PART - I

CONCEPTS AND APPROACHES IN AGRICULTURAL GEOGRAPHY
CHAPTER 1

CONCEPTS AND APPROACHES IN AGRICULTURAL GEOGRAPHY:

Geography as a discipline draws its subject matter both from the physical as well as social sciences. Geographers with their usual training and background do cover in their fold the multidimensional facets of the ever-widening and inter-disciplinary field of agriculture. Agriculture falls within geographic studies not only because of its structural and spatial characteristics but also with its taxonomic character. These have attracted attention particularly when the tools and technologies have been sharpened recently. Like any other specialists, geographers are also much interested in studying various aspects of agriculture at macro, meso and micro levels. Over the last few decades, agricultural geography like any other specialised branch of geography has quite apparently acquired a stable position and has also attracted numerous geographers. The specialists have gradually developed the subject matter of agricultural geography more and more with the help of sophisticated and dependable tools of investigation and analysis.
Agriculture as a branch of economic geography has its emphasis on the spatial pattern of agricultural activities as well as on the nature of relationships between agricultural activities and biological, economic and cultural elements that influence those activities. In fact, these relationships are very complex in nature. Agricultural pursuit as a way of living, as the low source of human energy invites geographers to keep it in the forefront of geographical research. Now, the field of geography is changing from the inventory, narrative and descriptive to an analytical, quantitative, interdisciplinary and predictive science of any item distributed over the surface of the earth. Thus, agricultural geography has also changed from the inventory to a predictive science of crops and livestock and forecast about their trend.

Etymologically agricultural geography means the art of cultivation of soil with reference to natural environment and human circumstances. Since agriculture is one of the primary economic activities, the study and relationship of agriculture with its environment may well deserve the title 'Geoagerculture'. As a science agricultural geography is concerned with the formulation and testing of hypothesis, interpretation of spatial
distribution and location of various characteristics of agricultural activities on the surface of the earth and measurement of geographic relationships. Further as a science it also seeks to identify, describe and clarify the problems of agriculture against the geographic background.

Nature and Scope of the Subject:

The welfare of the human society depends upon the agricultural potentialities of a region. The growth of this aspect brings economic prosperity through better agricultural production, planned industrial location, population concentration and developed communications. Thus, one cannot think of any progress without improving the conditions of the people, agricultural land use and industries which are of immense value in any scheme of regional development and planning. Agriculture includes land devoted to the production of cultivated plants, crops and rearing of livestock. However, some writers restrict the term agriculture to the growing of crops alone. As such the scope of agricultural geography includes regional agricultural analysis, food and commercial crops, agricultural problems and planning, the ownership of agricultural land, agroclimatology,
A synoptic View of the Systematic Interrelationships Among Agricultural Disciplines vis-a-vis Agricultural Geography
classification of agriculture region, land conservation, crop combination, crop diversification, crop concentration, agricultural productivity and efficiency, levels of agricultural development and ultimately supply of food in relation to population growth (refer to "Model of Synoptic view of systematic inter-relationship between allied sciences").

The concept of agricultural geography is generally based on the following ideas of agricultural economies:

1) The use of resources of environment, space, time, energy, property, goods, techniques and information,

2) The choice of alternative enterprises, farming systems and methods of agricultural practices, transport network and market behaviour of agricultural goods,

3) The scarcity of land resource or agricultural commodity on a particular space and time which provides an opportunity for an individual farmer to make the best use of what he has,
4) The exchange of agricultural goods and landed property rights which play an important role in subsistence agricultural economy,

5) Improving the quality of agricultural land.

With the help of these ideas agricultural geographers are studying on two levels: (1) They have been interested in the roads, barren fields, soil characteristics, farms, availability of water, fertilizer, irrigation, cultivation and production of individual crop, marketing of agricultural goods and livestock rearing. (2) Geographers have been concerned with the functional relationships of these structures that give rise to the complex and dynamic character in agricultural practices. Under these two levels of agricultural studies, the principles of agricultural geography are:

1) Principles of comparative advantage,
2) Law of diminishing returns,
3) Principles of economic rent,
4) Minimisation of effort and input,
5) Maximisation of production,
6) Optimisation of crops and protective space,
7) Optimisation of the quality of produce in relation to environmental factors and demand,
8) Principles of agricultural typology.

The Aims and Objectives of the Dynamics of Agricultural Geography:

1) to know how different kinds of agricultural systems are distributed over a region and how they function with spatial arrangement,
2) to understand how particular types of agriculture have developed in a particular area and how they are similar or dissimilar to farming in other areas,
3) to analyse different systems of farming and their operations and also to know the changes that they undergo,
4) to highlight the volume and direction of the changes in agriculture of a region,
5) to demarcate the crop regions with reference to crop production and combination or the system of agricultural enterprise,
6) to measure and examine the causes for the levels of agricultural development and the disparities,
The three sets of relations in agricultural geography which are given more attention in the study are:

1) Between the physical environments and agricultural operations, as physical environments exert their influences upon agricultural operations.

