institute of Policy Studies and Samurdhi Division, Ministry of Nation Building and Estate Infrastructure Development (2009). SAARC Regional Poverty Profile 2006/2007: Infrastructure Development and Poverty Reduction (to be published). Kathmandu: SAARC Secretariat.

Diener, K. (1912), "Trails of the Himalayas". Mem. Geological survey of India, 36:1-5.

Digest of Statistics (2008-2009), Directorate of Economics and Statistics, Government of Jammu and Kashmir.

Dilley M. and Boudreau T.E. (2001): Coming to terms with vulnerability: A critique of the food security definition. Food Policy, Volume 26, Number 3, June 2001, pp. ' 229-247(19)

Dube, R.S. (1987), "Agricultural geography issues and applications". Gian Publishing House Delhi, pp. 156-170.

Duffy, M. (1996), "Factors affecting cropping pattern". Department of Economics, Iowa State University, 560 Heady Hall Ames, Iowa 50011.

Economic Survey, (2008-2009), Directorate of Economics and Statistics, Government of Jammu and Kashmir.

European Commission (2009), "Food Security: Understanding and meeting the challenge of Poverty, European Communities, Belgium, October 2009

Ewers, R.M, Scharlemann JPW, Balmford A, Green R.E (2009), "Do increases in agricultural Yield spare land for nature?" *Global Change. Biol*.,15(7): 1716-1726

FAO (1996) - The World Food Summit and its Follow Up*; http://*www.fao.org

FAO (1983), "Guidelines: Land evaluation for rain fed agriculture." *Soils Bulletin* 52, FAO, Rome. Pp.237

FAO (1996): Agro-ecological Zoning Guidelines".*FAO Soils Bulletin 73*, Rome. Pp. 78

FAO (2008): Food Security Programme/www.foodsec.org

Food grains Enquiry Committee Report(1957), Department of Food,Ministry of Food and Agriculture, New Delhi.

Food and Agriculture Organization of the United Nations (FAO), (1976), "A framework for land evaluation", Soils bulletin, 32, Rome: FAO.

Food and Agriculture Organization of the United Nations (FAO), (1984), "Guidelines for land evaluation for rain fed agriculture", Soils bulletin, 52, Rome: FAO.

Food and Agriculture Organization of the United Nations (FAO), (1985), "Guidelines for land evaluation for irrigated agriculture", Soils bulletin, 55, Rome: FAO.

Francis, B.(2010), "Using GIS to create an agro-climatic zone map for Soroti District", Makerere University, Department of Surveying, Faculty of Technology, Kampala, Uganda.

Gersmehl, P. (2004), "The Geography of Agriculture and Food Production." In A Teacher's Guide to Advanced Placement Geography: Essays, Strategies, and Resources, ed. R. S. Bednarz, 31-36. Jacksonville, Alabama: National Council for Geographic Education.

Gliessman, S. R. (1992), " Agro ecology in the tropics: achieving a balance between land use and preservation. *Environment. Management* **16**, 681-689

Govt. of J&K (2009), "Economic Survey Report" Directorate of Economics and Statistics, Planning and Development Department, Srinagar. Pp73-100

Government of India (2004): Economic Survey 2003-04, Ministry of Finance, New Delhi.

Gupta, N.S. and Singh, A.(1979), "Agricultural development of states of India". Vol. I, Jammu and Kashmir", Seema Publications New Delhi, pp.123-141.

Guttenberg, Albert Z. (1959), "A Multiple Land Use Classification System". *Journal of the American Planning Association*, 25: 3, Pp. 143-150

Gupta, N.S. and Singh, A.(1979). "Agricultural development of states of India vol. I J & K" Seema Publications New Delhi, pp.123-141. Hazra,C.R (1997), "Crop Diversification in India". http://www.fao.org/docrep/003x6906e /x6906e06 htm. Unpublished.

Hasan, M. (2005), "Kashmir under the Sultans" Aakar books, Delhi.

Hayami, Y. (2003), From the Washington Consensus to the Post-Washington Consensus: Retrospect and Prospect, *Asian Development Review*, Vol. 20, pp. 40-65.

Hazra, C.R. (2006), "Crop Diversification in India". http://www.fao.org /docrep /003x6906 e/x6906e06.htm. Unpublished

Henricksen, B. J. (2005), "Determination of agro-ecological zones in Africa and Expectations". Computer Unit, ILCA, P.O. Box 5689, Addis Ababa, Ethiopia

Hossain, I. (2009), "Cropping pattern change can double yield in North". http:// www. bangladesheconomy.wordpress.com/…/cropping-pattern-change-change-double-yield-in-north/-

Huffman, W.E., and R.E. Evenson (2001), "Structural and Productivity Change in US Agriculture". 1950-1982, *Agricultural Economics*, Vol. 24, pp. 127-147.

Hussain, M. (1979), "Agricultural geography". Inter India publications, New Delhi, Pp. 114-126.

Hussain, M. (2006), "Geography of Jammu and Kashmir", Rajesh Publications New Delhi Pp.1-15,113-138

Husain, M. (1986), "Geography of Jammu and Kashmir State" Rajesh Publications, New Delhi.

Husain, M. (1996). "Systematic Agricultural Geography" Rawat Publications, Jaipur.

Immink, M.D.C. and Alarcon, J.A (1992), "Household food security and crop diversification among small holder farmers in Guatemala, Institute of Nutrition of Central America and Panama (INCAP), USA.

Javeed-ul-Aziz (2010), "Economic History of Modern Kashmir with special reference to Agriculture (1947-1989"). Ph.D thesis, Post Graduate Department of History, University of Kashmir. Pp. 183-218.

Joshi M.V. (1999), "Green Revolution and its impacts". APH Publishing Company, New Delhi, Pp. 1-6.

Kalogirou S.(2002),"Experts systems and GIS: an application of land suitability evaluation Computer, Environment and Urban Systems, 26, P 89-112.

Kaur Inderpal and Sarbjit S. (2009), "WTO & Indian Agriculture- An empirical analysis". *Political economy journal of India*", July- Dec, 2009.

Khan, B.A (1981), "Economic Consequences of Land Reforms in the state of Jammu and Kashmir". Ph.D Thesis (Unpublished), Post Graduate Department of Economics, University of Kashmir, Pp. 111

Khan, A. R. (2001), "Jammu. Kashmir and Ladakh- A Geographical Study" Gulshan Publishers, Srinagar, Kashmir.

Koal, A. (2005), "Archeological remains in Kashmir" Gulshan Publishers, Srinagar.

Khan A.R et.al (2001), "Jammu and Kashmir, A Geographical study", Gulshan Publishers, Srinagar, pp.1-65

Khan A.R et.al (2001), "Jammu and Kashmir- A Geographical study". Gulshan Publishers, Srinagar, pp.1-65

Kothari, C.R. (2009). "Research Methodology: Methods and Techniques". New age international publishers, New Delhi

Kurosaki, T. (1999), "Agriculture in India and Pakistan, 1900-95: Productivity and Crop Mix", *Economic and Political Weekly*, Vol. 34, pp. A160-A168.

