THE AGRICULTURAL GEOGRAPHY OF HISSAR DISTRICT

by

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VOLUME I

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General Introduction

Agriculture is more than simply the growing of crops. Agriculture involves systems by which people thoughtfully organise and use the various elements of farming. But to understand how particular kinds of farming systems have developed in particular areas, and how they are similar to or different from the farming of other areas; to explain how different kinds of agriculture are distributed over the earth and how they function in spatial arrangement; to analyse how the farming systems are changing and to highlight in what direction with what combinations and volume the movements are taking place - all these fall within the scope of the agricultural geographer. It is the business of the agricultural geographer to organise such type of studies with reference to the agronomic and socio-economic basis of farming in the historical perspective. Such series of studies of agricultural geography of the newly developing areas in India are necessary on account of the heavy reliance of the population on agriculture and the challenging problem of food. Until this is done the picture of agricultural systems in the developing land will remain vague and inadequate. It is in this spirit that the present sample study of the agricultural geography of Hissar has been made.

With an area of 5,363 square miles and an average density of 288 (1961) persons per square mile, Hissar is the largest and the least densely populated district in the Punjab.* It is the

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* The state of Punjab has been re-organised into two, Haryana and Punjab. Hilly parts of the old state have been added to the Himachal Pradesh. Hissar district as a whole falls in the Haryana from the 1st of November, 1966.

south westernmost of the districts of the state (Fig. 1). It represents the north-east fringe of the Indian Desert. There are 11 towns and the 1033 villages constituting 19 assessment circles, administratively grouped into five tahsils, viz., Sirsa, Fatehabad, Hissar, Hansi and Bhiwani (Fig. 2). Hissar has derived its name from the town of Hissar, the headquarters of the district administration.

Inadequacy of rainfall and the predominantly sandy nature of the soils have stood in the way of the effective development of Hissar for agricultural purposes. As a result of the high variability of rainfall, notwithstanding its meagre amount, the district has been frequently subjected to famine conditions. The grain production agriculture, which has directly engaged more than 80 percent of the working force of the district, has been responsible, among other factors, for its poverty and backwardness. In degree of urbanisation and literacy the area comes at the tail of most districts of the Punjab.

With the introduction of canal irrigation from the Bhakra-Nangal Scheme in parts of the district in the middle 'fifties, the area has experienced an economic and demographic revolution of a high magnitude. The new irrigational facilities have attracted streams of inmigrants from the heavily populated areas of the northern Punjab Plain. Also it has attracted a large number of displaced persons who formerly belonged to the canal colonies of the West Punjab (Pakistan) but who came over to the Indian side of the state subsequent to the partition of the United Punjab in 1947. With these newcomers and the irrigational facilities a new page has been turned in the economic and social history of the district. The overwhelming subsistence economy, precarious and inferior, is giving place to an increasingly thriving commercial farm economy. The incoming of efficient and adventurous farmers to the local backward society has wrought a great economic and social change thereby affecting the land-use. Yet the border of Hissar included areas which had hardly emerged from subsistence farming. In tracing the development of Punjab agriculture since the beginning of the First Five Year Plan (1951-56), Hissar provides excellent material for a case-study, for she represents changes in many ways.

The primary aims of this study are to map, describe and analyse the contemporary pattern of Hissar peasant grain farming and the currently evolving and changing land-use pattern with special reference to the changes that have taken place since 1951, the year the First Five Year Plan was launched. The factors of farming underlying the changes of the land-use of the newly colonised areas or the stability in the old irrigated and the crisis in the rainfed areas are outlined according to the evidence of statistical analysis through a consistent period of 10 years: 1951 to 1961, and the characteristic features and changes in land-use are described. On the basis of the comprehensive study of land, climate, soil, water resources, population, land-use, crop distribution, cropping pattern, crop ranking and crop combinations in association with livestock, delineation of agricultural regions has been made. The trends of the various aspects of land-use of each region are studied for a period of 12 years: 1950 to 1962, covering the pre- and post-irrigation periods. A geographical approach is maintained throughout. The spatial relations of determinants and agriculture are emphasized and, the contributions which the geographer can make to agricultural geography are made by treating the subject comprehensively.

The fundamental problem in the dry lands is the practice of subsistence agriculture based on millet, or inferior grain cropping, on account of moisture deficiency and the soil limitations. The development of irrigation during the 1950's in the Punjab, of which Hissar alone shared more than 70 percent of the increase, has eliminated many causes of crisis in the dry lands and there has been a consequent increasing pressure of population. It is essential, if these semi-arid lands and precious canal waters are not to be irretrievably lost, with consequent serious economic effects, that the basis of farming, direction, volume or intensity and combination of changes in land-use, tenures and cropping be appreciated and comprehended. Such a study has distinct economic and social utility in the agricultural area where the impulse of irrigation, the influence of the new-comers and the impact of cash crops are increasingly modifying the rural life, and where the forces of population increase and urban growth, with consequent alterations in food demands, will bring changes to a considerable degree in the future. It is also hoped this account will supply a background to detailed land-use and regional studies of Hissar.

Finally, the basic data contained in the present work have an intrinsic value as the vast amount of first hand unpublished information which remains buried in the departmental records and exists in the minds of the officers have been brought to light with cartographic and statistical techniques. There is a need of such information to be made available in a consolidated form for future planning based on the past experiences.

Three main approaches to the geographical study of subsistence agriculture can be suggested, namely an ecological approach, the land utilization approach, and a statistical approach (McMaster, 1962). Statistical approaches are adopted in the present study. These contribute to a good understanding of agriculture and yield direct illuminative and quantitative information of cropping and changes. The present work is confined to the areal framework of assessment circles and a large number of sample villages. Such works depend upon the availability, accessibility, duration, consistency in recording and the reliability of official records. Those who helped in the collection of the returns are acknowledged on page i. At the beginning of each part in introduction wherever necessary, the sources, the systems of recording and the validity and use of the data are mentioned. Hissar has an unusually large and significant body of detailed statistical information on agriculture, rainfall, irrigation and population available at the local offices. The consistency in the boundaries of the component areal units and the homogeneity in the systems of land records over area and time are worth mention. It was decided to conduct the present study upon the unpublished estimates of the assessment circles and sample villages.

Intimate personal contacts with Hissar since 1950 helped considerably to conduct the systematic land-use analysis. The estimates are collected from the primary source personally. Opportunities were taken wherever possible to interview the local inhabitants and the migrants to gather the relevant information to synthesize with the statistical analysis.

Any statistical approach is limited by the quality of the official information upon which it is erected. It must be said that the present Hissar acreage statistics for each crop season, rainfall figures and census records are efficiently, officially documented with a considerable breakdown for the period of study: 1950 to 1962. The methods of handling the returns are exhibited at appropriate places in the text.

In the analysis and summary of the data all clerical work has been checked more than twice. The collection and computation of data have been done from the revenue records for a period of twelve years for all the assessment circles and a large number of sample villages based on systematic grid pattern which offset the disadvantage of mistakes and limitations if any in the data. While great care has been taken to avoid errors, still it is scarcely to be expected that all have been avoided, and if any are discovered by the reader, the writer would greatly appreciate having his attention called to them. Calculations are quite large and complicated ones and carried to two to three decimals. Thereafter, in certain cases, the figures were rounded.

The correlation of field observations and data have been demonstrated. The essential matter so derived is presented in the graphs, diagrams and distribution maps, after boiling down of a large body of data to a thesis size. Most of the maps are choropleth maps in which regional differences in the importance of particular elements are shown by the differences in the density of shading. The choice of the class interval is a compromise of three ideals, the quartile method, the selection of values which group areas with similar physical, economic and human characteristics and the production of a map which is effectively comprehended. It is hoped that such maps themselves will be a challenge to produce more adequate explanations.

No detailed work has previously been published which depicts the geographical investigation of the agriculture of Hissar based on the all areal components. The District Gazetter (1915), the Settlement Reports (1875 to 1915) and the Economic Inquiries (1937 to 1962) are the only official documents covering agriculture in a very generalised form. It indicates the scope which existed for further geographical inquiry of Hissar.

Contemporaneously agricultural economics has gained new life from the logical analysis of systematically collected data which strongly equipped the writer for the study of composition, practices and changes of agriculture in Hissar. These further endeavour to calculate the carrying capacity of the land on the basis of land-use and production, the economic density and the changes in economic density by computing the returns into standard nutrition and production units and to ascertain the volume and combination of change in the various aspects of land-use as detailed in the Appendices: I and II respectively. The proposed logical outline of the work is as follows:-

Parts I, II and III attempt to deal with the physical, economic and demographic bases of farming respectively.

Parts IV, V and VI try to relate the agricultural problems to the prevailing physical, economic and social conditions, emphasizing their impulse on the land-use during the 1950's.

Finally, in Part VII, the analysis of the component areal units is integrated to derive agricultural regions on a statistical basis and the findings have been brought together for the use of the irrigation and agriculture personnels for future developments.

It is hoped, too, that this arrangement will ease the task of such readers as have not a very detailed knowledge of the physical and socio-economic geography influencing the agricultural geography of Hissar.

PART I

THE PHYSICAL BASIS OF FARMING

Introduction

The agriculture of an area needs to be analysed against the physical environmental setting. Furthermore, it is the product of the people who have established and adjusted it to the changing agro-climatic variables. Agricultural activities are governed in large measure by the agro-climatic controls, thereafter modified by socio-economic factors. The physical basis of farming are the compound of land, climate and soils, which come first.

CHAPTER 1

THE LAND

In both rocks and landforms Hissar is essentially simple: alluvial and aeolian deposits predominate, with limited outcrops of old hard rocks. Over a vast area it is a gently rolling country without the interruption of any natural irregularity except for the scattered hills of the south and the Ghaggar channel of the north, disrupting the monotony.

Geological Structure (Fig. 4)

Structurally, Hissar forms the south-western part of the Sutlej-Ghaggar plain of the Punjab. The geological evolution of the plain is a matter of discussion. The common view is that the plain was formed in the depression in the front of the high crustal wave of the Himalayas by the deposition of an immense amount of detritus brought by the rivers rising from the mountains. Sedimentary rocks, predominantly sand and clay, floor the major part of the area. In the south the base rock outcrops from under thick alluvial deposits as hills which are small, few and discontinuous. These offer sharp contrasts with the open vistas and rolling horizons of the Hissar Plain and severely limited the agricultural potential.

Wadia (1953) and Krishnan (1960) suggest that Hissar falls into two parts, viz:-

(1) The Alluvial Plains (Pleistocene System)

(2) The Exposures of Old Rocks (Dharwar System)

Fig. 4 Table showing the geological formations of Hissar

Group	System	Age	Location	Composition	Local Name
Aryan	Recent and Pleistocene	1. Sub-Recent	Flood	Red clay	Sotar
		2. Recent	Plain	Clay-sand	Khaddar
		3. Middle Pleistocene	Sand Dunes	Sand	Bagar
		4. Lower Pleistocene	Alluvial Plain	Sand-clay	Bhangar
Purana or Archaean	Dharwar or Aravalli	5. Lower Huronian	Tosham Hills	Quartzite etc.	Tilla

The Pleistocene System

The deposition of alluvium commenced after the upheaval of the Himalayas and has continued all through the Pleistocene. The total thickness of the fluvial deposits is unknown but from a few borings made for tube-wells (pipes) it appears that the thickness is more than a thousand feet. The basement of the deposits is probably not a smooth surface but is in a corrugated form. The deposits have buried sub-alluvial ridges of variable magnitude. The influence of such impervious geological structure on the existence and utilization of under ground water is a matter of deep concern for the semi-arid area. One such ridge has been surveyed running south-eastward up to a distance of 100 miles from the Salt Range in Pakistan, as is evident from the Geodetic Reports of 1934-36. These geodetic surveys revealed the existence of a continuous sub-alluvial ridge below the alluvium of Pakistan's rivers with its visible parts represented by the Sangla, Chinot and Kirana Hills (in Pakistan). It has been thought by many investigators (Auden, 1950 and Uppal, 1953) that beyond Sangla, the ridge has been concealed under the Punjab Plains and juts out again near Delhi (Fig. 3). Three evidences can be put forward to support its existence, viz:-

(1) The water table in the north-east of Punjab is within 30 feet and in the south-west is above 30 feet i.e., mostly beyond 60 feet. Within one to eight miles of this ridge the water table falls considerably but surface topography does not show any marked variation.

(2) Waterlogging is more a problem to the north-east of the 30 feet contour of sub-soil water depth than in the south-west Punjab.

(3) The underground water is mostly brackish to the south-west of the 30 feet contourline due to a limited underground replenishment and the process of salinisation.

In summary, the intruded ridge of impervious material which is lying concealed under the Sutlej-Ghaggar alluvials acts as an obstacle to the flow of subterranean water from the Siwalik area towards the south-west dry region of the Punjab. It is an obstruction to the rise of the water table in Hissar, inhibiting accessibility to fresh water for drinking and irrigation purposes.

The materials of Hissar are of fluviatile and sub-aerial formation i.e., massive beds of alluvium, either sandy or loamy, corresponding to the silt, mud and sand of variable ages deposited by streams and winds. Hence, the division of Hissar into depositio surfaces provides a suitable framework upon which a systematic analysis of the morphology and productive potentials of the soils may be constructed.

The alluvial deposits of Hissar consist of old and new deposits, commonly known as the "bhangar"* and "khaddar" respectively. In geological age they correspond with the two main divisions of the Quarternary era: the Pleistocene and Recent. It is difficult to draw any distinct line of separation between the two unless they contain fossils, but generally speaking the "bhangar" land occupies the higher ground and is not flooded by the rivers during the rains, while the "khaddar" forms the flood plain.

The deposits of the Quarternary era in Hissar can be classified as:

(a) The Flood Deposits (Sotar)

(b) The New Alluvium (Khaddar)

(c) The Old Alluvium (Bhangar)

(d) The Aeolian Deposits (Bagar)

(a) The Flood Deposits:- The flood deposits lie close to the Ghaggar stream and are flooded every year. Hard alluvial red clay predominates. It is difficult to work when it dries up or becomes too wet.

(b) The New Alluvium:- This is generally confined to the vicinity of the Ghaggar channel and imperceptibly merges into the flood deposits of sub-recent age. This alluvium is flooded whenever there are heavy rains in the Siwalik and Sub-Siwalik catchment area of the Ghaggar. It contains a considerable amount of clay.

(c) The Old Alluvium:- This occupies higher grounds, which are too high to be flooded by the Ghaggar, even during its maximum rise. Sand and clay are the major components. The old alluvium covers the Rohi of Sirsa and the Haryana of Fatehabad,

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* All such Indian terms are explained in the glossary on pp:339-40.

Hissar, Hansi and Bhiwani tahsils.

(d) The Aeolian Deposits:- The aeolian deposits are found in the undulating lands situated along the Rajasthan boundary in Sirsa, Fatehabad, Hissar and Bhiwani tahsils. These wind-blown sand accumulations have quartz in well rounded grains as their predominant component, with a fair proportion of calcareous grains. The origin of the sand is attributed, in the first instance, to a long continued and extreme degree of aridity, combined with the sand-drifting action of the south-west monsoon during the hot and dry months of the year.

The Dharwar System

The most ancient, metamorphosed, marine sedimentary rock systems of India occur locally as the Tosham hills, the extensions of the Aravallis. These meta-sedimentary Archaean rocks are grouped under the Dharwar System of Mysore (Holland and Tipper, 1913) and came into existence during the Lower Huronian mountain-building. Through long process of mechanical weathering they have spread sediment over the surrounding deposits. The small, remnant hills of today are made of quartzites, shales, slate, crystalline limestone and gneiss. The absence of fossils and the presence of iron content are the distinctive features in the material of these hills. These are unsuitable for cultivation because of the notable absence of soil cover and their economic importance, if any, lies in providing building and road-metalling material.