2) Between socio-economic and agricultural space, as socio-economic factors affect the intensity of land use, choice of cropping, farming methods, relationship between cropping and livestock raising, etc.

3) An ensemble of historical relationships to find out the causes of stagnation in agriculture in the past. These would assess the degree of change from subsistence to commercial type of farming.

One of the biggest established themes in agricultural geography is the study and analysis of agricultural regions.
In this regard the work of Whittlesey (1930) is well known. Among the various fields of geography, economic geography, perhaps, more than any other, has experienced and undergone a remarkable change within the past 30 years. "Geography was tended in the past to be the descriptive rather than analytical". Today agriculturists and agronomists are increasingly concerned with the worldwide distribution of crops, animals, types of rural economy and the problems associated with them. Gregor opines that it was only at the end of the eighteenth century that geographic literature on agriculture began to be seen. In the same period Arthur Young of England and J.N. Schwerz of Germany also thought on the same lines as Gregor contributed significantly to the literature on agriculture. Gregor calls it as old subject and Young field. Combining of crops and other parts of areal agricultural complex is reflected by the use of the word "Painting" by Alexander Von Humboldt.

in 1807 refers to the 'Natural Paintings' of tropical lands. Serious discussions on the nature of agricultural geography were to await the present century and heralded by Krzymowski's article on the "Scientific position of agricultural geography" in 1911. By 1933, agricultural geographic writings had increased to the point of encouraging Leo Waibel to become the first geographer to devote methodological work to the "problems of agricultural geography". T.H. Engelbrecht (1883) and a host of other young geographers from the U.S.A. and north-western European countries have contributed substantially to the themes of agricultural geography. J.H. Von Thunen's (1826) work of isolated farm which was an agricultural location theory was published in German in 1926 but it was not available to the English speaking world till 1960. The works of other distinguished

Geographers like O. Jonasson (1925), O. E. Baker (1926), L. D. Stamp (1931), D. Wittlessey (1936), J. C. Weaver (1954), J. W. Birch, J. W. (1954), Evans, E. E. (1962), Chisholm, M. (1962), Coppock, J. T. (1964), Kostrowiki (1965), and many others have given dimensions to agricultural geography. In addition to these geographers, the following other geographers have also contributed:

much towards the development of agricultural geography:

Hettner, A. (1905), Schluter, O. (1906), Bernhard, H. (1915), Buchanan, R.O. (1935), Cholley, A. (1946), Harvey, D.W. (1966), and Reeds, L.G. (1972). They have not only covered the thematic aspects but also the various salient features of the subject ranging from concept, definition and methodology to the behavioural system and type of general pattern of distribution from macro to micro scales and from hunting to well developed agricultural economy.

Agriculture in India is an age old occupation and followed as an ancient culture. Though it is basic occupation of more than seventy per cent of the working population of the country, it has been continued in its old traditional form except by a few enlightened farmers and in the irrigated tracts. After the independence of the country in 1947, national development through Five Year Plans launched agricultural development. But the effects were not felt till 1960. Only after 1960 did the country realise that it could get away from the traditional way of agriculture. It was also realised that economic development is not possible unless there is agricultural development. Hence, new scientific and technological methods and also mechanisation (wherever possible) began to be applied in agricultural operations. The Green Revolution in the late 1970s through high yielding varieties of seeds enforced the development of agriculture in India. "Agriculture has an important role to play in the present stage of the development of economy in India. Though its performance has set a stride in the growth of the economy as a whole, the
agricultural sector has been much below its potentials and barely sufficient to meet the population growth".  

The Green Revolution in 1960s and the associated diversification and also the development in Indian agriculture have their relations in agricultural geography as well. The interest of Indian agricultural geographers now goes much beyond the static land use studies of the earlier times. The themes have very much diversified. Geographers now take greater interest in regional disparities in agricultural development, crop productivity, agricultural income, agricultural infrastructure, etc. Research papers on the agricultural geography of Karnataka in general and its districts in particular are rarely seen. But so far no comprehensive and exclusive efforts are made towards evaluating the agricultural geography of arid and semi arid areas in Karnataka. Thus, the present investigation has the one objective and purpose of contributing something on the agricultural geography of a micro region: "Bellary District" in Karnataka State.  

Indian agriculture as is well known has undergone a revolutionary change in recent years. Agricultural production has increased substantially and the cropping pattern in many areas have witnessed significant structural changes. There are certain district/river basins/zones that are highly developed in agriculture and some are moderate and still many are very poor in agricultural development. It is this spatial variation which makes geographers to probe the problems. Statistics do not always reveal a complete picture in qualitative terms, but they do indicate, in this context at least, the great strides made with regard to agricultural production in India during the last twenty to thirty years. It is interesting to note that food grain production increased by more than two-fold from 50 million tonnes in 1950-51 to 150 million tonnes in 1985-86 and 160 million tonnes by 1988.