Kurosaki, T., and M. Fafchamps (2002), "Insurance Market Efficiency and Crop Choices in Pakistan", *Journal of Development Economics*, Vol. 67, pp. 419-453.

Lawrance, W.R. (1996), "The Valley of Kashmir" Navbharat Printing Press, Delhi.

Lawrence, R.W. (2006), "The Valley of Kashmir". Ali Mohammad and Sons, Srinagar, pp. 319-358.

Lovejoy, D. (1979), "Land use and Landscape Planning". Leonard hill, Glasgow, UK, pp. 91-102.

Maghimbi, S (2007), "Recent changes in cropping patterns in the Kilimanjaro region of Tanzania: The decline of coffee and the rise of maize and rice". *African Study Monographs*, Suppl. 35: Pp. 73-83, March 2007.

Mahesh, R. (1999), " Causes and Consequences of change in cropping pattern: A location specific study". Discussion paper No. 11, Kerela Research on local development, centre for development studies, thiruvananthapuram, Kerela India.

Manoj Panda and A. Ganesh-Kumar (2008), "Trade Liberalization, Poverty and Food Security in India", Indira Gandhi Institute of Development Research, General Arun Kumar Vaidya Marg Goregaon (E), Mumbai- 400065, INDIA June 2008. http://www.igidr.ac.in/pdf/publication/WP-2008-013.pdf

Mittal, S. and Sethi, D. (2009*),* "Food Security in South Asia: Issues and Opportunities", Indian Council for Research on International Economic Relations (ICRIER).

Misra, V.N. and M. Govind Rao (2003), "Trade Policy, Agricultural Growth and Rural Poor: Indian Experience, 1978-79 to 1999-2000", *Economic and Political Weekly*, Vol. 38, pp. 4588-4603. Mohan, C.P.(2009), "Cropping patterns and Diversification in India" cab.org.in

Mohan, C.P (2009), "Cropping patterns and Diversification in India". Department of Geography, Banaras Hindu University, U.P. India

Mohammad, N. (1981), "Perspectives in Agricultural Geography", Vol. V, Concept Publishing Company, New Delhi.

Moran W.B.,and Mounton R.J (1981), viewed in their book Agriculture geography, the relationship between agricultural activities and physical environment and the pattern of distribution.

Murtaza, Shahid E., Zaidi Tasawwur H. and Khan M. Firoz (2008), "Population Growth and Food and Food Security in the Valley of Kashmir (Jammu and Kashmir, India): A Regional Analysis", *Population Geography*, 30 (1 & 2), 2008: 27-44.

Mustafa, M. (2006), "Comparative Profitability of Agricultural and Non-Agricultural Operations in Kashmir Agriculture". Ph.D Thesis (Unpublished), Post Graduate Department of Economics, University of Kashmir. Pp. 281-295.

Nandy S. N., Pant, R. and Rao, K. S. (2001), "Indian Himalaya- A Demographic Database" G. B. Pant Institute of Himalayan Environment and Development.

National Commission on Agriculture (1971), "Delineation of Agricultural Regions Report", Ministry of Agriculture, New Delhi, 1971

Nigeen, F. (2005), "Returns on agricultural Investment in Kashmir". M.Phil Dissertation (Unpublished), Post Graduate Deptt. of Economics, University of Kashmir. Pp.27-99.

NMSA (National Meteorology Service Agency), (1996), "Climatic and Agro climatic Resources of Ethiopia". Vol.1, No.1. National Meteorology Service Agency of Ethiopia, Addis Ababa.137 pp.

Parry ML, Rosenzweig C, Iglesias A, Livermore M, Fischer G (2004), "Effects of climate Change on global food production under SRES emissions and socio-economic scenarios' Glob. Env.Change 14:53-67.

Qazi, S.A. (2005), "Systematic Geography of Jammu and Kashmir", APH Publishing Corporation, New Delhi-110002

Ramay, Shakeel Ahmed (2009), "Food Security in Afghanistan and Pakistan", Mimeo, ICRIER.

Rao, C.H.H. and Gulati, A. (2005), "Indian Agriculture: Emerging Perspectives and Policy Issues", in selected papers by C.H.H. Rao, Academic foundation, New Delhi.

Rai, M. (2004), "Hindu Rulers, Muslim Subjects-Islam, Rights and the History of Kashmir". Permanent Black Publications, New Delhi.

Raza, M., Ahmad, A. and Mohammad, A. 1978, "The Valley of Kashmir, Vol. 1, the Land". Vikas Publishing House, New Delhi.

Rahman,R and Saha,S.K, (2009), "Spatial dynamics of Cropland and Cropping Pattern change analysis using landsat TM and IRS P6 LISS satellite images with GIS: Geo-spatial information Science".Vol.12,No.2.

Raina, A.N (2002), "Geography of Jammu and Kashmir State", Radha Krishan Anand and Co. Pacca danga Road, Jammu. Pp. 3-9

Rao, D. & Shahid, P. (2005),"Dynamics of cropping pattern in Sorghum growing states of India". *Indian Journal of Agricultural Economics*". Oct. 2005.

Rashida, N. (2004), "Demand for food grains in Jammu and Kashmir State". M.Phil Dissertation, Department of Economics, University of Kashmir, pp.1-19, 70-77.

Ray & Kumar S. (2007), "Economics of change in cropping pattern in relation to credit: A micro- level study in West Bengal". *Indian Journal of Agricultural Economics,* April, 2007.

Rehana, R. (2008), "Economic evaluation of vegetable and paddy cultivation in J & K state: A Case Study of District Budgam". Ph.D Thesis (Unpublished), Post Graduate Department of Economics, University of Kashmir.

Rehman, S. (2008). "Food Security Scenario in J&K with particular reference to Kashmir: An Analysis". unpublished

Shafi, M. (2000), *"Agriculture Geography"* Dorling Kindersley India Ltd. pp. 99-107.

Sharma, R.R., Kaul, M.N (2005),"Agro-climatic zones of the Jammu Siwalik, Transactions of the Institute of Indian Geographers Volume 27, Issue 2, June 2005, Pages 31-43

Siddhartha, K. and Mukherjee. S. (2007), "A Modern Dictionary of Geography". Kisalaya Publications, Pvt. Ltd. Pp.117.

Sidhartha, K. (2008), "Economic Geography:Theories, Patterns and Processes". Kisalaya Publications, Pvt. Ltd. Pp.117.

Singh, R.B. ed. (1992), "Dynamics of Mountain Geo-systems", Ashish Publications, New Delhi.

Singh. S. (1984), "Technological Transformation in Agriculture". Arian Publishing House, New Delhi, pp. 9-27.