Relief: (Figs. 5 and 8)

Relief of the land exercises a direct influence on land-use particularly through slope, elevation and ruggedness, whilst on lower ground it affects flooding. Relief also influences farming by modifying climate and by affecting the ease of cultivation and accessibility. In Hissar the latter factors are of the greater significance.

The general slope of Hissar is from north-east to south-west with an exception in the south (Figs. 5 and 8). The form of the land does not permit the extension of flow irrigation in the south which is therefore altering less rapidly today. The gradient is very gentle - about 1:4000 over most of Hissar, which makes it accessible to the expansion of irrigation. In the south the gradient is not gentle and it has created a problem of soil erosion. On the whole, the gentle gradient leads to sluggish movement of surface water. During the periods of monsoon rainfall solutions are washed down towards the water-table. In the hot and dry period extensive evaporation takes place resulting in capillary action. On reaching the surface these solutions evaporate and the salts crystallize as a white incrustation on the surface looking like a skin disease. Such incrustations are common in the old irrigated areas.

The major part of the district lies from 625 to 725 feet above the sea level. In the south the elevation rises to over 1100 feet. On the whole, the terrain is fairly level land accessible to farming.

<u>Drainage</u>: (Fig. 6)

Hissar is drained by the Ghaggar, a seasonal monsoon river flowing from north-east to south-west across the northern parts of

Hissar and Fatehabad and the central portion of Sirsa tahsils.

In the past the Ghaggar was considered as a sacred and a mighty perennial river. The hydrographic romance of the Ghaggar is extremely complex. A sufficient explanation of what has happened to the drainage system of the Punjab on account of the aggrandizement of the Indus at the expense of the Ghaggar has been worked out by others (Wood, 1924 and Siddiqui, 1944). In the Punjab the general theme is the gradual westward drift of the Punjab rivers, which appears to have brought about the elimination of a large river (Ghaggar) that once watered the south-east Punjab. It resulted in the reduction to desert or semi-desert of the great tracts formerly capable of supporting prosperous settlements.

The persistence of Hakra or Ghaggar till historic times would as noticed by James Fergusson (1863), account for the old vedic tradition and the settling of immigrating Aryan Hindus, exclusively in the tract of country between the Sutlej and the Yumna. Stein (1942), in his survey of the ancient sites along the lost river of the Indian desert concluded by saying, "we have clear evidence that the drying up was gradual, at least in the historical period." Ruins of towns and villages observed are closely associated with the drying up of the Ghaggar. At one time there was certainly at least a seasonal flow in the dry section of the Ghaggar, which can be traced for a further 200 miles in arid country on a course parallel to and south of the Indus. As to the causes of this deterioration of the Ghaggar, current opinion suggests that destruction of forest and the spread of agriculture during 3,000 years on the plains had far-reaching effects on ground water. Natural or artificial diversion of former headstreams into the Sutlej or Jumna could have been an influence, while in recent times the building of road and railway embankments at right angles to the general slope of the plain has certainly interfered with natural drainage, probably to the disadvantage of the Ghaggar (Rawson, 1963).

The Chitraung was dry in 1351 A.D., when its bed was used by Firoz Shah for his canal to Hissar and the orchards of Hansi. In Tod's Annals of Rajasthan (1914) it is stated that the Hakra (the name of Ghaggar in the Rajasthan) became dry for the first time in the early 11th Century. If so, dry and desolate conditions have developed in Hissar since the middle of the 11th Century. Therefore, the fertile alluvial soil is not here shrouded by a thick layer of drifting sand. Thus, the sandy areas of Hissar besides the south, with deep ploughing and irrigation facilities, may be the prosperous agricultural zone of the Punjab.

Traces of abandoned beds of many tributaries which drained into the Ghaggar, namely the Chitraung, the Sirhind and the Naiwals are found in Hissar. These deserted courses left wide depressions of fertile alluvial soils, known locally as "tals" hemmed by the elevated pieces of old alluvium. Agriculturally, these "tals" are most productive strips. Ultimately, the dwindling Ghaggar became a seasonal stream without outlet to the sea, leaving behind a large flood plain and "tals".

The rainy season flow of the Ghaggar normally ceases at Hanumangarh (in Rajasthan), about 290 miles from the source, and about 15 miles west of the Hissar border. Occasionally it extends a further 20 miles still during the season of heavy rains. During the remaining part of the year it flows to Ottu, but mostly becomes dry and is changed into a channel of lakes in dry periods.

The closer character of the Ghaggar in Hissar as observed during field work and from the topo-sheets, may be summarized:

From Jakhal for 3 miles downstream it flows through an incised course and thence to Ratia it occupies a well defined channel varying in depth from 15 to 20 feet. Thereafter, in Sirsa, it becomes shallow with gentle sides. However, it is marked off distinctively from the adjoining old alluvial plains. It is clearly defined by banks and sand ridges on either side, by its rich clay soil, and by a vegetation of different character from that of the neighbouring tracts. The channel is a very remarkable physical feature. Within Hissar it is known as "Sotar" and is a valley varying in depth from 8 to 20 feet. In Sirsa the stream overtops its banks and floods the neighbouring land every year for miles. The flood plain is wider in Sirsa and narrower in Hissar and Fatehabad tahsils. The construction of a dam below Ottu has converted the several temporary lakes into one large one. During the dry season the lake shrinks to a small pond of water, and by June is usually dry. During the 'fifties a branch from the Bhakra canal was deflected into it above the dam site and has turned it into a permanent lake. Consequently, the Ghaggar canals have become perennial. A grassy swamp was formed by the Ghaggar floods to the south-west of Ottu, known as the Ankai Swamp. This has been reclaimed for farming.

The Physiographic Regions and their Suitability for Irrigated Farming: (Figs. 7 and 8)

The Hissar Plain slopes imperceptibly towards the south-west in its major part. Any unevenness of surface is either due to old banks and abandoned channels of the streams or the sand dunes and stumps of relict hills, otherwise the local relief is insignificant. Five sub-regions provide a suitable framework upon which a systematic outline of the environment may be founded, for use in the later analysis of agricultural distributions. These regions are:-

(1) The Hills
(2) The Sand Dunes
(3) The Flat Plain
(4) The Flood Plain
(5) The Grassy Swamp

The boundaries of some of the regions are well defined, as in the case of the flood plain and the broken outliers of the Aravalli hills. However, it is difficült to distinguish between other regions along a well marked line because there is no abrupt change in terrain character and the features of one merge gradually into the other. Thus the boundaries between rolling plains, sandy billows and swamps are not definable but are somewhat arbitrary.

(1) The Hills:- The hills lie in the Bhiwani tahsil. These are scattered rocky outcrops varying in height from 750 to 1100 feet above sea level, the highest point is 1125 feet. These stand out distinctively against the level horizon above the sandy swelling waves of Bagar. These rock protuberances are old and

present bare bold and rounded formations, a curiously wind-worn topography which illustrates the phenomena of desert erosion. Equally apparent is the abundance of debris, produced by insolation and the disintegration of the bare surface by desquamation.

(2) The Sand Dunes:- The sand dunes on a massive scale are found in an area which extends from south-east of Sirsa tahsil along the western border of the district, gradually widening and extending towards the south of Bhiwani tahsil. It resembles the treeless undulating deserts. Locally, the region is named as Bagar and is inhabited by the Bagri farming community.

The sand dunes of varying magnitude are the main features of the region. At some places the local relief is as high as 40 feet but generally the dunes are 10 to 20 feet above the level of the ground. Some of the dunes are moving, most are stationary. Their strike may be parallel to the wind direction. Generally longitudinal ridge-like dunes are common, with the crescentic type interspersed. The region is not altogether, as the name implies, a desolate treeless waste, but does support a thin scrubby vegetation in "tal" which serves to relieve its aspect. Furthermore, it is not one undulating waste of sands, but its monotony has been disturbed by a few rocky projection of low elevation in the south of the area.

Two sub-divisions having a variable suitability of land for irrigated farming may be recognised within this area (inset in Fig. 8), viz:-

(i) Area of Exceptionally low Suitability: It comprises the southernmost part of Hissar covering the maximum of Bhiwani tahsil. It has a considerable concentration of the rocky hills, sand hills and sand dunes. The nature of the terrain does not permit free flow irrigation or a high order of farm production. The lift irrigation is the only feasible means to meet the moisture deficiency.

(ii) Area of low Suitability: It embraces the south-west of Hissar. Sand dunes are a common feature. It may be that in the near future the existing sand dunes will be levelled down by the farmers with the expansion of irrigation facilities. Meanwhile, the existing surface undulations do not permit diversified irrigated cropping.

(3) The Flat Plains: Old rolling flat plains include the Rohi and Haryana belts of Hissar. The former stretches from the northern edge of the Ghaggar valley to the northern boundary of Sirsa tahsil and the latter extends from the southern confines of the tract watered by the Ghaggar channel to the south-eastern corner of the district near Bhiwani. It is wide in the north and towards the south is encroached upon by the Bagar sand. The Haryana includes parts of Hissar, Fatehabad, the whole of Hansi and a very narrow strip of north-eastern Bhiwani. It is inhabited by the Hindu jats from whom it derived its name. The Rohi has many abandoned beds of old streams which provide fertile strips of land. Hence, it is not completely flat due to the presence of "tals" and "tibbas".

The Haryana may be further sub-divided into two parts on the basis of variable landscape, viz., Inner-Haryana and Outer-Haryana. Inner-Haryana lies on the confines of the Bagar area, so is akin to the latter to some extent in respect of relief, with sand dunes of low height scattered here and there. Outer-Haryana lies on the north-eastern confines of the district and is a flat plain.

Within the framework of the rolling flat plains the degree of suitability of land for irrigated farming varies from medium to high. The areas of medium suitability either lies on the confines of the Bagars or on the sides of the abandoned channels. On the whole the land is accessible to irrigated farming. The blocks of a high degree of suitability include the flats, the old irrigated areas of the district. The present evenness of terrain has been increased by the farmers through levelling in centuries of irrigated farming.

(4) The Flood Plain:- The flood plain is an area flanking the Ghaggar stream, and is termed "Nali". The Nali tract is further divided into two distinct physical sub-divisions having variable features, namely, the Fatehabad Nali and the Sirsa Nali. Both regions are gently sloping, trending from north-east to south-west and are largely cleared of natural vegetation for cultivation. Due to the valley form, a far larger area is flooded in Sirsa Nali. The flood plain is wider and gradually merges into the adjacent old plains. On the other hand in Fatehabad it is narrow with a recognisable change to the old plains.

Sand dunes are common along the Ghaggar flood plain. These are formed due to the accumulation of sand, blowing away from the dry, abandoned beds. Therefore, at present the area has a moderate accessibility to irrigated farming. The new-comers will level down the existing sand dunes rapidly with the expanding irrigation facilities.

(5) The Grassy Swamp:- The Sirsa Nali is wide and shallow. The result is that a far larger area is flooded in the south-west of Sirsa, known as the Ankai Swamp. Sand dunes are common as it lies close to the Indian Desert. These dunes were of a shifting nature and crescentic in shape. Their march has been checked with the extension of irrigation facilities. The major part of the area has been reclaimed and brought under cultivation during the 'fifties on account of its suitability for irrigated farming.

The physical setting of Hissar thus provided important opportunities for settlement and cultivation. In vast areas lie the future prospects for the development of the irrigated farming and for increasing scope of farming. Topographically most parts of Hissar are also suited to the extensive use of farm machinery in the future. Though the land has great capability for the agricultural development, yet the great limiting factor is the location of Hissar in the north-west dry area of India.

CHAPTER 2

THE CLIMATE

The potential crop producing ability of a given area is dependent primarily upon the existing climatic and soil conditions (Klages, 1942), the voice may be accepted for the area under study. Hissar is situated on the confines of the Thar desert and its climate is greatly affected thereby. The nearest mountains are nearly 120 miles away in the north-east and the sea is 650 miles away in the south-west. In spite of the modifications wrought by interior location, Hissar continues to carry the stamp of a monsoon situation. On the whole its climate can be distinguished as a Sub-Tropical Continental Monsoon type. This climate has five chief features, viz., (i) Hot summers (ii) Cool winters (iii) Mostly dry except for two to three months (July to September) with scanty and insecure rainfall (iv) Great ranges of temperature and (v) Great variability of rainfall.

The Elements of Climate: (Fig. 9)

The elements of climate are treated below, particular consideration having been given to agricultural relevance.

(1) Pressure Systems:- The synoptic charts reveal that the pressure over Hissar is at a maximum in December and January. The high pressure cell over the north-western parts of the Indian Sub-Continent is well established. With northward movement of the sun, temperature rises and the high pressure cell is dismembered by the end of March. The minimum pressure is reached in June and July when the temperature is at its peak. Air pressure remains low

during the months of June, July and August. In September pressure begins to fill up due to the decline in temperature with the southward swing of the sun. From November to January the area remains primarily under the control of the high pressure extensions. The passage and approach of depressions occasionally disturb the high pressure cell.

(2) Air Masses and Wind Systems:- By December pressure is intensified and complete anti-cyclonic conditions are experienced because of the prevalence of subsident air masses. The invasions of cold, dry, northerly extra-tropical continental air masses from the higher latitudes and mountains are common. Minimum temperatures are recorded when the air masses come from north after sweeping over the snow clad peaks of the Himalayas. The shallow western disturbances sometimes encroach on Hissar during January. The extension of a cold air mass over the Rajasthan does not allow the depressions to drive towards the semi-arid region frequently. Thus these enter Hissar as the weakened counterparts of storms.

In March, April and early May the anti-cyclonic features of the cold months still prevail, but in a faded form. The extra-tropical cyclones cease to come by the middle of March, but sometimes a feeble cyclone may come at the end of March. Until the end of April, the surface winds are still north-west. In May and June tropical continental warm dry air usually prevails. The warm air mass with its source in south-west Asia gets further heated when it comes over Baluchistan and Sind (Pakistan). The winds coming in circulation around the low pressure of Sind and Punjab become turbulent and acquire a steep gradient. Thus it gives rise to strong dust storms. The magnitude and frequency of the dust storms may be high towards the confines of the Indian Desert in Hissar. Sometimes these storms are so strong that they blow away the harvested crops from the fields. These disturbances, short in duration, but violent and accompanied by thick red dust clouds, are designated locally as "Andhi".

In early part of July, there is a sudden change in the direction of winds and tropical marine air masses start to steer towards the Punjab. By the middle of July these are accelerated. Sometimes the late extension of anti-cyclonic conditions oriented over north India acts as a barrier to the advancing moist monsoon air masses and weakens the monsoon burst. Similarly the early development of an anti-cyclonic jet leads to the unexpected retreat of the monsoon before time. The north-west of India is a victim of this climatic phenomenon, leading to rain failures and famines in the pre-monsoon and post-monsoon periods.

By the end of September the flow of southwesterly equatorial air weakens and the tropical continental air masses begin to intrude into the area. These air masses are free from dust and moisture. They get more and more bracing till January when they become quite cool.