Ever since geography developed as an academic discipline, agriculture has always been a popular theme of geographic

studies in India. The early files of the Indian Geographical 
Journal, the first professional journal in the country, reveals 
extensive interest of Indian geographers in the spatial pattern 
of agricultural activities as early as 1920s. The organisation 
of the Madras Geographical Association, the fore-runner of the 
Indian Geographical Society in 1926 and the establishment of 
University Departments of Aligarh (1931), Madras (1932), 
Calcutta (1941) and B.H. University Varanasi (1946) gave 
fillip to investigations on agricultural themes. Crop contribu-
tion, ecological adaptations, irrigation development, land use 
and cropping pattern, yields of crops, livestock and various 
other facets of agricultural economy have received attention 
of the scholars in increasing measures. The latest review of 
research in geography bears the level of diversity of themes. 
Regional studies of Indian Agriculture at Macro, meso and 
micro levels claim more than 39 per cent of the research papers. 
Agricultural problems and planning account for 18 per cent, 
agricultural typology and regionalisation 12 per cent and Land 
use and land capability surveys 16 per cent. Although commodity 
studies have been given maximum attention in yester years, 
only about 15 per cent of research articles are available in
this respect. Attention is paid now to research methodology in agricultural geography. As a matter of fact the level of quantification is the highest in case of agricultural geography as compared to other branches in India.

Geographical studies made during the last half a century have been confined to regional agriculture alone which have close relationships with land use studies. The notable works on agricultural geography of India have come from the efforts of the eminent Indian geographers such as Gopalan, S.K. (1937), Mukherjee, D.N. (1942), Deshpande, C.D. (1942), Dayal, P. (1950), Mukherjee, A.B. (1955), Shafi, M. (1960), Mishra, S.N. (1964), Randhwa, M.S. (1968) and many others. Among other Indian geographers who have contributed in the allied fields of land utilisation, land use and agricultural planning and its methodology along with a number of case studies, the following are worthy of mention: Chaterjee, S.P. (1957), Bose, S.K., Rafiullah S.N. (1965), Ahmad, A., Siddiqui, M.F., Roy, B.K. (1967), Bhat L.S. (1968), Ayyar N.P., Misra, R.P. (1969), Reddy, N.B.K., Noor, Mohammad, Majid. Hussain, Mandal, R.B., De, N.K., Aijazuddin Ahmed, Reddy, K.V., Tewari A.K. Sindhe, S.D., Tiwari, P.S.,
Naregal, S.S., Sharma, T.C., Coutinho, O., Venugopal, B.,
Chaudhari, M.R., Sinha B.N., Jayachandran, S., Reddy Surender,
Ramamohan Rao, R., Subramanyam, V.P., etc.

Apart from the Universities a number of scientific
organisations have been engaged in research on agricultural
Institute and Central Arid Research Institute, National Atlas
and Thematic Mapping Organisation, Calcutta, established in
1956 have brought a number of thematic maps on Indian agricul-
ture. The Atlas of agricultural resources of India (36 plates)
and Irrigation Atlas of India (35 plates), incorporating
voluminous information on agricultural resources of the country.
The Regional Survey Unit of Indian Statistical Institute started
in 1955 did the studies of spatial patterns of agricultural
properties and agricultural land use planning under the leadership of Bhat, L.S. were also
taken up. The Central Arid Zone Research Institute Jodhpur has
conducted useful studies on land use and agriculture in the
arid and semi-arid tracts of Rajasthan.

Analytical Approach Towards the Study:

Land resource play a strategic role in determining man's
economic, social and cultural progress as it is evident from
the socio-economic history of different nations. Among the land resources, agricultural land resource has played a vital role since time immemorial engaging larger percentage of inhabitants of the world. It is the duty of the planners in general and agricultural geographer in particular to study the land characteristics in respect of various natural aspects and to suggest the land use under defined management practices for its sustained utilisation. It requires an exhaustive land use survey including all its important elements and decisive socio-economic factors of land utilisation.27

Information on the rate and kind of change in the use of land resources is essential to the proper planning, management and regulation of the use of such resources. Knowledge about such existing land use and trends of change is essential if the nation is to tackle the problems associated with haphazard and uncontrolled growth. A systematic framework is needed for up-dating land use and land cover maps that will be timely, relatively inexpensive and appropriate for different needs at

national and state levels. The rapidly developing technology of remote sensing offers an efficient and timely approach to the mapping and collection of basic land use and land cover data over large areas. The land-sat imageries are potentially more amenable to digital processing because the remote sensor output can be obtained in digital format as a more expedient means to map land use and land cover. "Land use data are needed in the analysis of environmental processes and problems that must be understood if living conditions and standards are to be improved or maintained at current level".  

Aims of Classification:

The major aim of the land use classification system is to provide a frame as broad as possible and would cover all the possible types of land use within the country that could be mapped within certain limitations. The second objective is to see the applicability of land sat data for delineating various land use, land cover categories through computer analysis as well as visual interpretation technique. The third

The objective of this classification is to provide a standardized land use classification system which is compatible with the present land use classification and which can be used with the satellite imagery available in India at present.