Sangwan, S.S (1985), "Dynamics of Cropping Pattern in Haryana: A supply Response Analysis". *The Developing Economics*, XXIII-2 (June, 1985).

Singh, R.B (1992), "Land use change, diversification of Agriculture and Agro forestry in Northwest India". Department of Geography, University of Delhi.

Singh, A.K. (2011), "Climate Resources for Agriculture", *ICAR*, New Delhi

Singh, I. and Gupta, N.S. (1979), "Community Development and Agricultural Growth in J&K state' Cited by Gupta, N.S. and Singh, A.J. "Agricultural Development of States in India". Vol.I, J&K, 1979, pp. 155-157.

Snodgrass, M.M. and Wallace, L.T (1982), "Agricultural economics and Resource management". Prentice hall of India, Pvt. Ltd, New Delhi. Pp. 504-507

Stamoulis, K. and Zezza, A. (2003): A Conceptual Framework for National Agricultural ,Rural Development, and Food Security Strategies and Policies. ESA Working Paper No. 3-17, Nov. 2003.Agricultural and Development Economics Div. FAO Rome.

Sue .W, Yohannes G, Eyesus. G, Kindie .T, Girma .M, Abebe. Y, Endalkachew .B. (2010). "The use of Agro climatic zones as a basis for tailored seasonal rainfall forecasts for the Cropping systems in the central rift valley of Ethiopia", University of the Free State Bloemfontein South Africa, Ethiopian Agricultural Research Org. Melkassa, Ethiopia, National Meteorological Service Agency, Ethiopia

Suryanarayana M.H and Silva D. (2008), "Poverty and Food Insecurity in India: A disaggregated Regional Profile", Indira Gandhi Instt. of Development Research (IGIDR) (IGIDR) General Arun Kumar Vaidya Marg Goregaon (E),Mumbai-400065, India INDIA. [2]*The estimates of poverty declined from 51.3 per cent in 1977/78 to 36 per cent in 1993/94 and 26.1per cent in 1999/2000 (GoI), 2004; p. 2004)*

Tak, G.M. (2008), "Agricultural Land is Vanishing, Production Decreasing*"* Greater Kashmir, Vol. 21, No. 156.

T. A. Butt , B. A. McCarl, J. Angerer, P. T. Dyke and J. W. Stuth (2005), "The economic and food security implications of climate change in Mali", *Journal of Climate Change*, Springer Netherlands Volume 68, Number 3 / Feb. 2005, pp.355-378

Tarrant, J.R. (1974), "Agriculture Geography". David and Charles Ltd. UK, pp.232-235.

Timmer, M.P., and A. Szirmai (2000), "Productivity Growth in Asian Manufacturing: The Structural Bonus Hypothesis Examined". *Structural Change and Economic Dynamics,* Vol. 11, pp. 371-392.

Todkari, S, et.al (2010), "Agriculture Land use Pattern in Sholapur District of Maharashtra *International Journal of Agriculture Sciences*, ISSN: 0975-3710, Vol. 2, 2010, pp.1-8.

Varsha V and Datye V.S. (1976), "Influence of some selected variables on the agricultural productivity of Maharastra".University of Maharashtra, India.

Verheye, W. H. (2010), "Agro-climate based land evaluation systems", *land use, land cover and soil sciences- Vol. II*, UNESCO, Belgium.

Viola, M., Najimi, F.K. & Bacon, B.(2007) , "Afghanistan Food Security Conditions and Causes", United States Agency for International Development Famine Early Warning Systems Network. (FEWS NET)

Von Braun, J. (2007), "The world food situation: New driving forces and required actions" International Food Policy Research Institute, Washington D.C., USA

Von Braun, J. (2007), "The world food Institution-New Driving Forces and Required actions. International Food Policy Research Institute, Washington D.C., USA.

Wadia, D. N. (1928), "Geology of Poonch and Adjoining Area" Mem. Geological Survey of India, 51: 1-3.

Wani, A.S et al (2002), "Compendium of SKUAST Research: 1987-97". Communication and Publication Center, SKUAST, Srinagar, 2002.

Wani, G.M. (2008), "Kashmir Centric Food Security Vision" http://www.articlesbase.com international-studies-articles/kashmir-centric-food-security-vision1683654.Wani,

M.H, Baba, S.H. and Yusuf,S. (2009), "Land use Dynamics in J&K". *Agricultural Economics Research Review*, Vol. 22, pp. 145-154

Wani N.A (2000), "Co-operative Credit and Agricultural Development in Jammu and Kashmir State". M.Phil Dissertation (Unpublished), Post Graduate Department of Economics, University of Kashmir. Pp.102-108.

World Food Summit (1996): Food Security Information for Action, Rome Italy.

World Food Programme (2008), "Food Security Overview,Where We Work- Afghanistan. http://www.wfp.org/country_brief/indexcountry.asp?country=004.

Zamir, S. R. (2005), "Agricultural Productivity and Ecological Imbalances in the valley of Kashmir". Unpublished.

Zamir, S. R. (2005), "Agricultural Productivity and Ecological Imbalances in the valley of Kashmir". Unpublished.

Zuo, H (1996), "Agro-climatic analysis for mainland Asia by a GIS approach. Ph. D thesis, Australian National University, Pp. 264

Zuo, H., M.F. Hutchinson, J.P. McMahon and H.A. Nix (1996a), "Developing a mean monthly climate database for China and South-east Asia. In: Booth, T.H. ed. *Matching trees and sites*, ACAIR Proceedings No. 63 Pp. 10-17

Zuo, H., J.P. McMohan, H.A. Nix, M.F. Hutchinson (1996b), "A GIS Based Agro-climatic Classification for mainland east Asia. In Proceedings of the second Australian Conference on Agricultural Metereology, The University of Queensland, 1-4 October, 1996. Pp.98-101.

Zutshi, B. (1996), "Society and Economy in Kashmir: Continuity and Change", *Journal of Peace Studies*, (3), 17:13-21,

Zutshi, B.(2001),"Gujjars and Bakerwals of Jammu and Kashmir -A Case Study of Rajouri District" in Warikoo, K.and K.Som (eds) "Gujjars of Jammu and Kashmir" HRCF and Indira Gandhi Rashtriya Sangrahalaya, Bhopal.