The Wind Flow diagram of Hissar presents the wind directions in the district (Fig. 10). The density of shading and the presence of a ridge with cols and an island, immediately show the important wind directions: west, south-west and north-west throughout the year but south, south-east and east only during the months of May to September. The former are dry and the latter are wet. Calms are frequent. In June, July and August, east and south-east winds are most frequent with west and south-west winds at intervals. West winds blow more than 30 percent of the time in September to April, while from May to August they have a frequency of less than 30 percent because of the greater influence of south-east and east winds. Thus the dominance of hot, cold and dry winds is obvious. It is detrimental for the crop agriculture due to the resultant high rate of evaporation. The Wind Rose diagram (Fig. 11) for the same station presents a simple picture. It exhibits the distinctive pattern of wind direction: the predominance of west and south-west dry winds over east and south-east rain-bearing winds is the keynote. Eventually, it can be presumed that sub-tropical cold and hot dry winds are dominant compared to monsoon winds. It accounts for the uncertain and meagre rainfall in Hissar.

(3) Temperature:- The influences of temperature on human beings, livestock and farming are varied. On the one hand, high temperatures are favourable to high density of population in that they (a) promote the onset of rapid growth of vegetation, (b) permit the practice of multiple cropping, (c) allow the production of a greater range of crops, and (d) reduce the requirements of clothing and shelter. On the other hand, high temperatures presumably stimulate the rapid propagation of insects, fungi and bacteria, and thus tend to reduce the habitability of the areas. They are also responsible for nitrogen deficiency in the soil. When high temperatures are combined with high humidity, a considerable body of evidence indicates that the effects on human life and activity may be deleterious. Low temperatures, especially when accompanied

by high humidities, make it necessary to house all kinds of livestock and limit the growth of crops.

In Hissar, temperature nowhere becomes the limiting factor to cropping, though it does exercise an important impact upon the choice of crops. What matters in crop growth is actual temperature, the temperature figures reduced to sea level equivalents - however important for climatic studies - rob the data of most of their direct significance to agriculture. Therefore, the actual temperatures recorded have been used for the crop production analysis of Hissar. The crucial temperature is $42^{\circ}F$ ($6^{\circ}C$ - Schimper, 1903), the air temperature at which active germination and growth begin to take place with most useful crops. Plant growth continues throughout the year as the mean monthly air temperature is above $56^{\circ}F$. There are two cropping seasons on account of the wide range of temperature, viz., summer (kharif) and winter (rabi) growing tropical/subtropical and temperate crops respectively. On the whole there is an adequate warmth and sunshine throughout the year to provide ripening conditions for food, fodder and fibre crops.

(4) Rainfall:- In Hissar rainfall is the dominant single weather parameter and climatic hazard as regards farming because of its meagreness, insecurity and variability. The ways in which rainfall characteristics affect agriculture will be investigated separately, as it is probable that their operation is more subtle, for crops can be affected by moisture conditions at germination, shooting, stalking and heading and at maturing and harvesting.

The Seasonal Rhythm:

In an agricultural area, such as Hissar, the success and failure of agriculture is closely tied up with weather. Therefore a comprehensive background of the seasonal rhythm of conditions is essential for understanding the patterns of agricultural land-use. The year can be conveniently divided into four well defined seasons. In addition there are two more which, though short, are yet of significance for agricultural operations.

The Climatic and Agricultural Year:-

Serial No.	Climatic Year	Agricultural Year
1.	Hot-Weather Season	Threshing of winter crops
2.	Harbinger of Monsoon	Preparation for summer crops
3.	The Rainy Season	Sowing and weeding of summer crops
4.	The Season of Retreating Monsoon	Harvesting of summer crops, preparation for the sowing of winter crops.
5.	Cold-Weather Season	Watering and weeding of winter crops.
6.	The Post-Winter season	Harvesting of winter crops

(1) The Hot-Weather Season (mid-April to May):

The hot season starts from mid-April, though the last days of March and early April are warm. The daily range of temperature is the highest ($31.5^{\circ}F$) during the month of May which is dry with clear sky and cool nights. The relative humidity is very low ranging from 36 to 41 percent. As a result plant growth is greatly hampered. For agriculture this is the slackest season.

The heat is hard, the days often cloudless. The south-west and west winds from the deserts hold sway. Locally known as "Loo", these bring scorching conditions to Hissar. Outdoor work is frequently suspended in the mid-day hours.

(2) <u>The Harbinger of Monsoon</u> (June):

In June the heat increases to its maximum. The air is dry with a large quantity of dust particles hanging in it. The sky is cloudless but with a grey pall, through which the sun shines as a lighted disc. Occasionally, the day temperature exceeds 110^{o}F. Indeed the temperature in the open is sometimes so high that sunstroke is common. Nights, however, are cool and pleasant because of rapid radiation. A fresh, cool breeze usually blows in the morning. Dust storms are frequent during the afternoon hours. In June sometimes these storms bring sharp showers of local rain and a very welcome cooling of the air. The landscape is bare and brown. Not a green patch is to be seen, except where maintained by irrigation. By the end of June the steep barometric gradient, sets the stage for the "Monsoon Bursts" reaching Hissar in the middle of July.

(3) <u>The Rainy Season</u> (early July to mid-September):

In the early part of July the weather takes a new turn because the winds start blowing from the south-east and by about the mid-July the monsoon clouds begin to appear, and the humidity increases rapidly, till at last a thunderstorm announces the advent of rains. It initiates the rainy and moist conditions that prevail for the next three months. It is rather a misnomer to speak of a rainy season in Hissar, because there is no such continuous rain as is experienced in the north and north-east of the Punjab. Almost all the rain coming in a few heavy thunderstorms which seldom last for more than two to three hours. This type of rain continues through August and the first half of September, and thereafter the humidity begins to decrease. The heavy night dews announce the onset of the cold weather. The night dew is beneficial in maintaining the soil moisture which helps in the germination of the winter crop seed.

The season of general rains is the most useful period and the agricultural year begins with it. The bare brown landscape is turned into life within a few days of the arrival of rains. The clouds shade the sun and the rain helps to cool the air. Henceforth the temperature falls sharply. Living things feel a sense of relief. The relief from heat is welcome, but the continued high relative humidity and high temperatures make conditions oppressive for hard work and human comfort. The moist heat is even more oppressive than that of the hot season. On the other hand, the humid heat is very useful for the luxuriant and rapid growth of plants. From an agricultural point this season is considered as the most productive and active period. However, breaks in the rains may be lengthy and the total fall reduced so much that crops fail and famine follows.

The moist wind has a marked effect on the prevailing temperature. The effect is most conspicuous on the maximum day temperature which is 105·62°F in June and comes down to 99·68°F in July. During the rainy season the relative humidity is high (65 to 70 percent). The daily range of temperature is at a minimum on account of a low rate of nocturnal radiation.

(4) The Season of Retreating Monsoon (mid-September to November):

With the retreat of the monsoon and the southward shift of the sun, the temperature starts declining rather fast during the months of October and November. The daily range of temperature is at its peak due to the rapid radiation at night. There are usually heavy deposits of dew at night which are ideal for the maturing of summer crops and the sowing and germination of the winter crop seeds. October and November have the best weather of the year, with bright days, clear air, good visibility, moderate temperature and cool nights. Ultimately there is a sharp fall in temperature from November to December, the latter brings the Cold Season.

(5) The Cold-Weather Season (December to February):

By mid-December it becomes cool for three reasons:-

(a) the maximum obliquity in the sun's rays.

(b) the shorter duration of insolation.

(c) the cold waves from the snow covered mountains in the north.

In December and January nights are chilly. Sometimes the minimum temperature falls below $36^{\circ}F$ during the last week of December and the first half of January. Under such conditions foggy mornings are not unusual. The month of January occasionally gets cloudy and wet with the influx of depressions. The winter rainfall is usually in January. The cloud cover acts to decrease the daily maximum temperature and the daily range of temperature comes down to 25·1°F. The frontal precipitation generated by the depressions is usually light to moderate (1 to 3 inches). This is of vital importance. It falls in the cool season when losses from evaporation are low, and thus the precipitation is highly effective for the growth of winter crops. The relative humidity is 65 to 69 percent, the same as that of the rainy season. This is very beneficial to the tender winter crops and is accompanied by heavy dews.

(6) The Post-Winter Season (March to mid-April):

In March and the early part of April the anti-cyclonic characteristics of the winter months continue. These, in combination with a stronger sun, set the weather pattern for the season. Temperatures are high and drought intensifies, the more so because of a high rate of evapotranspiration. Relative humidity declines. From early March the winter season begins to fade, and cyclones cease to come. Sometimes a feeble cyclone may come at the end of March, giving a shower of rainfall. Such a shower is frequently accompanied by hail which, if strong, damages the standing fragile matured crops. The warm-dry winds during the last days of March may ripen the crops too rapidly to preserve the quality of the grain. By the middle of April hot-dry conditions again prevail.

Conclusion

The elements of climate and the seasonal rhythm have a profound influence on the agricultural activities in Hissar. The temperature as a factor in the agricultural operations is subordinate to rain. The major percentage of annual rainfall is contributed by the monsoon. To the cultivator the monsoon means one thing - rain. Rainfall enters every aspect of life. It is a pivot upon which the farm life swings. Any variation in this pivot, however slight, means a consequent variation throughout the whole agricultural and marketing structure in Hissar. The fluctuations in the annual harvest correspond to the trends of rainfall up to 1954-55, thereafter the extension of irrigation changed the situation (Fig. 13). There was a time when over 90 percent of the cultivation was rain fed. This figure still stands at more than 50 percent for the district as a whole.

The cultivators of the region express the monthly need of rain in the following words:

Sawan barse nit nit; Bhadon ke din char; Asoj barse mainghla; Phulen phiren ganwar (If heavy rains come in Sawan (mid-July to mid-August), and Bhadon (mid-August to mid-September) brings few showers, with further falls in Asoj (mid-September to mid-October), then the joy of the rustic (cultivator) knows no bounds). Very concisely the need of the rainfall in Hissar for ideal crop production is as:

On the rainfall of June and July depends the sowing of summer crops and that of August and September is no less important for the ripening of the summer crops and the sowing of the winter crops in the rainfed areas. If the rainfall has been good in September, the winter crops will require no further rains till near the end of January; in that case the heavy dews of the winter season supply sufficient moisture to keep the crops from withering. If, however, the September rains have not been sufficient or they cease early in the month, a fall about Christmas is necessary, or else the crops will be damaged. The rainfall distribution in Hissar does not coincide with the required distribution detailed because of a high degree of oscillations in it. In Hissar farming is indeed balanced on a knife edge without irrigation. There may be good years as well as bad; but a run of two to three deficit seasons may spell complete disaster, and even a well-to-do peasant may then have to sell his livestock. Further, the precipitation is a limiting factor in crop diversity and distribution of population. The shadow of drought is always present and life is more a struggle with nature than an enjoyment of her bounty. Although the canals and improved means of transport have dissipated the spectre of famine, yet the scarcity of food and fodder still occurs with unpleasant frequency in the rainfed agriculture. The rain has a dominant role in the farming pursuits of the rainfed areas, where most of the cropping depends on it.

The change of the warm sub-humid season to the cold-dry period is the fundamental feature of climate which enables Hissar to grow temperate crops in winter and sub-tropical/tropical crops during summer with or without irrigation. On the other hand, insufficient and erratic rainfall threatens to put farming out of gear. It is distressingly apparent that the variable monsoon rains are usual and the summer crops frequently fail and the sowing of the winter crops is minimised without artificial irrigation.

Therefore, drought-resistant crops or irrigated farming are a necessary part of regional adaptation.

CHAPTER 3

THE RAINFALL

The ensuing rainfall analysis is based on the precipitation records of 41 rain-gauge stations for a period of 12 years: 1950 to 1962 (Fig. 12). The rainfall figures of Hissar observatory for the period 1940-65 are used for the long-term precipitation analysis.

The average annual rainfall in Hissar decreases from north-east to south-west (Fig. 14). The uncertainty and ill-distribution of rainfall during the last decade and variation in rainfall during the same season and month in different years are notable. These features of precipitation over time and area in Hissar make a suitable case for the statistical investigation of rainfall data. In the following survey and analysis of rainfall data, the role of duration, intensity, concentration, seasonality, frequency distribution, variability (daily, monthly, seasonally, annually and spatially), coefficient of variability, trends, cyclical movements, effective moisture values and climographs have been emphasized. They are the chief aspects of rainfall which need a careful and detailed regional understanding and treatment in agricultural meteorology. These may be of great importance for the future orientation of agricultural policies and irrigation schemes on a regional basis based on the experience of the past years.

Rainfall effectiveness:

By effectiveness of precipitation as distinguished from the total fall recorded by the rain-gauge, is meant the quantity of water which effectively enters the soil and ultimately determines the condition of life over the surface of the earth. The effectiveness of the rainfall is not judged from its distribution but also by other factors which reduce or increase the value of actual moisture. For example, the strong winds blowing in July to September from Rajasthan dry up the land quickly and retard dewfall in the coming months, but gentle easterly winds in monsoon months are moist and to some degree serve the purpose of rain. Finally, the effectiveness of rainfall for agriculture, soil erosion and floods is reckoned by its duration, intensity and evapotranspiration.

Duration of rainfall: In the present text, a day of rainfall is taken as such, when it records a rainfall of 2·5 mm. (0·10 inch) or over in 24 hours (Memoirs, 1962). Inspection of the figures showing the total number of rainy days in summer, winter and a year at Hissar displays the following facts:-

(a) The maximum number of rainy days in any summer is 28 (1942-43) and the minimum is 10 days (1947-48).

(b) The maximum number of rainy days in winter is 10 (1955-56) and the minimum is zero.

(c) The maximum number of rainy days in a year that ever occurred since 1940 is 31 (1942-43) and minimum is 14 days (1963-64).

(d) Mean monthly duration of rainfall is maximum in July with 5·04 days which is also the wettest month and the minimum is 0·40 day in November which is the driest month.

Intensity of rainfall: The expression intensity is used in this investigation in the sense of intensity in a 24 hour period. It is an aspect of significance as it influences the intensity of soil erosion by rain and the usefulness of rain for agriculture. The calculations of the average intensity of rainfall ($I = \frac{A}{n}$; Monkhouse and Wilkinson, 1964) for 1940-65 at Hissar exhibits the following facts:-

(a) Summer intensity of rainfall varies from 0·44 to 1·32 inches per day of rainfall.

(b) Winter intensity varies from 0 to 1·04 inches per rainy day.

(c) Annual intensity varies from 0·41 to 1·20 inches per day of rain.

(d) In summer the maximum amount of rainfall is contributed by falls of about 0·50 to 0·90 inch and in winter by 0·10 to 0·50 inch. These results establish that the summer rainfall is less effective because of greater runoff than winter fall.

(e) The mean monthly intensity of rainfall is the highest in the months of July to September (0·99 to 1·02 inches) and the lowest in November (0·94 inch). On the whole it is at a maximum in the monsoon months (average 0·94 inch) rather than during the cyclonic period (average 0·38 inch). Hence monsoon winds are less feeble than cyclones. The most of the summer rainfall is wasted in run-off, and in winter most of it falls in a state of light drizzles with lower intensity allowing time for its absorption into the ground.

Rainfall Concentration:

Generally speaking more than 75 percent of the rainfall is concentrated during the three months of the monsoon season from

July to September. The average annual rainfall of 16·24 inches at Hissar is received in 22 rainy days. The concentration of the rainy days is in the monsoon season (15 days), followed by the cold season (3 days). The precipitation and the number of rainy days may be quite sufficient to meet the annual requirements of successful crop production, provided they are spread so that rain is received at the time required. The characteristic of monthly concentration of the rainfall decreases its usefulness in Hissar (Fig. 15). The sowing season of the crops may remain without rain in the south-west. The frequency of long dry spells is also a limiting feature for agricultural development (Fig. 16).

Rainfall Seasonality:

Two periods of rainfall can be recognised, viz., the period of primary concentration, or monsoon regime, and the period of secondary concentration, or cyclonic regime.