Need for Standard Classification:

Various departments in the Central and State Governments, private sectors and university departments have been collecting data about land and its resources for the last many years but their works mostly were independent without any coordination and resulted in certain amount of duplication. It has also been found in most of the cases that data collected for specific purposes were of little value or by the time data collected they were out dated because of the slow process involved in the collection of such data. A need has been identified in India by various user organisations for a standardized present land use/land cover classification system with the help of recently available satellite Landsat imagery and be capable of providing useful information on both regional and national levels.

At present, there is no standard land use classification system in India, and very few organisations like National Atlas...
and the Thematic Mapping Organisation, All India Soil and Land Use Survey, Directorate of Economics and Statistics, Department of Agriculture, etc. have developed their own classification schemes for land use mapping and are limited to particular areas and do not appear to fulfill the requirements of all sectors. Remote sensing techniques can be used effectively to complement surveys based on ground observation and to provide an accurate inventory of the current use of the Nation's land resources. Therefore, a standard land use classification using Landsat data which will be compatible with the existing land use classification developed by the various departments is very much desirable.

**Land Use Inventory and Needs:**

Land use mapping concerns classification of land according to use. For planning purposes a land use map should depict the distribution and extent of different land utilisation of the study area. Successful interpretation of land and their uses entails evaluation of man's adoption to environment. The land use features of an area are created by human needs and anthropo-geographical processes, understanding of which enables
the landsat image interpreter to classify land use units according to their properties. The authors have recognised the relationship between agricultural land and canals in U.P., Punjab, Haryana States, etc. Forests with physiography and rains in the north eastern regions, sandy and dry climate in the western parts of Rajasthan, tanks and agricultural land in the Southern part of India, and irrigated and non-irrigated land have been distinguished on Landsat imagery. Similarly, ravines, sand-dunes, jhum cultivation, grazing land, scrubs and water bodies can also be identified and mapped not only once but at regular intervals of time.

Land use map so prepared gives an idea of land use pattern and trends of change. The last thirty years have witnessed drastic changes in land use in India caused by both increasing population and natural calamities. Thus the current land use map which is an important land use data for land use planning programme is very much needed. National Remote Sensing Agency, Hyderabad, has used landsat imagery to update the existing land use map in a short time in certain areas. This method is also found to be more economical, compared with other surveying methods. It can be very useful in the task of monitoring the environment and the changes that occur naturally as well as those that are induced by man.
Objectives of Land Use Map:

1. The land use map will be utilised as a basic data base which provides the foundation for allocating new land use practices.

2. It will incorporate demographic, economical and environmental impact which have occurred as components of the planning programme.

3. Not only will the information indicate where intensive development has already taken place and where there is open land suitable for future expansions, but it will also make possible to determine special areas such as prime agricultural land.

4. Rapid production of a small scale map from Landsat multispectral scanner imageries showing the broad distribution of land use pattern could serve as a basis for monitoring land use change, e.g., increased irrigated area, changes in forest boundaries, etc.

5. The land use will serve as a base in the overall integrated planning of agricultural and industrial development of a region.
Basic Concepts of Land Use: ²⁹

There are nine major ideas or concepts about land. They are: (1) 'Location or the relation of a specific parcel of land to the poles, equator and the major oceans and land masses'. These are the relationships between various tracts of land, as well as political location.

(2) Activity on the land, for what purpose this piece of land or tract is used.

(3) Natural qualities of the land, including its surface and subsurface characteristics and its vegetative cover.

(4) Improvements to and on the land. This is closely related to activity.

(5) Intensity of land use or amount of activity per unit of area.

(6) Land tenure, i.e., who owns the land and uses it.

(7) Land prices, land market activity and credit as applied to land.

Interrelations between activities on the land and other economic and social activities.

Interrelations in the use between different tracts of land.

Characteristics of Good Classification of Land Use:

Clawson discussed 'good' in terms which are essentially qualitative generalities based on usefulness of the data. He assumed that 95 per cent of all data should be correctly classified.

The six characteristics of a good classification as outlined by Clawson are as follows:

(1) The classification should deal exclusively with activities, non-activity data can be input at a later stage.

(2) It should be flexible in detail.

(3) It should be based on what is observed. The interpreter should do only a minimum of grouping.

(4) Field work should be based on the smallest unit which can be differentiated.
(5) It should be susceptible to machine processing.

(6) The classification should be compatible with existing systems.

Thus keeping the importance of land use in view, various geographers of the world and India have worked on different themes, scales and lines depending upon physical, economical and social conditions. A critical review of all these themes indicate that there are broadly three approaches which have been adopted in all these studies. The idea of land utilisation was first suggested by Baker, O.E.\(^\text{30}\) he had drawn up a project and it was called the study of China's Land Utilisation. A study carried out by Professor Stamp, L.D.\(^\text{31}\) is foremost, perhaps, a very useful work carried out in Britain in the thirties. The work has placed on record that the scientific planning of land use survey provided the base for increasing Britain's food

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production substantially. It is from this point of view that the land use survey of Britain may be considered as a unique and fundamental study. According to Coppock agricultural geography is a part of economic geography which is mainly concerned with production processes. Harvey had developed 'satisfier model' to examine sub-optimal behaviour on the parts of farmers to achieve some satisfactory returns. In judging the best agricultural holdings, recently, Hagarstrand has used agricultural innovation models. Bowden also propagated innovation waves.