Dynamics of Cropping Land use Pattern and Status of Food Scenario in Jammu and Kashmir- A Spatio-temporal analysis

Department of Geography and Regional Development, University of Kashmir

Questionnaire / Schedule

1. Place of Respondent (Village/Town) ……..... 2. District ……

3. Demographic Profile

S.No	Relationship With Household Head	Sex M/F	Age	Marital Status	Education	Occupation	Income (INR)
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
	Total						

4. Total agricultural land (in kanals) ……

5. Net sown area (in kanals) …… Area sown more than once …….....

6. Irrigated area (in kanals) …… Un-irrigated area (in kanals) ……

7. How many family members are engaged with agriculture ……

8. Area under different crops (in kanals)

Paddy	Maize	Wheat	Oilseeds	Orchards	Vegetables	Fallow Land	Land put to Non-agricultural use

9. Agricultural productivity (Quintals / kanal)

……

10. Surplus production (in Quintals) -- Crop wise

……

……

11. Do you export any agricultural commodity/product, if yes how much --- Crop wise

……

……

15. Total revenue generated from agricultural products annually (in INR)

……

16. Do you import food items? Yes / No, if yes how much (Item wise)

……

……

17. Total money spent on food imports annually (in INR)

……

16. Do you have changed agricultural land to horticulture or other crops or development projects, Yes / No, if yes how much

……

17. Reasons for conversion of agricultural land to horticulture or cash crops

(a) Economic Factors

1. Economic returns 2. Diverse market facilities 3. Availability of agricultural products at reasonable cost 5. Easy advance borrowings

(b) Geographical & Environmental Factors

1. Climate 2. Soil 3. Physiography/ Terrain

(c) Institutional & Infrastructural Factors

1. Lack of Irrigation 2. Lack of transport facilities 3. Lack of storage facilities

4. Lack of Credit facilities 5. Land holding size 6. Developmental projects

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RESEARCH ARTICLE

SPATIAL ANALYSIS OF CROPPING LAND USE DYNAMICS IN JAMMU AND KASHMIR-A DISTRICT LEVEL STUDY

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ABSTRACT

The present paper attempted to assess the spatial cropping land use change in Jammu and Kashmir. Cropping land use is a dynamic process and it keeps on changing with the change in economic returns, agro-climatic conditions, farm programmes, conservation strategies and environmental regulations. The state of Jammu and Kashmir experienced a change in the cropping land use though with varying degree of intensity across its spatial units (*districts*). The analysis of the data reveals that net sown area has increased by 3.36 percent though it increased more in Jammu district (19.73 percent), but it decreased in Srinagar, Budgam and Pulwama. The area under paddy has recorded a negative growth in all the districts with the state average of -29.92 percent decreases from 1980 to 2008. The highest decrease has been observed in Srinagar district (-48.95 percent) followed by Udhampur (-46.64 percent). The area under maize crop registered a net decrease from 229925 ha in 1980 to 198464 ha in 2008 (-13.68 percent). At district level, the highest decrease is found in Rajouri and Udhampur (-28.78 percent), while as area under maize increased in Budgam, Baramulla and Kupwara districts. Wheat also registered a negative growth of -21.47 percent in its area during these twenty eight years with highest decrease in Udhampur district (-43.46 percent). The area under orchards has increased in all the districts of the state though maximum increase has been experienced by Kashmir valley than Jammu and Ladakh provinces of the state.

INTRODUCTION

Land use is the human use of land and it involves the management and modification of natural environment into built environment such as fields, pastures, and settlements (FAO, 1997a; FAO/UNEP, 1999). Land use is a synthesis of physical, chemical and biological systems and processes on the one hand and human/societal processes and behavior on the other. The monitoring of such systems includes the diagnosis and prognosis of land use changes in a holistic manner at various levels (Singh, 1992). One of the first land use patterns that geographers studied is the pattern of crops across an agricultural landscape. Different crops represent different agricultural land uses (Bednarz, 2005). Cropping pattern refers to the proportion of the area under different crops at a point of time. It also reveals the rotation of crops and the area under double cropping etc. in any state or country (Siddhartha and Mukherjee, 2007). Cropping land-use is a highly dynamic process and the farmer's choice of cropping pattern is determined by various factors, viz; *physical factors* such as soil, climate, *technological factors* like irrigation, improved varieties of seeds, availability of fertilizers and plant protection chemicals; *Institutional factors* like land reform, consolidation of holdings, credit facilities, price structure, procurement policies and storage facilities and other factors like the rate of return, agro-climatic conditions, farm programmes, conservation programmes, and environmental regulations (Duffy, 1996; Shafi, 2000; Das, 2004; Adihikari *et al.*, 2005). These factors are not watertight but inter-related. For instance, the adoption of crop technologies is influenced not only by resource related factors but also by institutional and infrastructural factors. Economic factors play a relatively stronger role in influencing the crop pattern in areas with a better irrigation and infrastructure potential. In such areas, commercialization and market networks co-evolve to make the farmers more dynamic and highly responsive to economic impulses (Bhalla and Singh, 2001). The cropping system of any locality is the cumulative results of the past and present decisions by individuals, communities or governments and it keeps on changing in consonance with change in prices of goods, Govt. policies and other related factors (Gupta & Singh, 1979). The interacting driving forces of population increase, income growth, urbanization and globalization on food production, markets and consumption have changed food and agricultural system worldwide (Braun, 2007). The relative importance of crops, crop yields and farm size leads to change in cropping pattern of an area. The introduction of new agricultural technology especially during the period of green revolution in the late sixties and early seventies resulted in wide spread change in cropping land use pattern in India especially from cereals to non-cereals (Hazra, 2006). Agriculture is the main occupation for the people of Jammu & Kashmir. About 65 percent of the people are directly or indirectly dependent on agriculture and allied activities for their livelihood. Agriculture and its allied activities are the predominant sector of the economy of Jammu and Kashmir and this sector contributed more than 31.29 per cent of Gross Domestic Production (GDP) in 2007 (Digest of Statistics, 2007-08). The cropping land use in the state also underwent drastic changes

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which led to the decrease in area under food crops and increase in area under cash crops/plantation agriculture. The study of this shifting land use was necessary for the sustainable agriculture of the state. Knowledge of cropping land use helps in maximization of productivity and conservation of land (ICAR, 1980). The spatio-temporal change in the area under different food crops (*Paddy, Wheat, and Maize*) and area under orchards etc. in the study area from the year 1980 to 2008 is presented in detail below.

Study Area

The state of Jammu and Kashmir constitutes northern most extremity of India and is situated between 32° 17′ to 36° 58′ N latitude and 73° 26′ to 80° 30′ E longitude. It falls in the great northwestern complex of the Himalayan Ranges with marked relief variation, snow-capped summits, antecedent drainage, complex geological structure and rich flora and fauna (Raina, 2002). The state is 640 km in length from north to south and 480 km from east to west. It consists of the territories of Jammu, Kashmir, Ladakh and Gilgit and is divided among three Asian sovereign states of India, Pakistan and China. The total area of the State is 2, 22, 236 km^2 comprising 6.93 per cent of the total area of the Indian territory including 78,114 km^2 under the occupation of Pakistan and 42,685 km^2 under China (Qazi, 2005).

MATERIALS AND METHODS

Materials

- The Survey of India toposheets (1971) on scale 1:50,000 were used to generate a base map of the study area.
- Cropping land use data of different crops has been obtained from Financial Commissioner's office, Srinagar/ Directorate of agriculture, Jammu and Srinagar.