The general trend of summer rainfall distribution (Fig. 17) is similar to the annual. The summer rainfall is distributed over the period from July to September. It starts with the burst of the monsoon and ends with its retreat. It rarely happens that any rain falls in October. But whenever this is the case, it is an occasion for great rejoicing on the part of all, because the harvest, which is always most precarious, is assured.

During the winter season the area is under the sway of anti-cyclonic conditions. However, some disturbances are steered into Hissar from the north-west giving the region a small amount of rain. The fall decreases from north to south on account of the fading frequency and intensity of the cyclones (Fig. 18). The arrival of cyclones is highly variable. They generally come in the first week of January. However, on certain occasions the arrival is in the second half of January. A dry January is not unknown, though such occurrences are very rare. The early arrival of the winter rainfall is beneficial but the late arrival affects the winter crops adversely. The cyclones are neither intense nor regular, so there is a wide gap between the consecutive rainy days. This is one of the reasons which makes the winter rainfall more effective than the summer. Most of the winter rainfall comes in January and February. The early March rainfall is very beneficial for the swelling of the grain while the late rainfall spoils the standing mature crops as is accompanied by strong winds and hailstorms.

Frequency Distribution of Rainfall:

January and July are taken as the representative months for the study of the frequency distribution of rainfall over a number of units and years. January percentages, as dealt in Fig. 25, reveal some very interesting features. There are areas in the south-west showing the least percentage of annual rainfall in January, less than 2 percent. In the extreme northern parts of the region an appreciable rise of over 4 percent in the same period is shown. This reveals the increasing influence of cyclones in the areas nearer to the Siwaliks with a vanishing influence towards the south.

July percentages (Fig. 26) reveal the decrease from north-east to south-west. They make clear the actual variable monsoonic influence over the region. The tendency of major areas to reach a maximum of 25 percent in the single month of July is a prominent feature.

From the comparative study of the actual percentage distribution of the annual rainfall in January and July, we arrive at a conclusion that the monsoon is normal to weak and cyclones are feeble in Hissar. It will suffice to note that the units in the north-east reveal a tendency to reach a maximum of 30 percent precipitation or over in a single month of July. The need of water for irrigation varies within the district.

Variability of Rainfall:

Daily: There is a high degree of variability in the daily rainfall records of Hissar observatory over the last 25 years. The average of the maximum day's rainfall in each year is 2·76 inches. The highest fall in one day during the period under observation was registered on the 26th September, 1947 at 0800 hours. It was 6·20 inches and shows a percentage deviation of 124 percent from the average. In 1941 on the other hand no day exceeded a rainfall of 0·70 inch, recorded on the 17th August of the year.

Monthly: The average monthly rainfall at Hissar shows a mean maximum value of 4·96 inches in July and a mean minimum value of 0·10 inch in November. These figures show that the range of dispersion is 4·86 inches, which is high. During the last 25 years, the monthly rainfall was at a maximum in July, 1956 (13·40 inches) which showed a deviation of 170 percent from the monthly average. The second highest monthly rainfall occurred in September, 1958 (11·76 inches) with a percentage deviation of

232 percent from the monthly average. Although July and September recorded the highest rainfalls, yet the same months also remained without rain in 1947 and 1952 respectively. It establishes a high degree of uncertainty and variability of rainfall. The study of the rainfall variability in the months of January, February, June, July, August and September is of great significance for crops. The uncertainty of rainfall is more during these months (Table 3.i):-

Table 3.i

Months	Maximum	Minimum	Range
January	3·16	0·00	3·16 inches of rainfall
February	3·37	0·00	3·37 inches of rainfall
June	3·83	0·00	3·83 inches of rainfall
July	13·40	0·00	13·40 inches of rainfall
August	9·75	0·00	9·75 inches of rainfall
September	11·76	0·00	11·76 inches of rainfall

Average monthly rainfall, as indicated by the representative histograms (Fig. 29), is in close accord with the movement and force of the monsoon and depressions. Furthermore, the monthly variation of rainfall is pronounced, and affects the season and crops even more than does the variation in annual rainfall.

Seasonally: The inspection of the summer and winter rainfall records of the last 25 years shows that variability is haphazard: no simple periodicity can be fixed. Further it indicates that there is a high degree of dispersion within the mean summer rainfall (13·70 inches) and the mean winter rainfall (2·54 inches). The mean summer rainfall is more than five times the winter mean. Another conspicuous observation is that the highest summer rainfall was 25·17 inches in 1945-46 having a deviation of 360 percent from the lowest rainfall of 5·47 inches in the 1951-52 summer. The maximum winter fall was 10·44 inches in 1955-56 as against the minimum of 0·10 inch, registered in 1952-53.

Annually: The inspection of annual rainfall figures displays the facts enumerated below:

(a) During the period under observation 11 years registered rainfall above and 14 years below the average.

(b) The highest rainfall was 25·98 inches in 1945-46 and the lowest was 7·33 inches in 1951-52, a year of great distress.

(c) Twelve years have been notably dry, the annual rainfall being 15 inches or less in each case.

Spatially: Rainfall also varies to a great extent from place to place within short distances. For instance, the distance between Hansi and Hissar is 14 miles, but variability of rainfall is great (Table 3.ii):

Table 3.ii

Years	Hissar	Hansi
1951-52	7·33	11·46 inches of annual rainfall
1955-56	23·08	17·04 inches of annual rainfall

Indeed it happens frequently that one part of the village lands has a good fall and good crops, another part has particularly no rain, and the crops are quite sharply affected. The reason for this patchiness in the rain is that most of it comes in thunder-showers. The effect of increasing distance from the monsoon bursts is seen in the records for Bhiwani (18·55 inches) and Sirsa (12·87 inches), or likewise for Chandpur (24·73 inches) and Surewal (9·94 inches).

Degree of Deviation in Rainfall:

The exact degree of variability cannot be visualised by the mere inspection of the data. To judge the exact nature of deviation in annual, seasonal and monthly rainfall, the use of Mean Deviation, Departure from Median and Coefficient of Variability is necessary. These have been calculated by the standard methods.

Deviation from Mean: Histograms in Fig. 27 represent the deviation from mean of the annual, summer and winter rainfall. Search through the diagrams elicited some interesting features:-

(a) The yearly departures from the mean annual rainfall were having a pronounced negative tendency up to 1954-55, thereafter showed more positive trend. It establishes the favourable rainfall situation in the later half of the 'fifties.

(b) The summer rainfall deviations from the mean are identical with the annual except a very few departures from the situation. On the whole, a primary role is played by summer rainfall in annual deviations.

(c) The deviations of winter rainfall from the mean are more erratic having a considerable degree of negative tendency making it least useful to farming.

With the careful inspection of the deviations from the mean we can find out how the monsoon and cyclones behaved in Hissar during the last 25 years. It will be of interest to know the behaviour of the past monsoons, how many were beneficial, how many were total or partial failures. For this purpose the use of deviations is indispensible. If the deviation of actual rainfall in a year in a sub-division is more than twice the mean deviation, that year may be defined as a wet or drought year according to the departure, which may be either positive or negative. In Fig. 28 the filled circle indicates a wet year, the open circle one of drought; the blanks are years with more or less normal rainfall. The years 1941-42, 1951-52 and 1959-60 stand out most prominently as years of general drought. These were actually years of great distress.

Departure of the Monthly Rainfall from the Median: The rains may start a few weeks late. The cessation of rains may be earlier than usual. There may be long breaks in the rainy season in the months of August and September, when it is most needed. From an economic point of view these conditions have the greatest bearing on the agriculture of an area. A measure of variability of monthly rainfall over space from the median has been sought to give a key to its reliability by plotting the monthly lower quartile, median and upper quartile of rainfall data of a given period. The ordinary average is insufficiently sensitive, and sometimes it is over sensitive to extreme variations (Crowe, 1933). For example in the case of rainfall figures, the occasional high value of no agricultural significance may raise the average unduly, especially in semi-arid lands like Hissar. In order to illustrate the regional distribution of monthly rainfall deviation from median, the stations selected lie along north-east to south-west, north to south, and east to west cross-sections (Fig. 30):-

(a) Although the inter-quartile distances in the dispersion diagrams indicate that the June rainfall is less variable than the rainfall of July, August and September, yet it should be remembered that the higher variability in July and August as indicated by the inter-quartile distances is less significant on account of the high monthly totals in the north-east and east. The much smaller variability in June is more likely to be critical in farm operations because the monthly average is low and rainfall in this month is very essential for farming.

(b) Long breaks of rain are common in between monsoon and cyclonic rainfall. These are more prominent in the south and south-west.

Coefficient of Variability: The investigation of the coefficient of variability of rainfall on the basis of spatial observations for the period 1950 to 1962 has been attempted. The study covers the level of rainfall for 21 observation stations, for which average rainfall and coefficient of variation have been worked out throughout the stated 12 years. The different years (Fig. 31) and different observation stations (Fig. 32) have been plotted on the dispersion diagrams on the basis of the average rainfall and the coefficient of variability. It is observed that 12 years and 21 stations show variability higher than the level of average rainfall and none came under the diagonal. This situation is unfavourable for crop production.

The coefficients of variability for summer and winter for Hissar observatory have been derived as 31·90 percent and 85·47 percent respectively. The rainfall becomes highly variable as the distance from the Siwaliks increases (Fig. 33). The coefficient of variability of annual rainfall increases from north-east to south-west.

Trends and Cycles of Rainfall:

A search for long term changes in rainfall along with cyclical periodicity, if any, has been made with the help of standard statistical methods, such as, the use of moving averages and computed means.

Annual: Curve 'a' in Fig. 19, which is very irregular, represents the variation in annual rainfall totals. From it no long term change in rainfall can be noticed. Curve 'b' indicates the 15 yearly moving mean value. It gives a smooth annual trend which shows a steady gradual rise. A straight line 'c-d' drawn through the computed means further confirms it.

Seasonal: In order to study the long range seasonal changes, the values of the summer rainfall (April to September) and winter rainfall (October to March of the next year) have been computed. Since the 15-yearly running means have shown the annual secular trend, the use of 15-yearly running means alone for the long range changes in rainfall of various seasons has been deemed adequate.

(1) Summer: In Fig. 20 curve 'a' shows the fluctuations of summer rainfall which are rather erratic. It has the same features as that of annual totals. Curve 'b' and line 'c-d' represent the secular change of summer rainfall and both reveal the slight, insignificant increase in rainfall during the last 25 years.

(2) Winter: Curve 'a' in Fig. 21 represents the graphical changes in winter rainfall and reveals that these are not so violent and irregular as the summer, except on one occasion, for the year 1955-56. Even a cursory glance at the summer and winter curves of actual totals unmistakably shows their dis-similarity. Curve 'b' and line 'c-d' indicate that the winter fall has an increase but is immaterial for agricultural purposes.

The ranges of rise as derived from the semi-averages are as follows (Table 3.iii):

Table 3.iii

Rainfall Period	1940-52	1953-65	Range
Annual	14·73	17·64	+ 2·91 inches
Summer	12·36	14·93	+ 2·57 inches
Winter	2·36	2·70	+ 0·34 inches

On account of considerable diversity in the long term changes observed in the two seasons (summer and winter), it would be desirable to undertake the analysis of the long term changes in the various agricultural-rainfall seasons of a year in Hissar.

The range of secular change, if any, in the rainfall of different periods can be screened with the help of semi-averages (Table 3.iv):

Table 3.iv

Periods	1940-52	1953-65	Range
1. Hot-Dry (April-May)	0·50	0·41	- 0·09 inch
2. Harbinger of Monsoon (June)	1·06	1·55	+ 0·49 inch
3. Rainy (July-September)	10·80	12·97	+ 2·17 inches
4. Warm-Dry (October-November)	0·54	1·30	+ 0·76 inch
5. Cold-Dry (December-February)	1·21	1·12	- 0·09 inch
6. Post-Winter (March)	0·61	0·28	- 0·33 inch

It is evident from the ranges that the rate of rise or fall is very small. This is insignificant for agriculture except in the wet period. The rainfall of rainy period (wet) is erratic as is depicted by curve 'a' in Fig. 22. Curve 'b' and the line 'c-d' show the secular trend showing the trend of the monsoon rainfall, may be of some significance for summer crop production. Fig. 23 shows the rainfall conditions of the cyclonic period having a downward trend and more dry years. It underlies the necessity of irrigation facilities for the successful winter crop production in Hissar.

Thus a critical examination of the rainfall data does show that there has been insignificant change in the annual and seasonal rainfall during the last 25 years. On the whole, it has characteristics of steady changes and erratic fluctuations. Old inhabitants, say that the rainfall now is a little better than it used to be, and this improvement they ascribe to the breaking up of the wasteland and the extension of irrigation. Probably the fact is that there is no permanent change in the amount of the rainfall during the period under study.

Cyclical Movements of Rainfall: Efforts have also been made to measure rainfall cycles. The idea of measuring the rainfall cycles is to determine the periodicity of rainfall, if any. Forecasting cyclical movements of rainfall with a fair degree of accuracy would be of considerable use for farm operations over a long period. No regular and uniform cyclical periods in rainfall can be established in Hissar (Table 3.v):

Table 3.v derived from Fig. 24

Dates of Specific Cycle			Total number of Months in each		
Revival	Peak	Trough	Expansion	Contraction	Full Cycle
Nov.41	Sep.42	Aug.43	11	11	22
Sep.43	Sep.45	Feb.47	25	17	42
Mar.47	Feb.48	Sep.48	12	7	19
Oct.48	Mar.51	Jul.51	30	4	34
Aug.51	May.55	Apr.57	46	23	69
May 57	Jan.58	Sep.58	9	8	17
Oct.58	Apr.60	Nov.62	19	31	50
Dec.62					

An examination of the curves in Fig. 24 based on 12-monthly overlapping averages (centred) also reveals the irregular and uncertain tendency of rainfall cycles with no uniformity in the duration of periodicities.

Effective Moisture Value:

An effective moisture value is evolved by the subtraction of potential evapotranspiration from precipitation. The basis of argument is as follows:

When precipitation is greater than the potential evapotranspiration value for a month, more water enters the soil than is lost to it, and recharge of soil moisture results. When potential evapotranspiration is greater than rainfall, the reverse is true. Effective moisture values have a higher correlation with yield, maturity, and cropping than the actual rainfall alone.

From the comparison of the monthly precipitation with potential evapotranspiration for the various stations in Hissar, it is possible to obtain a clear picture of the periods of water surplus and deficiency in relation to monthly rainfall and to bring into perspective the nature of the water problems and requirements in the area for successful crop husbandry. Figs. 34 to 37 portray the monthly distribution of rainfall and potential evapotranspiration at the selected stations in Hissar. These reveal that the potential evapotranspiration exceed in every month over the actual rainfall except January in the north-east when there is 1·03 cm. moisture stored in excess in the soil. This is used in the following month to the extent of 0·67 cm. and the remaining in the first week of March. So irrigation to standing winter crops becomes a necessity in the beginning of March. The crop growth is closely related to the water use of the plants. The annual and seasonal potential evapotranspiration provide very general indices of the growth potential of an area. The annual potential evapotranspiration at Hissar is 139·48 cm. and actual rainfall is 41·25 cm. Hence, there is a deficit of moisture to the extent of 98·23 cm. resulting in soil drought.