In Poland under the direction of J. Kostrowicki Department of Geography and the Polish Academy of Science developed

a new pattern of land use based on agricultural typology, agricultural regionalisation and planning.

Similarly in China the land utilisation survey developed by J.L.Buck\(^{37}\) includes the type of agriculture and the provision for future production in relation to national needs. The agricultural land utilisation developed by A.P.A. Vink\(^{38}\) mainly concerned physical, biological and cultural factors in association and had analysed the same with the help of several systematic models and paradigms. Recently the subject matter of agricultural geography is studied in detail by Morgan and Munton.\(^{39}\) Inspired by the classical work of late L.D.Stamp on land use of Great Britain, Indian geographers played a significant role in conducting land use surveys in many parts of the country. The need for mapping and utilisation of land in India was first felt by Stamp (1926). Later


on S.P. Chatterjee drew attention of geographers to undertake a land use survey in India. Sensing its necessity M. Shafi made a strong plea to carry out land utilisation survey which will, in itself, combine with land capability survey. The significance and objectives of land use studies in a predominantly agricultural country like India are highlighted by K.Z. Amani. A comparative study of land use patterns during the years 1957 and 1967 by N.A. Siddiqui reveals that no major shift in the decade in land use patterns has taken place and usually cereal crops are dominated on the agricultural landscape. In the year 1968, A. Ahmad stressed the need to resort to an intensive use of land in the Arid Zone of India. Besides emphasizing the limitations imposed by environmental set up, he has assessed the regions' potentialities for their fullest

exploitation for future development. The work on land utilization was also done in many of the Indian Universities. They are completed in the form of dissertations and research work. In 1940, at session of the Indian Science Congress held at Madras, S.P. Chatterjee advocated forcefully the necessity of undertaking land use survey in India on the lines of the land use survey of Great Britain. The pioneering work on land use in the lower Godavari Basin by V.L.S. Prakash Rao (during 1942-1946) inspired a number of scholars to undertake similar studies in other areas. The Calcutta University’s Department of Geography developed an important centre of Agricultural Geography under the leadership of S.P. Chatterjee and B.N. Mukerjee. The well equipped soil analysis laboratory was started by Ranjit Iahir which provided facilities for pedagogical studies by geographers. Agricultural geography and land use studies assumed importance at Varanasi under the guidance of R.L. Singh. Several studies were conducted on agricultural themes with focus on land use, cropping pattern and consolidation of land holdings. Efforts were made for the first time with the active support and involvement of the farming community. The Department of Geography of Aligarh University has been an
important centre for studies on agricultural geography. Though land use and agricultural geography had always been among the major interests of the University reports, under the stewardship of M. Shafi, who had done pioneering work on land utilisation in Eastern U.P., equally important are his contributions on agricultural efficiency and agricultural regionalisation. The Aligarh group has covered a wide range of themes related to agricultural geography. Notable among them being land use survey and irrigation development. Agricultural geography also flourished at the departments of Geography in Universities like Kurukshetra, Delhi, Allahabad, Sagar, Hyderabad, Tirupati, Shiva Karnatak, Madras, Hisar and Ludhiana. In the University of Sagar, S.N. Misra presented a study of land use in Khadar and ravine tract of Lower Middle Gomati Valley and recommended a vigorous programme of soil conservation in the area. B.K. Roy, in 1961 made a sample study on land utilisation of five villages of Ballia district. Tremendous changes in the cultivated lands


of Varanasi district during the past fifty years (1911-1963) have also been pointed out by B. Mukerjee\textsuperscript{47} and J.N. Singh. A.N. Raina\textsuperscript{48} made an attempt to present basic factors affecting the type and success of land use in the floating garden region of the Kashmir Valley.

In India there are a number of research schemes and projects financed by the Government to study land use. In many places this type of work is not only conducted by individuals but also teams of researchers. Agricultural land utilisation and cropping pattern vary from one land to another according to the locational advantage, fertility of the soil and the need of people. Thus the land may be single cropped, double cropped or multiple cropped. In multiple cropping the same piece of land is cropped more than once and hence, the total cropped area of the same plot for different seasons is known as gross cropped area. The term 'mixed cropping' connotes the raising up of more than one crop from a field at a time. The term 'intensive cultivation' signifies the pattern of agricultural