Methodology

For depicting the spatio-temporal change in the cropping land use, the data sets generated were analysed. The temporal change has been calculated by using the following formula;

Change $(V_1) = \frac{St1-St2}{St1} \times 100$ (Kothari, 2009)

Where, V_1 *= Change in any variable,* St_1*= Status at time* t_1*,* St_2 *= Status at time* t_2

The results were then depicted by graphical representation method. Moreover, the data was subjected to GIS treatment to show clearly the spatial variation in the cropping land use across the state. The flow chart of the methodology adopted is given below (Fig. 1).

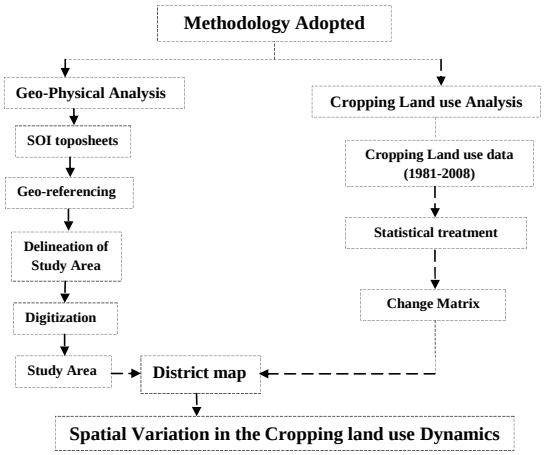

Fig. 1

RESULTS AND DISCUSSION

(I) Net Sown Area

Net sown area refers to the total area sown in an agricultural year. In the study area the average net sown area has increased from 7.05 percent of the total geographical area in 1980 to 7.29 percent in 2008, though with spatial variations across the districts (Table 1). The net sown area has increased overall in the state by 3.36 percent (715306 ha in 1980 to 739319 ha in 2008). It has increased fairly well in the districts of Jammu province except Kathua district (-3.56 percent), while as it has decreased in three out of six districts in Kashmir province. The net sown area increased in Jammu province on account of efficient land reclamation and increased use of technology, while as same process could not be repeated in Kashmir valley at that scale because of paucity of land which could be brought under cultivation. In the two districts of Ladakh namely Leh and Kargil, the net sown area has increased as firstly ample land is available for purposes other than agriculture and secondly efforts are put to bring more land under cultivation.

Table 1 Net Sown Area in Jammu and Kashmir (1980-81 to 2008-09)

	Net sown area (in hectares)							
District	**1980-81**	**1985-86**	**1990-91**	**1995-96**	**2000-01**	**2005-06**	**2008-09**	**Change (%)**
Srinagar	26843	23577	23089	23481	23615	21893	18755	-30.13
Budgam	53693	54915	51800	53558	53102	49576	42755	-20.37
Baramulla	88498	90463	88567	88207	84148	86236	89511	1.14
Kupwara	45023	43951	45057	45120	44728	47053	45651	1.39
Pulwama	56667	54398	54011	54331	54525	53229	51623	-8.90
Anantnag	74160	73629	79471	79201	79256	73235	78297	5.58
Jammu	95166	109872	107546	105466	110754	105201	113941	19.73
Kathua	63350	62770	57873	58405	63891	61540	61096	-3.56
Doda	56568	59679	58116	60570	63922	62220	66252	17.12
Poonch	25920	26997	28178	27800	27807	27498	27650	6.67
Rajouri	46505	47802	48424	49822	51951	53063	54084	16.30
Udhampur	64710	65601	69758	69303	70736	72994	69632	7.61
Leh	9636	9746	9875	9938	10052	10187	10196	5.81
Kargil	8567	8852	8947	8786	9544	9762	9876	15.28
Total	715306	732252	730712	733988	748031	733687	739319	3.36
PGA	7.05	7.22	7.20	7.24	7.37	7.23	7.29	

Source: Financial Commissioner's Office, Srinagar/Jammu, 2011, "PGA" means percentage to total geographic area

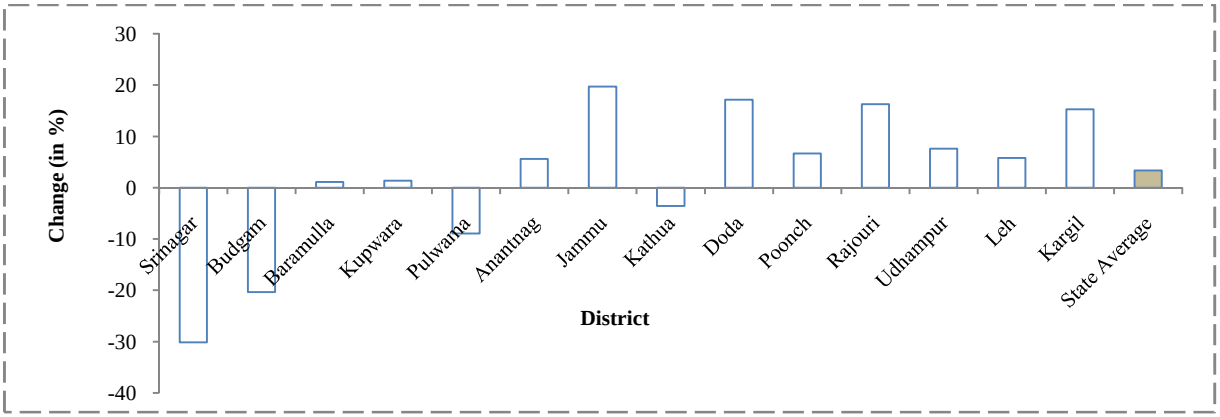

Fig. 2

Srinagar district lost the maximum net sown area (8088 ha) on account of developmental activities and urbanization, while as district Jammu has received considerable increase in it (95166 to 113941ha) on account of efficient land reclamation and enhanced irrigation facilities. Four districts (Srinagar, Budgam, Pulwama and Kathua) have received negative growth in the net sown area. The highest increase in net sown area is recorded by Jammu, Doda, Rajouri and Kargil, while as least increase is evident from Kupwara and Baramulla districts (Fig. 2).

(II) Area under paddy

Paddy is one of the dominant crops grown in the state of Jammu and Kashmir as it staple food of more than sixty percent of the population of the state. It is a tropical crop and requires high temperature and moisture conditions (24°C to 35°C and 150-250cm). Paddy cultivation is an age old practice in the state, but with changing times the area under this crop has decreased in all the districts (Table 2).