Soil drought is more accurately described as a condition in which the amount of water needed for transpiration and direct evaporation exceeds the amount available in the soil (Thornthwaite, 1948). Hissar comes under the class of contingent permanent soil droughts because the rainfall is scanty and variable everywhere and the water table is deep. These droughts depend upon the variability of the monthly rainfall. They are not certain to occur with the same intensity in any definite month, but are most probable at the time of maximum water need. In Hissar this is in summer, when evapotranspiration is at its peak and the standing summer crops require more water. The droughts are more treacherous. They vary greatly in intensity, duration and time of occurrence and are thus seldom anticipated. These are the greatest natural hazards to farm economy in semi-arid climates and the cause of the dreaded famines of the rainfed areas of Hissar, which are not wholly a thing of the past. They are chiefly to blame for low average yields. They cut quality as well and food grains or fodder that have suffered from drought are less nutritious than those that have not. Thus, the agriculture is not assured except by irrigation through the crop season.

As is evident the water need, rainfall and surplus or deficit in terms of the overall figures for Hissar varies through the year. The January surplus serves the potential deficiency of February and to some extent reduces that of March. Only 42·90 mm. of water is needed during the four months of winter: December to March. The need rises rapidly during the spring and reaches a high point in May of 189·60 mm. Requirements fall thereafter but rise again in October. This is agriculturally significant because it coincides with the sowing of the winter crops. Overall the rainfall and the water needs of Hissar do not coincide except in December (Table 3.vi):

Table 3.vi

A comparison of Water Need and Rainfall, Hissar (Average 1940-65)

Month	Water Need mm.	Rainfall mm.	Difference mm.	Resultant Surplus/Decifit + mm.	- mm.
January	6·40	12·70	6·30	+ 6·30	
February	17·40	13·70	3·70	+ 2·60	
March	61·80	16·30	45·50		- 42·90
April	159·10	6·60	152·50		-152·50
May	203·30	13·70	189·60		-189·60
June	210·90	32·00	178·90		-178·90
July	214·50	123·70	90·80		- 90·80
August	189·80	108·70	81·10		- 81·10
September	163·70	71·40	92·30		- 92·30
October	117·60	15·50	102·10		-102·10
November	40·50	1·50	39·00		- 39·00
December	9·90	9·90	Nil	Nil	Nil

(Calculated after the Method of Thornthwaite, 1948, see pp.92 to 94 Geographical Review)

The spatial variation can be observed in Fig. 38. The average annual water deficit reaches its maximum in the south-west part of Hissar with a general decrease towards the north-east. Similarly in summer it decreases from south-west to north-east (Fig. 39). In winter the whole of the district has a higher degree of intensity of soil drought than summer (Fig. 40). It suggests that winter soil drought is more injurious than summer and needs more regular flow of canals to assure the maturity of the tender crops. However, the high winter intensities are compensated to some degree by the drought-resistant nature of the crops and the low water requirement in acre feet per square mile of the cultivated area (Fig. 42). These decrease the possibility of the crises which are otherwise expected every year in the form of winter crop failures. The calculation of the intensity of soil droughts can be used as a guide for prescribing the appropriate monthly intensity of canal irrigation in Hissar on regional basis.

Potential evapotranspiration as a basis can be used for reckoning the need of water in acre feet per square mile of the cultivated area, after taking into account the actual rainfall. It has been done as:

Water requirements per square mile of the

$$\text{Cultivated area} = \frac{\text{Potential Evapotranspiration-rainfall}}{12} \times 640$$

$$= \text{Acre Feet}$$

where 12 is used for the conversion of inches into feet,

640 to change acres in a square mile.

Results thus derived mapped in Figs. 41 and 42 exhibiting the water requirements over and above rainfall in Hissar by assessment circles for respective crop seasons.

In summary, the extent to which the rainfall in any area can provide soil moisture available to crops therefore depends not only on the total amount of rainfall per annum, but also upon its seasonal distribution, its reliability within and between seasons, its intensity and rate of infiltration into the soil, and on the balance between rainfall and evapotranspiration from the crop and soil. Generally, the present calculations of soil drought do not take into account the surface run-off of rainwater which is unable to percolate into the soil on account of the gradient, and the poor structure and the rainwater which drains beyond the root range of plants into the deep subsoil. In Hissar the former is of some significance in the Bagar areas of Bhiwani.

Climatic Graphs or Climographs (Foster, 1944): The climographs of various stations of Hissar depict the intensity of aridity (Fig. 43). A comparison of these graphs reveals that nearly complete aridity prevails in the south-west which is best exemplified by the climograph of Surewal. As we proceed towards the north-east the intensity of aridity decreases. The climograph of Chandpur exhibits the humid conditions in the monsoon months which is an improvement over the climatic conditions of the south-west. Climatically the north-east of Hissar is akin to the Punjab Plains and the south-west to the Indian Desert. The shape of the climographs of Hissar and Chandpur show that the region has a suitable climate for the growth of wheat and cotton provided perennial irrigation facilities are adequate.

Conclusion

The coefficient of variability, deviations, departures from the median in rainfall and the potential evapotranspiration along with climographs provide an adequate ground for making future planning and improvements in agriculture and irrigation on regional basis. The analyses indicate that unless irrigation facilities are provided to cope with the vagaries of rainfall, the land will only be agricultural at the risk of disastrous famines. Although it can produce a bumper crop one year, it may be a pitiful sight of disaster in the next.

In semi-arid areas, fluctuation in rainfall has greater economic consequences than in arid areas. In semi-arid areas in an average year numerous livestock can be grazed, and in good years the harvest of crops may be excellent. Hence, human occupation is invited. Conversely, the losses during drought years are much greater than in arid regions, which, without irrigation, never support many people and stock. For these reasons, drought causes much greater loss in Hissar than it does in the neighbouring arid lands. The main aspects of rainfall detrimental to crop agriculture development in Hissar are small quantity, seasonal concentration, torrential character, sharp local contrasts and a high degree of variability. Furthermore, the excessive evaporation is a principal factor reducing the effectiveness of rainfall for crop growth. The percentage of the area of Hissar in crops has reflected the control of rainfall, so dominantly that other elements in the physical environment can be considered subordinate. Obviously the best hope for the future lies in the extension of irrigation. The extent of irrigation is determined by the structure and chemical composition of the soil and the water requirement of the crops to a considerable degree.

CHAPTER 4

SOIL FACTORS IN AGRICULTURE

Soil constitutes the physical basis of our agricultural enterprise (Bennet, 1939). Farming is a business and the good soil is part of the farmer's stock-in-trade. An understanding of good farming begins with an understanding of the soil. The top-soil is the most vital part of soil. Lying at an average depth of about 7 to 8 inches over the face of the land, this upper layer is the principal feeding zone of the plants, which provide food for human or livestock consumption, fibre for clothing, the timber for shelter. Soils having a proper combination of texture and structure (physical properties), salts (chemical properties) and humus (biological properties) yield good results. The cultivator must have the knowledge of the composition and combination of his soil. Only then can he put his soil to the best and most profitable use. Knowledge is essential for the purpose of the maintenance of soil fertility, moisture conservation, control of soil erosion, irrigation, crop rotations, the use and application of chemical and green manure and other similar matters.

The alluviums of Hissar are, on the whole, fertile. On the confines of the Thar desert the drifting sands have covered the alluviums. Alluvium possesses great natural fertility. It is less dependent on manures than other soils and does not require the same elaborate rotations. The original character of the alluvium has been modified by the prevailing climate and irrigation. In some parts the alluviums are loose in texture on account of low rainfall and excessive evaporation and in others compact due to irrigation. Elsewhere these are clayey and blocky because of the regular floods of the Ghaggar. In some areas gully or rain erosion and in others wind erosion are prevalent. Thus from many parts finer soil particles are removed and are re-deposited. All activities combined lead to the differences in the productivity and crop adaptability of the alluviums within the borders of Hissar. The area is mostly soil covered and the soil-less area is restricted to the hills.

The present description of Hissar soils is the synthesis of Settlement Reports (Punjab Government, Lahore: 1875 to 1912), Soil Samples (analysis conducted by the Soil Section of the Agriculture Department; Department of the Soil Science in the Punjab Agricultural University and the Chemical Section of the Irrigation and Power Research Institute, Punjab) and the personal observations.

The Physical Properties

The physical aspects of the soil may be approached from the standpoint of its texture, structure and depth as these are of great importance to its economic utilization. The close relationship of these factors to the water economy of plants and crop responses is evident. Differences in these factors often can be accounted for regional differential patterns in crop husbandry.

A vast expanse of Hissar is covered by the alluviums, consisting of deep layers of river deposits of recent times with superior tilth and nutrient value. Main components of these alluviums are sand, silt and clay. On the desert margins lie the sands re-deposited by the sweeping monsoon winds. The best soil is alluvium which has sufficient sand in it to prevent the clay particles from adhering together. With regard to development in the future, the variable physical and chemical conditions of the alluviums bring difficulties in the practising of irrigation.

The components of soil help in finding the quality of land for successful crop growth. Further, these determine the ease with which water may penetrate, the capability of holding water and the fixation of roots. Crop growth may be related to differences in "root room", which is effected both by structural conditions of the upper layers and by the depth of the rooting zone (Hardy, 1951). The latter can be limited by dense or hard layers, lack of aeration, or salinity or by ground water within the reach of the roots of a crop after the end of the rainy season, or differences in nutrient supplies, lime content, and acidity. Therefore, it is desirable to have standard soil types having texture and structure the primary criteria of classification. Ordinarily the soil textures are classified as sandy, silty, clayey and loamy according to the proportions of the different types of particle present. Apart from the purely physical property of permeability, however, soil properties are also very closely bound up with the relative amounts of clay and quartz in the inorganic fraction of the soil (Eyre, 1963). As regards structure, a farmer understands his soil well when he speaks of his land being in a good heart and his seed bed in a good tilth. The professional farmer of Hissar rubs his well matured soil through his fingers and observes its satisfactory crumb structure. The soils of Hissar are closely related to the geological formations and the deposition surfaces (cf. Figs. 4, 7, 44 and Table 4.i):

Table 4.i

The Physical Analysis of Soils of Hissar as compiled from the soil samples

Areas	Textural Grades after Alexander, 1952	Clay %	Fine Silt %	Coarse Silt %	Sand %
		Size of particles after Black, 1957			
		Below 0·002mm.	0·002 to 0·02 mm.		Above 0·02mm
1. Bagars South	Sand	4·65	2·55	5·02	87·78
2. Bagars South-West	Loamy Sand	7·62	5·68	4·52	82·18
3. Western Haryana	Sandy Loam	13·65	8·85	7·95	69·55
4. Rohi	Sandy Loam	13·50	15·55	10·70	60·25
5. Eastern Haryana	Loam	16·80	20·73	16·50	45·97
6. Nali	Silt Loam	24·50	38·70	15·20	21·60

The Chemical Properties

It is necessary to take account of the chemical conditions of the soils, which provide required nutrients for plants. The chemical composition of a soil depends upon the original mineral composition of the parent material, upon the weathering and the biotic activity. The latter factors to a considerable degree are governed by climate. On account of the semi-arid and arid conditions prevailing in Hissar, a copious accumulation of the salts can occur within the upper layer of the soil. The results of the sample analyses (Uppal, 1961) revealed that 31·40 percent of the soil in Hissar is in various stages of deterioration as a result of salinity and alkalinity at the surface or at some depth below the surface, and 68·60 percent is fit for normal cropping. The increasing salinity and alkalinity indicate the extension of the waterlogging tendencies. The sandy soils are the more alkaline, the loamy soils are saline-alkaline. Both are poor in humus because of the absence of natural vegetation cover and dry conditions. The heavy silt loam is poor in salts but rich in humus due to the vegetation cover in the flood plain.

The Department of Soil Science of the Punjab Agricultural University, Ludhiana, has demarcated the soil zones of the Punjab based on chemical properties and rainfall. Hissar is covered by two zones (Table 4.ii and Fig. 45):

Table 4.ii

Zone	Soil pH Range	Soil Characteristics: Ca Co 3% Av.	OM % Humus	T.N.% Nitrogen	Av. Nitrogen in lbs per acre	Av. P_2O_5 in lbs. per acre	Climate: Rainfall inches	Class: Soil Classification
v	8·0-8·6	1·84	0·50	0·04	79	18	10-20	Saline-Alkaline
vi	8·5-9·0	2·30	0·23	0·02	75	16	Below 10	Alkaline

The pH* value of the soils on the whole, is decidedly high showing the tendency towards alkalinity. Crops can be grown

* A pH value is a term related to the hydrogen ion concentration in a solution, which is a measure of acidity or alkalinity. Distilled water, which is neutral, has pH value of 7. In a soil this corresponds to neutrality-neither acid nor basic. A pH value above 7 indicates the presence of alkalies and below 7 of acidity.

easily in soils whose pH value goes up to 9 in the Punjab. If pH is greater than 9 the soil requires reclamation. Similarly if pH value is below 5 it requires reclamation. In Hissar the former is the situation. A pH value of 7 is ideal for crop production. When the pH value of the soil becomes greater than 8·5, the yield of crops diminishes markedly and the salt present in the soil may accumulate on the surface to such an extent as to render the soil uncultivable (Hoon et al., 1941). The principal salt present in the soils of Hissar is sodium sulphate.

The soil developed under low rainfall conditions contains more calcium carbonate (Ca Co) due to a good rate of calcification as a result of the absence of excessive leaching. Therefore, the soils of Hissar fall under the lime-accumulating group. The content of calcium in the soils of Hissar is twice that of the soils in the Kangra Hills (Siwalik) and the grasses growing in the former contain 17 percent more calcium than the latter (Nijhawan, 1956). Therefore the cattle of Hissar are superior in quality to those of the neighbouring districts in the north-east. The breed is known as Haryana and is famous all over India. The superiority of the Haryana breed is certainly not due to better feeding in point of quantity: the inference is that the little they get is usually of better quality and goes to make strong bone-formation. Eastwards the cattle, while remaining markedly of the Haryana type deteriorate in quality, although both rainfall and quantity of grazing rapidly improve. The suggested reason is the deficiency of calcium in the soil.

Kankar (nodular calcium carbonate) is found in the south-west of Hissar tahsil and in the compact and level soil on both sides of the Ghaggar in Sirsa tahsil (Irrigation and Power Research Institute, 1961). The Kankar formation is harmful to crop growth for four reasons, viz:-

(1) it does not allow the fixation of the roots.

(2) it accumulates the chemical manure around it.

(3) it forms a hard pan in the soil which does not allow the proper drainage of water.

(4) it reduces the availability of calcium and other nutrients. (Soil Specialist, Hissar, personal communication).

On the whole the soils of Hissar are deficient in humus, nitrogen, phosphorous and potash. The nutrient deficiencies and especially low soil nitrogen content constitute the main limiting factors to the attainment of high yields. The percentage of soluble salts by weight in a depth of soil ordinarily occupied by the roots of the plants varies from 0·51 to 0·95 percent and the degree of salinity ranges between medium to strong in Hissar. These salt concentrations are injurious for plant growth and may render the soil impervious. Salinity and alkalinity are serious problems and do not allow the area to grow sensitive crops which have low salt tolerance. Thus, the soil is suitable for barley, rape and cotton (high salt tolerance crops) as well as wheat, rice, millets, maize, linseed and pulses (medium salt tolerance crops). The present deficiency in plant nutrients in the soils of Hissar suggests that the State Agricultural Department should pay proper attention to the use and liberal distribution of chemical fertilizers to the farmers. The average use of fertilizer at present is 0·05 to 4·50 kilograms per acre in Hissar (District Agriculture Officer, Hissar, 1965). It is very small in comparison with the deficiency of chemical nutrients. The presence of salinity and alkalinity in the soils of Hissar suggests that the extension of irrigation, the design of a canal system and the cropping should be carried out scientifically keeping in mind the degree of impregnation of the soils with salts.