land use specially done on smaller plots with the help of modern farm implements, chemical fertilizers, mechanization, irrigation and scientific management, whereas the 'extensive cultivation' refers to bigger plots with single cropping in a year with little care on protection of standing crops. Cropping pattern means both the time and space sequence of crops. The variety in cropping pattern is the result of physical, economical and social factors. It is due to the variations in various components of physical environment. Economic factors affect cropping pattern through a comparative return which a farmer gets from a particular crop or a combination of crops. The physical environment provides a wide range of possibilities for growing crops but the social and economic conditions determine as to which crops are to be grown and how much of land is to be devoted to different crops. Cropping pattern also depends on nature and availability of irrigation facilities. Wherever water is available a system of double or triple cropping becomes possible. When irrigation facilities are provided, the whole method of cultivation may change. All the correlates of cropping pattern are of dynamic nature. Except physical elements which take comparatively longer time to change, other
determinants such as economic and other changes vary fast. Technological advancement such as irrigation, soil, water conservation, adoption of high yielding varieties of seeds, use of chemical fertilizers and pesticides, improvement in the means of transportation, marketing and storage facilities, price incentives and, above all the change in mental attitude of farmers, the policy makers, the researchers and the politicians have brought a tremendous change in cropping pattern. Consequently there is dynamism and diversification in the cropping patterns. A review of the work done by Indian geographers on the problems relating to agriculture clearly points out that crops have been engaging their attention for quite a long time.

A general understanding of the particular combination of the crops and the relative importance of each in an area can be very helpful in interpreting some aspects of social and economic geography of the region. J.C. Weaver has pointed out three different lines in which crop-combinational studies


may have more significance. Firstly, they are essential to an adequate understanding of individual crop geography; secondly, crop combination in itself is an integrated reality that demands definition and distributional analysis, thirdly, such regions are essential for construction of a still more complex structure of valid agricultural regions. Its delimitation is not an end in itself but only towards a better understanding of the agricultural situations. It is identified by the names of those crops which it primarily produces. Therefore, in order to have a more intensive structure of agricultural production the study of crop combination is necessary. Weaver, the pioneer of quantitative idea on crop combination, has considered a decreasing order arrangement of the percentage of different crops. Weaver's standard theoretical distribution such as 100 per cent of N.S.A. for monoculture, 50 per cent of N.S.A. for two crops combination, 33.3 per cent of N.S.A. for three crop combination, 25 per cent of N.S.A. for four crop combination and so on, where N.S.A. is the net sown area, the deviation (d) plus or minus of the actual percentage from any

one of the theoretical value for every set of crops are 
squared and summed up. Each sum is divided by the number of 
crops in the set, the square root of this result will give us 
a measure of crop combination from the theoretical distribu­
tion. The formula for standard deviation is as follows:

$$\sigma = \sqrt{\frac{\sum d^2}{n}}$$

Where
- $\sigma$ = Standard deviation
- $d^2$ = Squared deviation from the mean,
- $n$ = number of crops,
- $\sum$ = Summation of $d^2$.

Weaver considered all those crops which have at least one per­
cent of the net sown area for the analysis. The drawbacks 
of this method are as follows:

a) It needs laborious calculations.

b) The crop combination cannot be determined till all the $n$th crops are considered.

c) Sometimes quite a large number of crops are included in the crop combination.
In 1957 Kikukazi Doi presented his quantitative method of crop combination in his paper: "Industrial Structure of Japanese Prefecture." It is the modified formula to that of Weaver, i.e., $\leq \sigma^2$.

In 1965 Rafiullah introduced a new deviation formula which is quite suitable for delineating the primary crop combination. His formula states as follows:

$$\sigma = \sqrt{\frac{\sum Dp^2 - \sum Dn^2}{N^2}}$$

Where $\sigma$ is the deviation,

$Dp$ is the positive difference,

$Dn$ is the negative difference from the mean value of the theoretical curve of the combination.

$N$ is the number of crops in the combination.

As only relative rank of the deviation is needed the root sign may be ignored to save calculations and the formula may be used as under:


Just like Weaver's method, the difference of actual values is calculated from the middle value of the theoretical standard and the maximum positive deviation determines the number of combinations. Thomas (1965) modified Weaver's method by including all the crops up to zero percent theoretical values in each step of the comparison and applied this method in deriving the crop combinations in Wales. Instead of restricting the crops to the number involved in the combination, Thomas includes all the crops in the series under discussion. As this method involves all the crops in each step, there is no need of dividing $\varepsilon d^2$ by $n$. Thus, the formula for the least squared deviation may be expressed as follows:

$$\sigma^2 = \frac{\sum(D - \mu)^2}{N^2}$$

In each step we will get some value of $\sigma^2$. The theoretical percentage which gives the minimum value of $\sigma^2$ (i.e., least squared deviation) is considered to be matching the best with the reality and hence, the area is identified with it.

Thomas's formula, however, makes the calculations unnecessarily tedious without giving marked differences from the results obtained by Weaver's method.