Kashmir province has lost 34.66 percent of the area under this crop, while as Jammu province has recorded 21.96 percent decline. Table 2 depicts that Srinagar and Udhampur district lost maximum area under paddy during these twenty eight years (48.95 and 46.64 percent respectively), while as Jammu district has lost the least area (13.30 percent). The cultivation of this crop is not possible in Ladakh division of the state because of the very cold climate and short growing season. On an average in absolute values the state has lost 82321 hectares of land under paddy cultivation. In the state almost one third of the land under paddy (-29.92 percent) has lost during these twenty eight years though with regional variations. The maximum land loss under this crop is observed in district Srinagar (-48.95 percent) followed by Udhampur (-46.64 percent), Pulwama (-44.88 percent) and Budgam (-41.60 percent), while as least loss is recorded in district Jammu (-13.30 percent) and Doda (-15.35 percent). Four out of the twelve districts have recorded higher decrease than state average (Fig. 3).

Table 2 Area under paddy in Jammu and Kashmir (1980-81 to 2008-09)

	Area under paddy (in hectares)							
District	**1980-81**	**1985-86**	**1990-91**	**1995-96**	**2000-01**	**2005-06**	**2008-09**	**Change (%)**
Srinagar	18648	16278	15772	13744	12022	11736	9519	-48.95
Budgam	32857	32093	30593	28287	25907	22176	19188	-41.60
Baramulla	39704	36494	35683	34511	30176	29918	27924	-29.67
Kupwara	18363	18029	16583	16528	15015	14467	14012	-23.69
Pulwama	30774	28623	27854	26363	23330	22864	16964	-44.88
Anantnag	48860	47993	46877	45856	43575	40927	36026	-26.27
Jammu	48218	48106	47590	46359	46205	43195	41807	-13.30
Kathua	17314	15721	15428	14142	14908	14063	13402	-22.59
Doda	4327	3984	4394	4104	3803	3781	3663	-15.35
Poonch	3650	3497	3256	3267	3187	2884	2640	-27.67
Rajouri	4623	4580	4482	4141	4020	3748	3503	-24.23
Udhampur	7785	5636	5321	5040	4711	4590	4154	-46.64
Leh	-	-	-	-	-	-	-	-
Kargil	-	-	-	-	-	-	-	-
Average	275123	261034	253833	242342	226859	214349	192802	- 29.92

Source: Financial Commissioner's Office, Srinagar/Jammu, 2011

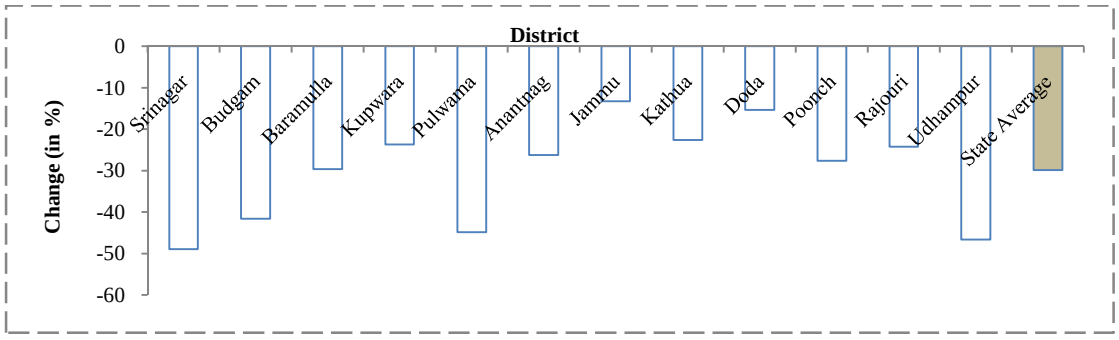

Fig. 3

(III) Area under Maize

Maize is also one of the prime crops grown in the state of Jammu and Kashmir as it is staple food of the Gujjars and Bakerwlas living in and around the pir panjal range consisting of more than ten to fifteen percent of the population of the state. It is a coarse grain and requires moderate temperature and less water (10°C to 25°C and 50-120 cm). Though maize is cultivated in all the districts of the state, but it is a dominant crop in the hilly districts having more low lying mountainous area (*kandi belt*) than the districts which have relatively more plain area as is highlighted in the Table 3.

Table 3 Area under maize in Jammu and Kashmir (1980-81 to 2008-09)

	Area under maize (in hectares)							
District	**1980-81**	**1985-86**	**1990-91**	**1995-96**	**2000-01**	**2005-06**	**2008-09**	**Change (%)**
Srinagar	4336	4291	3981	3808	3770	3842	4137	-4.59
Budgam	7895	7252	8203	8491	8156	8773	9182	+16.30
Baramulla	21353	25007	24054	25205	25321	22204	23666	+10.83
Kupwara	23290	24306	24607	24560	25175	27777	25114	+7.83
Pulwama	4578	4695	4481	4377	4311	4293	4146	-9.44
Anantnag	14036	14021	13920	13840	13580	13340	13121	-6.52
Jammu	12890	12670	13728	14630	14250	14340	11086	-14.00
Kathua	18525	17830	16650	16400	15605	14670	13802	-25.50
Doda	25233	24726	24090	23580	23100	22060	21327	-15.48
Poonch	21063	19555	19200	19565	20063	20412	18238	-13.41
Rajouri	40980	38915	37880	35600	34200	31600	29185	-28.78
Udhampur	35746	33057	31685	31280	30010	27270	25460	-28.78
Leh	-	-	-	-	-	-	-	-
Kargil	-	-	-	-	-	-	-	-
Total	229925	226325	222479	221336	217541	210581	198464	-13.68

Source: Financial Commissioner's Office, Srinagar/Jammu, 2011

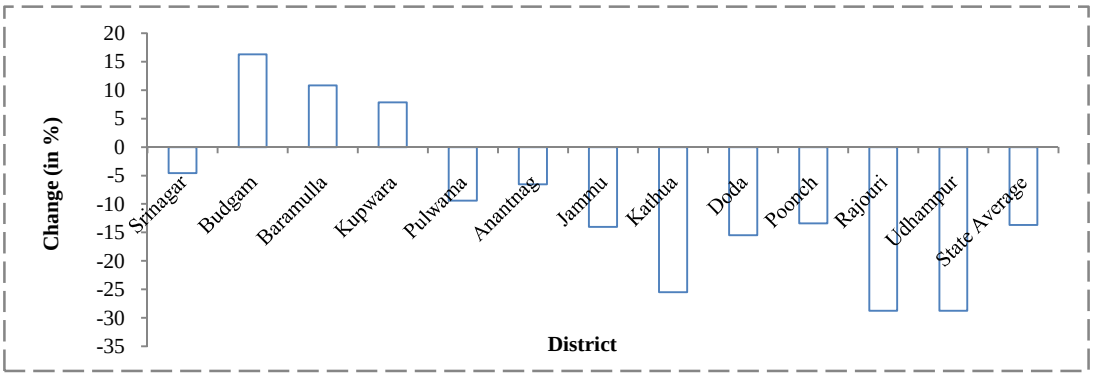

Fig. 4

The area under maize has overall increased in Kashmir province by 5.14 percent though it decreased in three of its districts namely Pulwama, Anantnag, and Srinagar by 9.44, 6.52 and 4.59 percent respectively. Jammu province has recorded a decline in the area under this crop by 22.88 percent, the maximum decline is observed in Rajouri and Udhampur (28.70 percent each) and minimum in Poonch (13.41 percent). In absolute terms, the area under this crop has increased by 3878 hectares in Kashmir Province, while as in Jammu province it has decreased by 35339 hectares. The crop is not cultivated in Ladakh division because of the unfavourable geographical conditions. The crop has witnessed a decrease in its area at state level (-13.68 percent) though there has been increase in its area in three districts namely Budgam (16.30 percent), Baramulla (10.83 percent) and Kupwara (7.83 percent). Highest decrease is observed in district Udhampur and Rajouri (-28.78 percent each) and Kathua (-25.50 percent), while as lowest decrease is evident from district Srinagar (-4.59 percent). All the districts of Jammu province have recorded a negative growth in the area under maize cultivation (Fig. 4).