The Agronomic Classification

Since plant growth and production are the main functions of the soils under cultivation, the criteria of classification should be agronomic. Classification according to agricultural capability rather than genetic classifications prevails when planning purposes are concerned. There is no basis as yet for a detailed soil map of Hissar. Fig. 44 attempts to define four major categories of soils having variable crop production potentials upon the basis of the limited work available. The categories are summarized below, much having been written alone on soil texture and structure.

Category I: The very Light Soil:

Sandy and Loamy Sand: Most of these lie on the undulations of south (sandy) and south-west (loamy sand) of Hissar. They are subjected to excessive wind erosion and to overlaying by drifting sands. They have a single grained structure because the individual particles exist independently. They suffer from the drawback of maximum permeability, causing excessive drainage and the tendency to dry up rapidly, and a low water-holding capacity. These features cause crops to suffer in periods of drought. The labour of ploughing is slight and aeration is very free. A high content of salt is present and sub-soil water is mostly unsuitable for irrigation purposes because of brackish nature. Soils are highly alkaline. The chief qualities of these soils are that they are very deep, light, well drained and highly permeable. Average yields are poor from these soils. Inferior food cereals, food pulses and seed crops are raised on these soils.

In the farmers language, a sandy soil is 'hungry'. It is desirable to build up the light sandy soil partly by irrigation, partly by mixing silts and clay in right proportions. There are tremendous opportunities for the latter in a crowded country like India where good land for agricultural activities is of vital importance.

Category II: The Light Soil:

(a) The relatively Sandy Loam: The sandy loam belt stretches between the sandy soils and the loams. Wind erosion and deposition are still significant. The sandy loam is highly granular and is porous. It has a crumb structure which is considered effective for plant growth. With a good proportion of sand to silt and clay in it, the ideal degree of both permeability and water-holding capacity is found. No crops can be raised on scanty falls. The soil gives a good response to irrigation, though like the sandy soils, it needs the help of modern practices to build up the soil.

(b) The Sandy Loam: The sandy loam is found in Sirsa tahsil to the north of the Ghaggar stream. It is soft with almost balanced proportions of sand and silt with clay. The considerable silt and clay fractions are associated with the old abandoned river courses. The soft loam is less granular than the relatively sandy loam. In view of the occurrence of sufficient seepage, care will have to be exercised in order to raise successful crops. With irrigation and a moderate amount of rainfall crop yields are high. Undoubtedly the best texture for a good all-purpose agricultural soil is that of soft loam: a mixture of fine sand and silt with a moderate proportion of clay to retain moisture and to prevent the rapid drainage of moisture and fertilizers from the soil. The light soils have advantage over the medium soils: less moisture is required for germination and growth.

Category III: The Medium Soil:

The Loam: The loam is found in eastern Haryana which is the oldest, prosperous agricultural area of Hissar. The soil is compact and stiff because of the addition of silt by canal water. It is less granular and has a low water-holding capacity. The moderate permeability characteristics of this soil linked with intensive irrigation led to waterlogging in the vicinity of the canals. With sufficient seasonal rain, it is very productive, but no crops can be raised on the scanty rainfall which may suffice on the sandy loams. It requires more labour to till because of its nature. On the whole the soil is deep, well drained and fertile capable of producing a variety of crops such as wheat, cotton and sugar-cane.

<u>Category IV</u>: The Heavy and very Heavy Soil:

Silt Loam and Silty Clay: The silt loam is found in the flood plain of the Ghaggar and the proportion of silt-clay components is more than sand. It has a blocky structure which reduces its water-holding capacity. The tillage of this soil requires more labour. It gives good yields under efficient soil management. A variety of crops can be raised on these soils.

The silty clay is found in the stream bed. The proportion of silt and clay is over 80 percent and it has an appearance of hard red clay. It has a compact and cloddy structure (dakkar). It tends to become puddled under direct impact of rainfall and floods and become indurated when exposed to insolation, both make its tillage and sowing impossible. It is poorly permeable and suffers from highly deficient drainage. It has less power of holding moisture. It needs frequent watering for plant growth, otherwise it is difficult to cultivate. It requires more labour to till and is less fertile than loams. Its fertility is renewed every year, which makes it fit for farming. It provides very fine pans for rice cultivation.

On the whole, the heavy and very heavy soils are rich in organic matter and poor in salt contents. Generally the quality of these soils appears to be good. In years of good rainfall gram and barley give yields as high as 20 to 25 maunds per acre, the wheat sown with irrigation gives outturn of 25 to 35 maunds per acre and the paddy with favourable rains and floods yields 40 to 50 maunds per acre.

The Soil on the Hills: The soil of the rocky outcrops is coarse, not sufficiently thick and fine for crop production. The soil is vanishing as it is being washed away by torrential summer rains and wind blasts of the hot-dry period. It is too shallow, too stony, or too infertile to be used for the production of field crops. It is a residual weathered material lying over the parent rocks and is a very hungry soil.

Problems Pertinent to the Soils of Hissar

The soils of Hissar pose three different problems:

(a) The Salinity-Alkalinity, leading to waterlogging and deficiency in chemical-biological nutrients, having decidedly depressing effects on crop yields.

(b) The soil erosion.

(c) Deficiency in soil moisture.

All these problems hamper agricultural prosperity. To overcome the long term damage caused to the soils in the newly developing areas of Hissar, the need of soil and water conservation arises.

The Soil Erosion

The information on soil and water conservation may be found in the standard works such as of Gorrie (1938 and 1946), Ree (1954), U.S. Department of Agriculture: Soil Conservation Service (1954), Bennet (1955), Stallings (1957), Rao (1962) and Arakeri _et al_.(1962). Therefore there is no need to attempt to detail the techniques of soil and water conservation. On the whole, the measures of soil conservation on a large scale are needed in Hissar to check wind erosion and waterlogging and to conserve the soil moisture effectively.

In Hissar, as in many counterparts of the world, the wind works as a powerful force in removing material leading to soil erosion on a decidedly bigger scale. During the hot-dry months, the winds with a considerable velocity remove fertile arable loose soils and deposit coarser sandier soil over cultivable lands. Hence the work of wind is twofold in Hissar. It suggests that the farmers should take twofold measures to save the top soil of arable land from erosion, and to prevent the deposition of an agriculturally useless sand. The seriousness of the wind action is increased because of the level terrain and the absence of vegetation cover. It has been further accentuated by overgrazing which made the already exposed coherent soil susceptible to wind erosion. The low rainfall, excessive evaporation, high salt and low humus content of the upper surface are inimical to the development of a good coherent soil cover. Eventually, this poor soil is constantly in the grip of wind action. The dominant action of wind should be stressed more in Hissar as it acts over most of the area.

Measures for the conservation of soil and water are largely interdependent. Methods of land-use, or agronomic and mechanical measures suitable for the control of water erosion, aim principally at reducing run-off by increasing the proportion of the rainfall percolation into the soil and are consequently beneficial in conserving water. Wind erosion only occurs when the soil is dry, hence one of the chief measures of its control is the conservation of water in order to raise the moisture content of the soil (Webster and Wilson, 1966). Measures to ensure the maximum conservation of rainfall and canal water as soil moisture available to crops must aim mainly at improving water infiltration, reducing run-off and increasing the water-holding capacity of the soil. Such measures should be given priority in Hissar an area having low, fickle and seasonal rainfall.

The Soil Moisture Deficiency

The soil drought has a different meaning from drought. Drought as defined by meteorologists is the shortage of rainfall. An absolute drought is a period of at least 15 consecutive days, to none of which is credited as much as 0·20 inch of rainfall. Such a definition would fail to take into account the amount of water needed. Furthermore, the effect of a shortage of rainfall depends on whether the soil is moist or dry at the farming period. Soil drought in its proper sense is related to soil moisture and it begins when the available soil moisture is diminished so that the crops or vegetation can no longer absorb water from the soil rapidly enough to replace that lost to the air by transpiration (Shantz, 1927). The soil drought is a common feature in Hissar having monthly, seasonal, yearly and spatial variability as has been already confirmed.

Since it is impossible to increase the rainfall to fit the water need, changes must be suggested which, in other ways, either adapt to, or counteract, soil drought. The chief adaptations that are feasible are four in number. Firstly, agronomic improvements can increase the storage capacity of the soil. Crop rotations, with the frequent sowing of the legumes, improve the soil structure and increase its water-holding capacity. So does the application of lime and green manures. These practices make the soil more absorptive, and less water is lost by direct run-off from the heavy storms. Secondly, drought-resistant crops with improved varieties should be raised. Thirdly, the crop calendar might be re-adjusted so that the harvest will come before severe drought. It can be done either by early sowing, which is difficult in Hissar without irrigation, or the use of early-maturing varieties. Fourthly, dry farming techniques could be improved. Dry farming is a system of conserving soil moisture for best of its use, of preventing soil erosion and of crop management in areas of low and uncertain rains. Farmers, in an attempt to find a living in this semi-arid area, through trial and error, have devised dry farming techniques which maintain the moisture and fertility of soil. These are the only secondary remedies against drought. Supplementary irrigation is the only final way of counteracting drought and makes canal irrigation a practical necessity at the present degree of soil drought.

Conclusion and Suggestions

On the whole, the soils are fertile and respond to irrigation. They require very little artificial drainage, unless their natural condition has been altered by excessive irrigation. They require little expenditure for cultivation on account of the easy workability. The farmers of Hissar are lucky because most of their soils are well drained and granular in structure. Irrigation is required to provide water frequently and to keep the soil compact for facing wind erosion.

Since soils are deficient in nitrogen, phosphorous and humus, the considerable use of proper commercial fertilizers is essential. Under high temperature conditions it will be found difficult and even impossible to restore the nitrogen and organic matter to its virgin level. With the use of a good system of cropping, that is, a system allowing for the liberal additions of crop residues, green manures, farm manures, and the use of legumes in rotation, it is possible to build up or at least maintain the nitrogen and organic contents to the required level. The pH value of these soils is high, so they are not suitable for sensitive crops. The soils are highly alkaline and saline and the soil management should be done judiciously with suitable cropping systems. Frequent dressings with green manuring are desirable for sustaining the level of fertility, increasing the soil moisture retentive power and reducing the alkalinity. In sandy areas it is essential for furnishing the soil with necessary plant nutrients and to keep it adhesive for facing the wind action. Great care is needed in irrigating the sandy soils on account of excessive seepage. To avoid it, the size of plots has to be small, allowing the water to reach all four corners of the field. The cultivation of melon should be encouraged over sand dunes to protect the soil from wind erosion and to withstand the moisture deficiency. Similar advantages are of the creeping pulses in inter-cropping. In addition the pulses help in the fixation of nitrogen in the soil. Ultimately these measures would [redacted] improve the economic status of the cultivator. Cultivation of gram is essential for improving the structure of soil that has been deteriorated by the formation of calcium sulphate.

Finally, a very detailed survey of the soils of Hissar is needed to know the soil conditions precisely for making well-grounded recommendations for crop rotations, cropping pattern, crop combinations and methods of cultivation with the judicious use of the surface water. Such a soil survey will prove of use to the Revenue Officials for ascertaining the prospective value of the land in colonization and assessment and the Irrigation Engineers in influencing the design of canal systems and in helping the Colonization Officials in settlement.

PART II

THE DEVELOPED WATER SUPPLY AS THE BASIS OF FARMING

Introduction

The water is one of the primary bases and the foundation of farming in the dry lands: without it, nothing; with poor water supply, inferior and subsistence farming, poor living of nomadic community, in otherwise productive dry lands inhabited by the sturdy farmers; with sufficient and assured water supply to the same, superior, stable, diversified and commercial farming and good living of sedentary farming community. The establishment of prosperous farming begins with the utilization of water resources by extending and improving the irrigation facilities in areas having meagre, concentrated and highly variable rainfall.

CHAPTER 5

WATER RESOURCES

Rainfall has been shown deficient in Hissar. The area has to exploit other sources of water for stable farming, mainly ground and surface water.

The Ground (Sub-Soil) Water: The meagre scale of development of minor irrigation in Hissar, which includes the exploitation of underground water, is apparent (Table 5.i):

Table 5.i

Area Irrigated (acres): Hissar District

	1950-51	1956-57	1963-64	Percentage Increase 1950-51 to 63-64
Canal	365,802	673,561	1,389,042	279·72
Well	7,663	9,954	12,102	57·93

The existence of underground supplies at greater depths (Fig. 51) did not allow intensive farming by lift irrigation. The change in water table is minor except in areas of new canal irrigation. Water seepage from canals raised it at several places to such a point that it has become a liability rather than an asset for agriculture.

Hissar has four assessment zones based on the quality and depth of the ground water. Fig. 54 reveals that the Ghaggar Flood Plain is the only suitable area for the sinking of wells and tube wells. Elsewhere, well irrigation is not feasible on account of the impairment of ground water either by the impregnation of undesirable salts or the deep thin strata having brackish water. The irrigation department has conducted analyses of water samples collected from cultivators' wells in Hissar. It has been found that only 25 to 30 percent of the wells are suitable for irrigated farming. The soils of Hissar have high pH and alkalinity-salinity, the ground water is of poor quality, thus the bad effects of such waters on soils soon become apparent.

In fact, the underground water resources of Hissar did not play a considerable role in its traditional system of irrigation. Details of these systems will be discussed later. At this stage the total scope of ground water usage is relevant (Table 5.ii):

Table 5.ii

Net Area Irrigated by Wells as percentage of Net Area Sown
Average: 1951-61

Area	Percentage
Upper Flood Plain	6·51 to 6·67
Lower Flood Plain	0·61
Rohi, Bagar and Haryana	0·00 to 0·71

Fig. 52 shows the greater concentration of wells in the flood plain and the old irrigated area of Hansi. Fig. 53 portrays the percentage increase in the number of wells in the flood plain. Elsewhere decrease is prominent. The future possibility for the exploitation of underground water lies in the flood plain with the allocation of liberal finances and cheap power for the installation of pipes (tube wells). Consequently, the canal water can be transferred from the flood plain to the Rohi, Haryana and Bagar areas of moisture scarcity. It is suggested that the State

Government should give a proper thought to the development of mechanical lift irrigation in the flood plain. The necessity of pumping and using the ground water for irrigation purposes in Hansi has been felt as an anti-waterlogging measure. Beyond the flood plain, in the rest of the district, the salt content of ground water is very high. Even a reasonable dilution with canal water will not make it fit for irrigation. In sweet water areas also there are pockets of highly brackish water which were observed during field work in Hissar villages. It was found that the women in such areas carried drinking water from the nearby village.

In many villages people rely on the pond water and they cover long distances to get a pitcher of drinking water from a pond and do not mind if sullage flows into these ponds. The wells in areas having brackish water at greater depths, are generally situated near ponds so that the pond water may percolate into the wells and make their water somewhat sweet. At some places, however, the filthy water is let into the well through an opening kept in the cylindrical wall of the drinking water well. The sturdy women of the area have to spend most of their time and life in transporting drinking water from wells and ponds to their homes. It is estimated that 25 women engaged in transporting drinking water from its source to their houses just do the job of a half inch pipeline working during the same period (Public Health Department, Punjab: personal communication, 1965). The loss in potential labour will be obvious. Water supply schemes to all the villages affected might save much working time at limited cost.

However, the women have splendidly made a virtue of this necessity and have woven all of their life's romance round the village wells and ponds. An officer of the Public Health Department says that in some cases women are attached romantically to the drinking water wells in the rural areas. They did not enthuse over the idea of water supply schemes in the villages which they thought would deprive them of the traditional enjoyment at the wells and ponds. The extension of the Bhakra canal system has solved much of the drinking water problem.