The crop diversification explains the necessity or possibility to raise a variety of crops which possess nearly an even proportion. It is an indicator of multiplication of crops which obviously involves intense competition among various crops for space. The keener the competition, the higher the magnitude of diversification, and lesser the competition, greater will be the trend towards specialization or monocultural farming where emphasis is given to one or two crops. Crop diversification is now almost a normal feature of stable agriculture and progressive farm management in most of the extensive agricultural areas of the world. In fact this has been made possible by modern irrigation and the use of fertilizers, high yielding varieties, pesticides, mechanization and technologies. Besides, there are other factors which force the cultivators to take up the practice of crop diversification. Firstly, vagaries of weather compel the cultivators to grow a number of crops on their holdings so as to get some return at
least under adverse conditions of weather. Secondly, rural life and the orthodox farm practices force them to obtain most of their domestic requirements from their holdings. For complete comprehension of the geography of crops, the interpretation of their diversification is essential. In view of the importance of these agricultural attributes many agricultural geographers have attempted to measure and map them. However, the works of Tress, Conkling, Shears, Rhatia, Ayyar, Martin, Navi and Gibbs are noteworthy and most of them have dealt specifically with agricultural diversification.

Tress\textsuperscript{54} used refined diversity index with a scale ranging from zero to one for measuring diversification. He arranged the percentages of each category in descending order or magnitude to obtain the cumulative total which he called the crop diversity index. This was again converted into refined diversity index. This method leads to tedious calculations. Conkling\textsuperscript{55} simplified Tress's method by dividing the area by Lorenz curve diagonally. But the method is not very precise.

\begin{itemize}
\item \textsuperscript{54} Tress, R.C. (1939): "Unemployment and the Diversification of Industry", The Manchester School, Vol.9, pp.140-152.
\end{itemize}
and accurate. Similarly John, B. Parr's\textsuperscript{56} study using Lorenz curve also appears to be inaccurate. Bhatia\textsuperscript{57} has evolved a simple formula by taking into account the cropped area to make an objective measurement of crop diversification. This method has an advantage of simplicity in calculation. However, this method cannot be accepted here because of its supersensitivity. N.P. Ayyar\textsuperscript{58} modified Bhatia's method and took into account only those crops which occupy at least 1.0 per cent of the gross cropped area. This method also proves to be supersensitive like Bhatia's method. Harpal Singh Mavi\textsuperscript{59} has used the mean of the differences in percentage of crops under each of which is more than 5 per cent of the total cropped area. This method describes the evenness factor, but it is not the

\begin{itemize}
  \item \textsuperscript{56} Parr, John, B. (1965): "Specialisation and Diversification in Regional Development", The Professional Geographer, Vol. 17, pp. 21-25.
\end{itemize}
better representative of number factor. The Gibbs and Martin\textsuperscript{60} Index of Diversification provides a useful alternative index for measuring the degree of diversification in the cropping pattern in an area. Hence, this method is adopted in the present study.

Today, the foremost challenges facing the world in general and India in particular are the appealing increase in population and a corresponding upsurge in demand for food. Food shortage is primarily due to insufficient production of food grains despite the best efforts to enhance the same. The causes are not far to seek. They are unfavourable weather conditions, socio-economic constraints and orthodox methods of farming which together stand in the way of successful application of new farm technology which accelerates farm production. Such constraints inevitably create regional imbalances in the levels of food productivity.

Agricultural productivity is frequently associated with the attitude of farmers towards work, thrift, industriousness

and aspirations for higher standards of living. The spatial variations in physical output from the soils are the result partly of natural circumstances and partly of human manipulations of the land resources. The regional differences in yields per unit area indicate the magnitude and the direction of the interplay of a multitude of factor. Furthermore, the level of agricultural productivity is a dynamic concept as any modification in physical and improvement in non-physical factors affect agricultural 'productkunde' per hectare. Hence, measurement and evaluation of agricultural productivity forms basis for planning, evaluating and taking appropriate measures for improving productivity at various levels.

The following are the different techniques adopted for computing the agricultural productivity and efficiency per unit area, or per unit of farm work force, etc.:

1. Assessing the value of agricultural production per unit area.
2. Measuring production per unit of farm labourer and man-hour.
3. Determining output in relation to input or output-input ratio (Khusro, 1964).

4. Expressing production of agriculture in terms of grain equivalents per head of population, Buck, E. DeVries, Clark and Haswell, (1967).

5. Considering output per unit area or yields per hectare after grading them in ranking order and thereby deriving the ranking coefficient (Kendall, 1939, Stamp and Shafi, 1960).

6. Giving weightage to the ranking order of the output per unit area with the percentage share under cash crops (Sapre and Deshpande 1964, Bhatia, 1967).

7. Using the carrying capacity of land in terms of population (Stamp, 1958, 1967).


9. Calculating the index numbers of agricultural efficiency by expressing the per unit area carrying capacity (in terms of population) of the component enumeration unit as a percentage of the per unit area carrying capacity of the entire region (Jasbir Singh, 1972, 1974).

11. Involving the area, production and price of each cultivated crop in each of the constituent areal unit of the region and then relating the out turn in terms of money value of the unit to the corresponding productivity of the region (Hussain, 1976).