(IV) Area under wheat

Wheat is also one of the important crops grown in the state of Jammu and Kashmir as it is staple food for the people of Jammu and Ladakh province consisting of more than fourty percent of the population of the state. This is a rabi crop in the state; i.e. it is grown in October-November and harvested in March-April and requires moderate temperature and less water (15^0C to 25^0C and 50-120cm).

This crop is mainly cultivated in Jammu and Ladakh division and less area is under this crop in the districts of Kashmir division (Table 4). In Kashmir valley wheat is grown in upper reaches and not in plain areas. In absolute terms, the area under this crop has decreased by 23423 hectares in the state though it increased by 502 hectares in Kashmir province. In Jammu province it has decreased by 24267 hectares and in the two districts of Ladakh, the area under this crop has increased by 342 hectares. The maximum area under wheat is in Jammu district (31564 ha), followed by Kathua (16023 ha), while as very least area under it is in Srinagar district (5 ha). The overall growth of the crop shows a declining trend. The area under this crop has decreased at state level by 21.47 percent. In Kashmir province, it has overall increased by 9.74 percent though it decreased in two of its districts (Srinagar and Anantnag); while as in Jammu province the crop has recorded a decline by 24.36 percent. The maximum decline in Jammu province is observed in Udhampur district (43.46 percent) followed by Kathua (-29.28 percent) and minimum in Jammu district (15.50 percent) [Fig. 5].

(VIII) Area under orchards

Orchard cultivation or horticulture is an old economic activity of people of the state especially Kashmir. Kalhana, the great Kashmiri historian mentioned fruit culture in Kashmir in his famous book *'Rajtarangini'* during the reign of king Nara as back as 1000 B.C. It was however, during the period of Lalitaditya (900 A.D) that horticulture in the state received considerable patronage. The valley of Kashmir, parts of Doda, Kathua, Udhampur, Rajouri and Poonch district fall in temperate zone which is conducive for the cultivation of fruits, thus occupying substantial area under orchards (Table 5).

not occupy substantial area in districts of Jammu division, therefore for the respective divisions, they have not been taken into account for analysis. The percent change in different crops grown in the state has been calculated (Table 6). The percent change in different crops grown in the state has been subjected to ranking method. The first rank was given to the district which showed highest decrease or increase in the cropping land use under any crop taken for the study and last rank or highest value was assigned to the district with lowest change in area under different crops.

Table 4 Area under wheat in Jammu and Kashmir (1980-81 to 2008-09)

	Area under wheat (in hectares)							
District	**1980-81**	**1985-86**	**1990-91**	**1995-96**	**2000-01**	**2005-06**	**2008-09**	**Change (%)**
Srinagar	18	18	6	12	14	10	5	-72.22
Budgam	1890	1865	1980	2342	2200	2300	2065	9.26
Baramulla	1616	1224	1112	2156	2400	2000	1830	13.24
Kupwara	1421	1421	1410	1420	1530	1506	1530	7.67
Pulwama	92	109	110	140	130	150	166	80.43
Anantnag	117	107	109	60	40	56	60	-48.72
Jammu	37353	36591	36296	35686	37794	35337	31564	-15.50
Kathua	22657	19358	19516	18039	17509	17149	16023	-29.28
Doda	9614	9400	9010	8100	7840	7570	7339	-23.66
Poonch	10550	9870	9660	9600	9580	9050	8820	-16.40
Rajouri	882	1290	1191	1010	1171	1015	1096	24.26
Udhampur	18530	15460	14723	14950	13724	12250	10477	-43.46
Leh	2427	2288	2380	2399	2550	2482	2464	1.52
Kargil	1946	2147	2218	2372	2053	2172	2251	15.67
Total	109113	101148	99721	98286	98535	93047	85690	-21.47

Source: Financial Commissioner's Office, Srinagar/Jammu, 2011

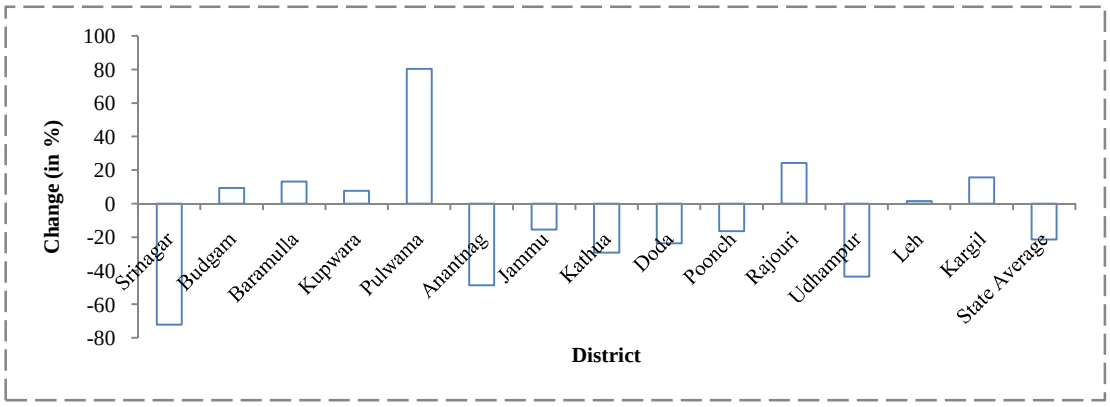

Fig. 5

The area under orchards has increased in all the districts of the state from the year 1980 to 2008. The maximum area has increased in district Pulwama (16482 hectares), while as in district Poonch very least area has been brought under orchard cultivation (74 hectares in 28 years). Though maximum area in absolute values has increased in districts of Kashmir valley (22469 hectares), but the intensity of expansion during the time period is observed highest in Pulwama (1533.21 percent) followed by Rajouri (735.29), Leh (416.66) and Poonch (389.47) and is much higher than the state average of 176.39 percent. The districts with least intensity of expansion are; Baramulla, Jammu, Kupwara and Anantnag.