<u>The Surface Water</u>: From the preceding discussion it is evident that the surface water is the only means left for providing substantial irrigation to stabilize and improve the agro-economic life in Hissar which otherwise has plenty of land potential. That of the uncertainty in the flow of surface water, it is probable that any attempts to improve the agricultural techniques and the planning of land-use without combating the problems associated with shallow and deep water table are bound to prove abortive. In order to improve the conditions of the ground water at greater depths, the following measures are deemed necessary:

(a) The breaking at selected places of the sub-alluvial ridge.

(b) The construction of earthen embankments round the fields so that the water may percolate into the sub-soil.

(c) Making provisions for collecting the flood water of the Ghaggar by constructing reservoirs, so that the water may ultimately sink into the ground.

(d) Increasing the intensity of canal irrigation in rainfed areas.

In the areas where the sub-soil water is in various stages of depletion at shallow depth, the following actions are needed:

(a) The elimination of percolation from canals by lining.

(b) Restricted or judicious irrigation.

(c) The installation of tube wells to pump out the undesirable ground water.

(d) The improvement of surface drainage system.

Here in Hissar, as elsewhere the efficient use of water and the priorities we attach to it will be the great natural resource problem of the next generation. The main problem in surface water utilization in the dry lands is the prevention of losses by (a) evaporation and (b) percolation and absorption. So it is essential to standardize certain methods for measuring evaporation from water surfaces and to find out some techniques to check it. Ultimately both of these will be of great use in the regulation of canal discharges and in making more water available for irrigation. Further, it is also necessary to stop the percolation and absorption of the canal water, by the lining of channels. In the beginning this will cost a large amount of money. Ultimately it will be advantageous as it will prevent waterlogging and the unnecessary loss of water.

CHAPTER 6

IRRIGATION AS THE BASIS OF FARMING

All the present inefficiently-used arable lands of Hissar have something the matter with them; they are either too sandy or too dry as a home for people. If the exploding population of this earth is to be fed, especially in a country like India where an agricultural economy dominates, it seems likely that the largest increase in food may be secured through more efficient use of the presently under-used and unused better dry lands. The individual pioneering in agriculture has attained its saturation point in the lands under cultivation with irrigation since immemorial times. The promise lies in the additional acreage through dry farming or by the provision of additional water. In Hissar grazing is usually possible but crops can be raised only by special techniques of dry farming. In the dry lands of the tropics dry farming is possible with 20 to 30 inches of rain. Agriculture is precarious and the production is meagre where rainfall ranges between 12 to 20 inches, farming without irrigation is very limited and if it decreases to less than 12 inches agriculture is impossible without irrigation (King, 1953). For the efficient utilization of existing land capabilities and increasing the resources of food, the existing climatic situation has created an acute need for irrigation.

Basically the formula for the development of irrigation is a simple one: (a) The need for irrigation should exist, (b) the facilities for it should be present and (c) there should be sufficient ingenuity and special organization to utilize the water resources judiciously and the private, or state enterprise to exploit it.

<u>The Need for Irrigation</u>: The irrigation is the cardinal factor in shaping agriculture and rural life in the dry lands. The contrast between the rainfed and irrigated areas is striking and is reflected in the life of the people and their standard of living. The rainfed areas in south-west are usually unproductive lands, having specialization on millets, on which subsist the human beings and livestock. The people know no comforts and live close to starvation. Agriculture is a highly speculative venture under the existing harsh conditions. The yields in these areas are low, as can be appreciated (Table 6.i):

<u>Table 6.i</u>

<u>Average outturn of crops in lbs. per acre: Hissar District</u>

Millets		Cotton		Wheat	
Irrigated	Unirrigated	Irrigated	Unirrigated	Irrigated	Unirrigated
440	180	215	120	1000	455

Source: Punjab Government Gazette, 1953.

In general, the lower the rain, the greater the variability and more is the need of irrigation. A variability in excess of 20 percent implies great risk in farming (Williamson, 1925). The coefficient of variability of rainfall is over 20 percent in the Hissar plain. In the absence of irrigation agriculture is reduced to a gamble and economic distress and famines can be apprehended any time. The need for additional water supplies for successful cropping [redacted] that arise from the crowning

has been felt.
disability of environment. The heated, sandy soil, with a high degree of permeability, is also responsible for desiccation and does not encourage agriculture without perennial irrigation. Further, it has been found that intensity of soil moisture drought is very high. Some sort of irrigation has always been practised in the area since ancient times in the form of traditional methods, the remnants of which still can be traced.

The social and economic need for irrigation was felt by the Government to support the growing population and to rehabilitate the refugees during the last decade. It could have been achieved only by extending irrigation to new areas. Further, the increasing commercialisation of agriculture has introduced crops like cotton which require more water and cannot flourish without irrigation. Of the canal irrigated area in the Punjab, Hissar is the worst off. It is at the tail of the Western Yumna canal and as yet receives little water.

Facilities for Irrigation: Where the courses are approximately north-south there is a tendency, on account of the rotation of the earth, for rivers to cut into their right banks. Right banks are therefore generally higher than the left banks, and it is easier to take off irrigation channels from the left banks (Rawson, 1963). The expanse of the Hissar plain to the left of the Sutlej river is to its advantage. Hissar is one of the most favoured districts of the Punjab for irrigation. Land looks like a flat pancake falling imperceptibly to the south-west. So that any canal which has its head near the hills of the left bank of the Sutlej is able to command practically the whole of the Hissar plain except the

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Tosham region. The absence of any great irregularity of surface enables the main canal of a system to be brought to the backbone of the area with a minimum difficulty and expense, whence lateral branches can run off.

The water regime of the rivers which supply water to Hissar is favourable. These rivers (Sutlej and Yumna) get water from the melting snow and heavy rains of the Himalayas. The water regime of the rivers of the Punjab has been subjected to a detailed and comprehensive analysis in relation to the Himalayan snows and glaciers. So enormous is the aggregate amount of water locked up in the crystalline state in the glaciers and icecaps on the Himalayas that if it were all released by melting and flowed down the Punjab rivers, most of the Punjab and Sind plains would be submerged (Sain, 1946). The snowfed perennial rivers of the Himalayas offered every facility for the construction of canals.

Besides the rainfall, the rest of the climatic conditions are favourable for the growth of a variety of crops with the help of irrigation. The soils are considered attractive and have given an impetus to the development of irrigation. The soil is soft, so it is easy to dig canals at low cost. The soils are best suited to irrigated farming because of their good structure and texture. The soils are deep enough and there is no hard rock near the surface which can make the shallow soil waterlogged. Although most of the soils respond admirably to irrigation, yet they are complex, and economic feasibility varies from one type to another. Therefore, it is desirable to plan irrigation schemes keeping in mind the moisture deficiency, the texture, structure and alkalinity-salinity of the soils.

Moreover, a large amount of percolation from the Ghaggar stream is contributing to the sub-soil water table at a level which can be easily tapped by sweet water wells. The importance of clay layer in the Ghaggar flood plain cannot be overestimated. It does not form one continuous layer (as observed by the local inhabitants), but occurs in patches at varying depths. The clay layer acts as a beam to support the masonry cylinder of the well, which is fed with water through a hole bored in the clay bed to tap the saturated sand below. Therefore, the flood plain is bestowed by nature for well irrigation potentials.

In the olden days, the nomadic life of the people centred about their flocks in most of the rainfed areas. When drought made pastures scarce and it became necessary for the people of the Punjab to storm into more plentiful pasturelands of the Haryana, the fighting and conquest became the law of survival (Trevaskis, 1928). [redacted] Kinship was the only political bond known to these people and they were hardier and so manly that neighbours have never had the power or even wish to attack the inhabitants of the Haryana plain. The climate tends to breed a hardy race. The farmers of Hissar have splendid physique, quite capable of enduring extreme climatic conditions. They are apparently industrious. They have devoted their time seriously to the business of winning a living from the soil under none too favourable conditions.

Cotton was raised but the uncertainty of the seasons prevented the development of cotton culture on a profitable basis prior to the extension of the Bhakra canal. Gram, wheat and mustard were also grown and they were declared to be of excellent quality. The chief obstacle to prosperous crop production in an area of sturdy farmers was declared to be the inadequacy of moisture.

Previously there were holdings of minute fragmentation, so that one may possess a dozen tiny strips scattered throughout a village. Such fragmentation involved a multiplicity of tortuous winding water courses and inevitable wastage of water, labour and space. At present all the villages under canal irrigation have been consolidated (Settlement Officer, Hissar: personal communication, 1965). It has increased the efficiency of irrigation and permitted the remodelling of channels.

The people are deeply sensible of the value of these canals. They mutually combine with an unusual degree of harmony and public spirit, not only for the construction of the reservoirs and canals, but also for the distribution of water and the regulation of supply. When the social awakening of the community displays as much aptitude for self-management, then it becomes easy for the Boards to implement a huge work. The marked degree of political stability and human ingenuity enabled the state to put into operation irrigation works on a large scale for Hissar during the 'fifties. Finally, it can be said that the capabilities of Hissar for canal irrigation are great and the facts narrated at once proclaim it to be an area eminently adapted to productive and protective canals.

Limitations: Though land-use capability in Hissar is in plenty by providing perennial irrigation, yet certain obstacles hinder canal development. [redacted] To make the irrigation fruitful, it is essential to base its future planning by keeping the hinderances in mind.

The volume of water in the rivers is subject to extreme variations. The seasonal regime of the Sutlej river is of great significance as it pours over 80 percent of the canal water into Hissar. The difference between the maximum and the minimum discharges of the Sutlej ever recorded is remarkably high (Table 6.ii):

Table 6.ii

River	Site	Minimum Cusecs Feet/Second	Maximum Cusecs Feet/Second
Sutlej	Rupar	2818	250,000

Source: Rupar Head Works

The Sutlej and Yumna are the perennial rivers but their flow is very irregular. As a result, the mean discharges in the canals vary (Table 6.iii):

Table 6.iii

Mean Discharge of the Canals at Head in Hissar
(cusecs feet per second)

Name of Canals	Summer crops		Winter crops	
	1955-56	1959-60	1955-56	1959-60
(1) Western Yumna	2665	2260	1714	1854
(2) Barwala	301	480	181	235
(3) Sirsa l. B.M.L.	879	1105	648	698

Source: Annual Reports of the Irrigation Department, Punjab.

The erratic fluctuation in canal discharges is the limiting factor for successful crop production. It affects the intensity of irrigation ultimately influencing the cropping pattern, extent of area matured and double cropped area. The heavy variation in canal discharges is most disconcerting to the farmers and if they could be adequately predicted, the task of the cultivators can become much easier to plan their crops in anticipation. The capacity of all canals and distributaries is determined by the duty (area of the crops which can be matured by a given quantity of water) during the period of pressure. It varies of course according to the nature of the crops to be irrigated. It amounts to the seasonal variation in irrigated cropped to a considerable area degree.

The available supply is distributed over as large an area as possible in order that a certain percentage of cultivation is assured. It does not promote farming on a commercial basis, but it has the great merit of keeping the maximum number above the starvation level. At present the irrigation planning in the dry lands coincides to the principle of keeping the farming above the level of subsistence.

Soil is mostly alkaline-saline. Therefore wherever drainage is inadequate and over irrigation is practised, the water percolation down to the sub-soil leads to the dissolving of the salts. Thereafter strong evaporative force brings them up deteriorating the soil. With the result that thousands of acres now lie outside the pale of cultivation in Hissar. Hence, it is just as important to get water off the land as to get it on, but, as we see, the cultivator has not yet grasped this truth. Method of irrigating the land is still primitive. Water is almost applied everywhere by excessive surface flooding. The field is divided into parts to which the water reaches under gravity unaided by the farmer. To him there appears an abundance of water since he is not charged according to the volume he uses but the area he irrigates. He is anxious to get as much silt for his land as possible without knowing its serious after effects. He considers silt as fertilizer because other chemical fertilizers are not within his reach, there is every temptation to over irrigate. To this temptation many cultivators succumb because of the depletion of land. The cereal growers of India are using too much water to obtain maximum yields. With plenty of water on his land the cultivator feels that little else matters but he does not know the consequences. The majority of farmers grow only limited crops and are underemployed. Limited crop farming depletes the soil and does not encourage the proper use of canal water. Illiteracy, ignorance, poverty of the farmers and the lack of guidance are the other main problems which do not allow the proper utilization of the existing water resources.

Sources of Irrigation

The irrigation may be done with the help of canals or by lifting the sub-soil water. The former is a large scale adventure which the individual cannot undertake. Moreover the canal water cannot reach every point. Hence there is a need of well irrigation. The sources of irrigation in Hissar adjust to topography, water table and quality of the ground water. It is apparent that traditional methods of irrigation play a minor role in the farming activities of Hissar (Fig. 55). The canals are by far the largest source of irrigation and these hold a great promise for future development. It makes a separate case of study for canal irrigation. Broadly speaking, there are two types of irrigation systems in Hissar, viz:-

(a) Lift Irrigation

(b) Flow Irrigation

Lift Irrigation

In Hissar from immemorial times the indigenous manual and bullock driven lifts are used. Although an alternative has been offered by the mechanically driven lifts, these are not successful as an incentive, cheap power and financial assistance are lacking.

(a) Manual Labour lifts: Counterpoise lift and swing basket are two methods which are in practice in the flood plain. The water from the depressions is lifted to the fields by manual force. These are poor man's lifts. These are employed by the farmers having small holdings for keeping up the superior crops at the time of drought. These are time and labour consuming devices with minimum outturn.

(b) Draught driven lifts: The irrigation from wells is very old and is as old as farming itself. The development of the well irrigation is due to the initiative of the individuals. It is mainly confined to the flood plain and elsewhere is negligible (Fig. 56). In areas where the depth of water is over more than 30 feet, wells for irrigation are very few due to the high cost of construction and lifting water with bullocks. In such areas the well construction is considered as an uneconomic venture and the farmers either rely on nature or canals or the both. Wells are used for winter crops because of restricted canal flows. These are used when the necessity arises as the cost of working the Charsa wells for irrigation is considerably high. It is used where the water table is more than 30 feet. It requires a long rope, a leather bucket and at least two pairs of draught force, with a driver to each and a man to empty the bucket and the other to direct the water in the field. In areas having sub-soil water within 30 feet, the persian wheel well is fairly economical.

The area under well irrigation is increasing in the flood plain and the areas lying in the south of the upper flood plain. Elsewhere it is declining (Fig. 57). The progressive migrants felt the necessity of wells for compensating the shortage of canal water for winter crops.

Conclusion

Out of lifts, mechanical lifts give the lower cost figures (Board of Economic Inquiry, Punjab, 1963). These can be recommended for the reduction of draught to bullocks and to increase the efficiency of farming. As a rule well irrigation is not advisable to be practised wherever the depth of the sub-soil water is over 30 feet as beyond that depth the cost of lifting water is excessively high compared to the values of crops grown. There is also an increase in draught for animals and as a consequence of this the life of draught force is considerably shortened. It is desirable to replace these lifts either by oil engine or electric motor centrifugal pumps. There are bright prospects for the extension of mechanical lift irrigation in the flood plain. It is suggested that the government should provide liberal financial and technical assistance for the installation and repair of power lifts. The speedy repairs are as important as the installation for the efficient working of water lifts. The supply of cheap power should be assured to the farmers. It may be added that tube well irrigation allows for intensive cultivation as water is available in required quantities whenever desired (personal experience) and it has proved admirably suited to small holding.

CHAPTER 7

Canal Irrigation as the artery in the Farming of Dry Lands

Many parts of India enjoy enough rainfall. If it has been properly distributed, commercial agriculture could be maintained over most of the land surface of the Indian Union. The principle of equality, now highly esteemed, is ignored in the distribution of rain, and down through the ages many attempts have been made to correct this inequality. The best way to do this would be to control the rainfall. The trouble has been that no one knew how to do this except the "rain doctor". Thus it becomes essential to redistribute the rain water which has fallen. Ultimately by means of canals man has planned to supplement little rain during the growing season.