12. Delimiting agricultural productivity by computing the intensity and spread indices of three variables i.e., (i) yield, (ii) grain equivalents and (iii) cropping system (Singh, V.R. 1979).

13. Assessing net income (farm business income) in rupees per hectare of cropped area or per adult-male unit of farm family work force (Jasbir Singh, et.al, 1982).

Often the term 'agricultural productivity and agricultural efficiency' are used synonymously. In a broad sense, these two terms may be perhaps equated but, there is a subtle difference between them in their profundity as is noted in the respective chapter of the thesis. After considering the merits
and demerits of all the above methods, Kendall, Sapre and Deshpande, Ganguli, Singh Jasbir, Yang's, per capita/per hectare yield of agricultural worker and Bhatia's methods have been calculated for agricultural productivity. Since Bhatia's method is a modification over other methods the results of his method are analysed in detail. Weighted and transformed standard score method is used to find out the agricultural efficiency. The results of the method which suit the most to the environmental setting of the district are analysed in detail.

Agricultural development is a fascinating field of study in geography. The geographer's role lies primarily in identification, description and interpretation of regional variations in the level and the rate of agricultural development. And this must be done in the context of physical resource base, technological advancement, institutional framework and external relations of different areas. Secondly, the spatial diffusion of agricultural development in its nature, intensity and direction, present another interesting field of investigation. The basic geographic query would be as to how the different areas respond to the impulses of development in agriculture. Lastly,
geographers can provide a typology of different areas from the viewpoint of agricultural planning. Such a regionalisation must have a multi-dimensional perspective imbibing existing patterns, trends and potentialities of agricultural development.

Agricultural development is unquestionably a multi-dimensional concept of which crop productivity is one of the vital aspects. Implicitly or explicitly agricultural development is equated with the level and the rate of agricultural productivity. Diversification of agriculture should be considered as the second vital aspect of agricultural development. It stands for promotion of dairying, cattle rearing, poultry farming, pig raising, bee keeping and fishing. Commercialisation of agriculture is still another dimension of agricultural development. The percentage of cropped area under cash crops may be used as a measure of commercialisation of agriculture. The density of market centres per 1,000 sq.km. of area can also provide a clue to the degree of commercial agriculture. A more reliable indicator would be the share of market arrivals in total production both of which can be computed in terms of
their cash value. The development of agriculture is to be judged also from the degree of equity in farm incomes and the nature of agrarian relations. Non-exploitative and tension-free agrarian relations are an essential ingredient of any agricultural development. Above all agricultural development should not produce deterioration in ecological conditions and should not lead to defacement of forests, exhaustion of soil nutrients, depletion of underground water, emergence of water logging conditions and creating waste lands. Conservation of physical resources is an integral part of any agricultural development.

A review of geographical literature covering agricultural development in India reveals that seldom is an attempt made to define agricultural development and to select criteria in the light of any conceptual framework. Criteria are chosen on an ad-hoc basis depending upon convenience of the availability of data. A focus on productivity dimension is dominant and only a few studies take into account the matters relating to commercialisation of agriculture. And it also testifies that all the studies take a partial view, in varying degrees of
agricultural development. Main attention was devoted to the dimension of productivity and its determinants. All the studies were constrained by the problem of data availability. The hunger for data was so voracious that even statistics of marginal value were not spared from usage and that too without any critical evaluation. Therefore, based on the availability of data and after considering their importance in determining agricultural development, 16 indicators have been taken to get the composite index of agricultural levels of development in the present study.

Comprehensive Approach:

Agricultural activities are the results of the decisions made by the farmers after appreciation of the biological constraints and possibilities, the technological and cultural assets and choices and economic implications. Since the farm is the decision making unit, it should be a major focus of interest of agricultural geographers. More indepth studies indeed at farm level and better understanding of the decision making processes at the individual farmer's level should be aimed at. Along with production oriented investigations, transport and marketing of agricultural produce as well as
regional operative structure, so far given scant attention to should also receive priority in investigations of agricultural development in future. The farm, the market, the agro-processing unit, the producer, the consumer linked through the intermediary and linkage and flows all constitute the interrelated components of the changing "agricultural landscape" which constitutes the focus of agricultural geography. The agroclimatic regions and the regional settlements hierarchic framework constitute the conceptual and analytical framework.

Sources of Data and Statistics:

To study the various aspects of agricultural geography of Bellary district the data for two periods i.e., 1975-76 and 1985-86 are taken, from the following sources:

1. Talukawise plan statistics of Bellary district, District Planning Unit office of the Deputy Commissioner, Bellary, District and Regional Planning Unit, Planning Department, Government of Karnataka, Bangalore.

3. Superintending and Executive Engineers, Minor and Major Irrigation Departments, Bellary.

4. Principal Agricultural Officer, Bellary.


7. Assistant Director of Animal Husbandry and District Industrial Centre, Bellary.


9. District Forest Officer, Bellary.