Spatial Variation in the Cropping Land Use Dynamics

The cropping land use has not changed uniformly in the state but exhibit greater variations. In order to quantify the spatial variation in the cropping land use, four variables have been taken for analysis, *viz*, area under paddy, wheat, rice and orchards. Since wheat occupies miniscule area in Kashmir valley and orchards do

The ranks of all the crops have been added to get composite index and finally a choropleth map has been prepared to highlight the spatial variation in the cropping land use of the state (Fig.6).

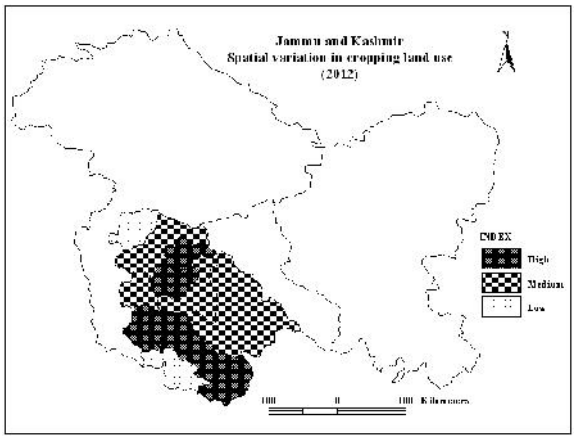

Fig. 6

Table 5 Area under orchards in Jammu and Kashmir (1980-81 to 2008-09)

District	Area under orchards (in hectares)							
	1980-81	1985-86	1990-91	1995-96	2000-01	2005-06	2008-09	Change (%)
Srinagar	1686	3600	3049	2267	3132	3048	3487	106.82
Budgam	1869	1886	1651	2267	1929	1954	2891	54.68
Baramulla	2602	2920	2454	2418	2372	2989	3050	17.22
Kupwara	753	1014	938	967	1195	841	1122	49.00
Pulwama	1075	3800	4147	4479	5899	11777	17557	1533.21
Anantnag	3632	3858	3333	4207	4460	4857	5979	64.62
Jammu	1553	1609	1732	1877	1612	1765	1934	24.53
Kathua	106	112	243	294	290	360	425	300.94
Doda	104	186	154	191	196	278	290	178.85
Poonch	19	18	27	43	45	72	93	389.47
Rajouri	17	56	61	74	90	194	242	735.29
Udhampur	37	48	151	131	155	168	172	364.86
Leh	73	245	266	335	338	346	377	416.44
Kargil	146	194	167	204	219	239	269	84.25
Total	13672	19546	18373	19754	21932	28788	37788	176.39

Source: Directorate of Horticulture, Srinagar/Financial Commissioner's Office, Srinagar/Jammu, 2011

Table 6 Percent change in area under different crops from 1980-2008 CE

District	Change in area under crops (in percent)				Ranking				C.I
	Rice	Maize	Wheat	Orchards	Rice	Maize	Wheat	Orchards	
Srinagar	-48.95	-4.59	-	106.82	1	11	-	2	14
Budgam	-41.6	16.3	-	54.68	4	3	-	4	11
Baramulla	-29.67	10.83	-	17.22	5	7	-	7	19
Kupwara	-23.69	7.83	-	49	9	9	-	5	23
Pulwama	-44.88	-9.44	-	1533.21	3	8	-	1	12
Anantnag	-26.27	-6.52	-	64.62	7	10	-	3	20
Jammu	-13.3	-14	-15.5	24.53	12	5	6	6	29
Kathua	-22.59	-25.5	-29.28	-	10	2	2	-	14
Doda	-15.35	-15.48	-23.66	-	11	4	4	-	19
Poonch	-27.67	-13.41	-16.4	-	6	6	5	-	17
Rajouri	-24.23	-28.78	24.26	-	8	1	3	-	12
Udhampur	-46.64	-28.78	-43.46	-	2	1	1	-	4
Leh	-	-	-	-	-	-	-	-	-
Kargil	-	-	-	-	-	-	-	-	-

Source: compiled from table 2,3,4 and 5; **C. I** means '**Composite Index'**

CONCLUSION

The analysis and interpretation of the data revealed that on an average, net sown area has slightly increased in the state of Jammu and Kashmir on account of reclamation of waste and barren lands. The net sown area has decreased in some districts because of urban expansion and developmental activities. The area under the three major food crops grown in the state (*Paddy, Maize and wheat*) has decreased at state level though with regional variations, it has increased in some districts as well. But the area under paddy recorded a decline in all the districts and the area under orchards has registered a high positive growth in all the districts. This increase is largely explained by the shifting of cropping land use from food crops to plantation agriculture (orchard cultivation).

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References

Adhikari B., Bag M. K., Bhowmick M. K and Kundu, C. 2005. Status Paper on Rice in West Bengal. Rice Research Station, Govt. of West Bengal Chinsurah – 712102.

Bednarz, R. 2005. Understanding land use patterns. A & M, University College station, Texas USA.

Duffy, M. 1996. Factors affecting cropping pattern. Department of Economics, Iowa State University, 560 Heady Hall Ames, Iowa 50011.

Das, P. 2004. Cropping Pattern (Agricultural and horticultural) in different zones, their average yields in comparison to National average/ Critical Gaps/ Reasons Identified and Yield Potential, ICAR, New Delhi.

FAO 1997 - The World Food Summit and its Follow Up*; http://*www.fao.org

FAO 1999. Agro-ecological Zoning Guidelines. *FAO Soils Bulletin 73*, Rome. Pp. 78 Govt. of J&K. 2007. Economic Survey Report.

Directorate of Economics and Statistics, Planning and Development Department, Srinagar. Pp73-100 Govt of India. 1980. Indian Council of Agricultural Research (ICAR). New Delhi

Hazra, C.R. 2006. Crop Diversification in India. http://www.fao. org/docrep/003x6906 /x6906e06.htm. Unpublished

Kothari, C.R. 2009. Research Methodology: Methods and Techniques. New age international publishers, New Delhi

Qazi, S.A. 2005. Systematic Geography of Jammu and Kashmir. APH Publishing Corporation, New Delhi-110002

Raina, A.N. 2002. Geography of Jammu and Kashmir State. Radha Krishan Anand and Co. Pacca danga Road, Jammu. Pp. 3-9

Shafi, M. 2000. Agriculture Geography. Dorling Kindersley India Ltd. pp. 99-107.

Siddhartha, K. and Mukherjee. S. 2007. A Modern Dictionary of Geography. Kisalaya Publications, Pvt. Ltd. Pp.117.

Singh, R.B. ed. 1992. Dynamics of Mountain Geo-systems. Ashish Publications, New Delhi.

Von Braun, J. 2007. The world food situation: New driving forces and required actions.International Food Policy Research Institute, Washington D.C., USA

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