It is imperative to utilize to the maximum extent possible the available surface water before attempting to utilize the ground water, as the latter is always costly. The canal irrigation has a particular significance in Hissar, in view of the unfavourable rainfall and ground water conditions. The pressure of expanding population and the desire for equality in social and economic status, security and a higher standard of living everywhere have served to focus attention with rapidly increasing sharpness in recent years on problems connected with water economy. The effect of such attention is responsible in the institution of Bhakra canal system which has given opportunities to the engineers, planners and agriculturists to put their skill to work for humanity.

Development of Canal Irrigation: The development of canal irrigation began in the second half of the 14th Century at the initiative of Sultan Feroz Tughlaq (1351-1388) for the uplift of agriculture. The most important was the canal which carried the waters of the Yumna to the orchards of Hansi and the city of Hissar. In 1888 Hissar received limited water supplies from the Sirhind canal in the extreme north. In 1897 some irrigation was provided from the Ghaggar seasonal canals to the western part of the Nali assessment circle of Sirsa below Ottu. The Rangoi Inundation channel was instituted to irrigate the Rangoi assessment circle. The development of canal irrigation in 1896-1897 was the result of the famine of 1896 which compelled the state to devise some measures to secure the farming. No doubt the development of irrigation was started in the south-east of the United Punjab on a limited scale. At the close of the 19th Century all engineers were concentrated on providing irrigation facilities to the western districts (now in Pakistan). The claims of the dry fertile lands of Hissar were ignored keeping it a recruiting area for the armed forces and labour force.

The network of canals which existed at the beginning of the 'fifties was limited (Fig. 59). It reveals that Hissar had a meagre share in the canal protected land and the free flow of the rivers in the new Punjab. The economy of the new Punjab was shattered, granaries were lost, millions of refugees were to be rehabilitated and the shortage of food grains was observed. The formidable array of problems needed immediate attention for handling the situation. These formed the basis for future irrigation planning to develop the available dry lands. Under such conditions the development of irrigation for increased food production occupied a priority in planning. The new Punjab state, fortunately, had plenty of natural resources in land, water, sturdy displaced peasants, engineers and above all the determination of the people and state to rehabilitate the crippled economy. The vast areas of land were lying unproductive for the need of water. The need to provide irrigation facilities to such marginal lands was keenly felt in Hissar. The state government, therefore with ready aid from the centre, made all out efforts to bring the maximum of the dry lands under irrigation. One such effort was the Bhakra-Nangal scheme. During the First Five Year Plan (1951-56) the construction on the scheme was started wholeheartedly and in the first instance it provided non-perennial irrigation. On completion of the project perennial flow was extended. The maximum benefits in the form of discharges and intensity of irrigation have been laid down for Hissar (Project Report, 1953). The network of canals at the beginning of the 'sixties reveals that every assessment circle gets a share of perennial canal irrigation except the Loharu, Amrain and Behl-Siwani Bagar assessment circles of Bhiwani tahsil (Fig. 60). Further, the importance of the Sutlej and Bhakra canal system can be envisaged for the Hissar Plain. As a result of these all out efforts in Hissar, the annual irrigation registered a sizeable increase with magnificent effects each year from 1952-53 onwards (Fig. 58).

The development of canal irrigation on various systems in Hissar was substantial during the 'fifties, such as (cf. Figs. 59 and 60):

(1) The branches of the Sirhind canal in the north-east of Hissar were transferred to the Bhakra system, improving the intensity

of irrigation by avoiding the winter closures.

(2) To make up the shortage on the Western Yumna canal system, the Sirsa, Barwala and the parts of Hissar branches were merged with the Bhakra canal releasing a discharge of 1894 cusecs of the Western Yumna canal (Irrigation Department, 1959). It proved useful in many ways, viz., converted the non-perennial irrigation to perennial, minimised the chances of canal closures, improved the water allowance in the dry areas at tail and extended irrigation to new rainfed areas of Hansi and Bhiwani tahsils.

(3) The Ghaggar canal system was connected with the Bhakra grid. The annual irrigation increased from 23,029 acres in 1950-51 to 74,890 acres in 1960-61 having a perennial supply of water.

(4) Formerly, the Rangoi inundation channel was dependent for its supplies on the high floods of the Ghaggar but now it is occupied by the perennial distributaries of the Bhakra canal.

(5) The improvements in the existing discharges of the Western Yumna, Sirhind, Rangoi and Ghaggar systems have been made by the Bhakra system sharing the water load of the former. The first waters from the Bhakra canal commenced flowing into the dry lands in the summer season of the year 1952-53 and irrigated an area of about 73,000 acres. Since then the irrigation facilities are being extended to more and more areas. During the year 1960-61 an area of 767,000 acres received perennial irrigation from it. Actually the project envisaged to irrigate 1,690,000 acres of the arable land of Hissar and in 1960-61 it covered only 41 percent of the scheduled area to be irrigated. It clearly exhibits the importance and scope for the expansion of canal irrigation in

the Hissar Plains.

The Bhakra canal discharged 13,744 cubic feet per second (June 20th, 1961) or about 18 times more than the amount discharged by the Thames at Richmond. Some idea may be obtained of the magnitude of the whole system, and the wonderful achievement of the engineers who designed and constructed it. Working at the construction of a new canal through an inhabited area, as may be imagined, is much more pleasant than making it through what is practically desert (Buck, 1906). This canal traverses the area which was already inhabited to a reasonable extent prior to the institution of the system.

What has already been achieved during the Second Five Year Plan is not enough. The vast stretches of fertile areas within the command of existing irrigation boundaries of the canal systems remain to be without water. There are vast expanses of area in the south clamouring for water which can be solved only by lift irrigation. For this purpose the offshoots of the Western Yumna canal can be used by extending these in depth to the unirrigated areas of Bhiwani tahsil. Afterwards the water can be lifted by mechanical lifts from the deep flowing canals to irrigate the adjoining lands. It is desirable to provide irrigation to these areas as a protective measure.

The importance of canal irrigation in Hissar is relatively very high as everywhere more than 98 percent of irrigated cropping is watered with canal water (Fig. 61). It masks the importance of the other sources of irrigation. In the upper flood plain the importance of canal irrigation is moderate because of the presence of the traditional methods of irrigation. On the whole canal irrigation is the mainstay of agriculture.

Regional Distribution of Canal Irrigated Area in 1956-61 (Fig. 62)

The noticeable fact in the regional variation in canal irrigated cropping is that a considerable percentage lies in the areas served by the old canals, the low and moderate proportions are in the newly irrigated areas, very low in areas where irrigation facilities have been extended during the late 'fifties and negligible in the rainfed areas (Fig. 62). The magnificently varied regional pattern shows that there is little room for the extension of canal irrigation in the old irrigated areas but there are considerable avenues for extension in the rainfed areas. The areas having more variability of rainfall in the south-west of Hissar should have more share of water supply, but at present it does not coincide with this principle.

The distribution of annual canal irrigated cropping is as follows (Fig. 62):

(1) Areas of very Low Proportion (under 15 percent): The Bagar assessment circles of Sirsa, Fatehabad and Hissar and Haryana-Garbi assessment circle of Bhiwani tahsils are included in this category. These areas have minimum share on account of the recent extension of irrigation, physical handicaps and the location of the areas at tail. Ultimately this region will have a significant proportion with the levelling of the sand dunes, increasing water allowance and the lining of the distributaries. On the whole, some of the dry farming has been secured with the supplementary irrigation.

(2) Areas of Low Proportion (15-30 percent): The Nali assessment circle of Fatehabad and the Rohi assessment circle of Sirsa tahsils come within this class. These areas have a low ratio due to the importance of well irrigation in the flood plain and the physical unsuitability of some parts for the rapid expansion of irrigation. Further, the vast culturable unirrigated land cannot be brought under flow irrigation at once.

(3) Areas of Medium Proportion (30·01-45 percent): The areas where the irrigation was in practice prior to the construction of the Bhakra canal fall in this group. It occupies the Nali assessment circle of Sirsa, the Nehri and Barani assessment circles of Fatehabad, the Nali and Barani assessment circles of Hissar and Haryana-Sharqi assessment circle of Bhiwani tahsils. With the transfer of the major part of these areas to the Bhakra canal the situation of canal water supply has been improved. The medium proportion may be considered sufficient provided the potentials of the ground water are explored wherever feasible and cropping pattern is scientifically planned. On the whole, it is essential to increase the share of canal irrigation for the efficient and commercial farm economy.

(4) Areas of High Proportion (45·01-60 percent): The Nehri assessment circle of Hissar and the Barani assessment circle of Hansi tahsils are embraced by this category. These areas can develop farm economy on commercial pattern.

(5) Areas of very High Proportion (over 60 percent): The Nehri assessment circle of Hansi tahsil is the one which falls within this category. It is irrigated by the main stems of the

Western Yumna canal since immemorial times. The existing intensity of irrigation is responsible for the stabilized diversified commercial farming.

Based on the preceding discussion it can be observed that in areas having intensity of irrigation under 45 percent there is a great scope for the further extension of canal irrigation facilities. Thereafter, it will need the improvisation of a new framework of cropping pattern. The moderate changes can be brought in areas with 45 to 60 percent of the canal irrigated cropping. There is little room for expansion except the improvements in existing techniques of irrigated farming in the areas having over 60 percent of the intensity of irrigation.

Percentage increase in canal irrigation (1951-56 to 1956-61): An indication of relative percentile change has been accomplished in Fig. 63 portraying the following facts:-

(a) there is a fair correlation between the areas of rapid gain and medium intensity of irrigation (cf., Figs. 62 and 63).

(b) there is an even better areal correlation in percentage change and the impact of old and new canals (cf. Figs. 59, 60 and 63).

(c) a considerable change has been seen in areas formerly rainfed or partially getting canal water.

(d) in the old irrigated areas the relative change is less pronounced.

The areas having an increase of over 75 percent may receive the overspill of rural population and may be a scene of rapid change in land-use and cropping pattern.

Seasonal Distribution of the Canal Irrigated Area (1956-61)

The proportion of irrigated cropping is not the same in the two crop seasons, nor is the relative importance within the crop season equal throughout the area (cf. Figs. 64 and 66). The reasons being the variability in rainfall, soil drought, moisture requirements of various crops and river regimes.

During summer the potential evapotranspiration and the resultant deficit of moisture to recharge the soil are maximum leading to acute soil drought and the water requirement of the summer crops is considerably high. Obviously, the percentage of the cropped area irrigated [redacted] in summer with canals is low in spite of more canal discharges and rainfall.

During winter the percentage of cropped area irrigated with canals is high, notwithstanding the small rainfall, minimum canal discharges and frequent canal closures. It is on account of the minimum resultant moisture deficit, less runoff of rain water, the compensatory character of dew and low duty of crops. For the winter crops irrigation has the same importance as for the summer crops because of the high temperatures and low humidity at the sowing and maturing periods of the former. It is only the months of December, January and February when soil moisture exceeds or is nearly sufficient for standing crops, otherwise the necessity of irrigation is felt.

Kharif (Summer) Cropping by Canal Irrigation (1956-61):

Two broad categories can be observed in the regional distribution (Fig. 64):-

(i) Areas of Low Proportion (30-40 percent): These occupy the areas irrigated by the Western Yumna canal in the east, the flood plain and the rainfed areas of the south-west. The irrigation in the east has been practised for a long time but the proportion is low because of the low water allowance being at the tail of the system, more loss of water in channels on the way and more duty on canals on account of cotton culture and compact loams. In the flood plain the supply during summer is reinforced by floods, rise in the water table and comparatively more rainfall in the upper flood plain. Consequently, the duty on canals is decreased. In the rainfed areas of the south-west the loss of water is maximum due to soil structure leading to the low intensity of irrigation.

(ii) Areas of Moderate Proportion (40·01-50 percent): These embrace the Rohi assessment circle in Sirsa and the Nehri assessment circles of Fatehabad and Hissar tahsils. In the Rohi circle the water allowance is increased because of the less demand of the flood plain. The canal feeding this area is lined, therefore the percolation is minimum. In the Nehri circles the moderate share is the result of the merger of these areas to the Bhakra canal which improved the water allowance. The soil is loam in which the seepage is comparatively less. The areas lie at the head of the main distributaries.

<u>Percentage Increase in Kharif Canal Irrigation (1951-56 to 1956-61)</u>:

The change in canal irrigation in summer exhibits the following facts (Fig. 65):-

Firstly, less change in the Nali assessment circle of Sirsa tahsil is worth mentioning due to the presence of seasonal canals of Ghaggar and the availability of flood water. Secondly, the percentage increase in the Nehri assessment circles of Fatehabad and Hissar tahsils is small in spite of increased water allowances on account of the existing irrigation in 1951-56. Thirdly, the Rohi assessment circle of Sirsa tahsil noticed a marked increase. The extension of irrigation on a rapid scale, minimum facilities of canal irrigation from the tails of the Sirhind canal in 1951-56 and more allowances from the Bhakra canal in 1956-61 are the chief factors attributable to the significant change. Fourthly, there is a rapid gain in areas where irrigation was extended in 1956-61.

Rabi (Winter) Cropping by Canal Irrigation (1956-61): The proportion of canal irrigated area in winter crop season is very enoouraging as it is everywhere over 50 percent. Hissar can be grouped into two categories (Fig. 66):-

(a) Areas of High Proportion (50·01-60 percent): The old irrigated areas come under this category. In the Rohi assessment circle of Sirsa tahsil the ratio is brought down by the water needs of the Ottu lake for running the Ghaggar canals and the winter closures of the Sirhind feeders. Similarly, the Nehri assessment circles of Hissar and Fatehabad tahsils get a low share of water from the Bhakra canal on account of the increasing demand of water in the upper flood plain.

(b) Areas of very High Proportion (over 60 percent): It is an exceedingly favourable ratio for prosperous grain farming. It is achieved in the flood plain. More area can be irrigated with a limited water supply from the canals because of the conserved flood moisture in the soil. There is another strip having very high ratio in the north-east of Bhiwani tahsil. It has sandy loam which requires less water for the maturity of drought-resistant crops.

Percentage Increase in Rabi Canal Irrigation (1951-56 to 1956-61):

Fig. 67 showing the relative percentage change in winter canal irrigated areas reveals some interesting features, viz., the minimum gain in the areas irrigated by old canals in Hansi and Hissar tahsils, the moderate change in the Rohi assessment circle of Sirsa tahsil because of the low water allowance in winter as compared to the summer crop season, the considerable change in the Nali assessment circle of Sirsa because of the change of the Ghaggar canals to perennial flow and the rapid increase in the areas to which canal irrigation has been extended recently.

The changes in the seasonal canal irrigated cropping are quite distinctive in the Bhakra canal, Western Yumna canal and rainfed areas. Therefore it is worthwhile to study the agricultural economy of Hissar under three groups to find out the effects of canal irrigation on the farm economy of the formerly rainfed areas.

Effects of Canal Irrigation

The canal irrigation has benevolent as well as malevolent effects and the former outnumber the latter. Further, there are scientific remedies for checking the injurious consequences of canal irrigation.

Beneficial Effects: Irrigation completely changes the aspect to one of smiling fields, well planned villages and flourishing sedentary communities of prosperous peasants who produce more than their need. In the vast unproductive culturable wastelands of Hissar transformation has taken place recently through irrigation work of the Bhakra canal. Farmers of these areas who had been practising dry-farming for centuries have changed to irrigated farming. It would be true to say that the dry land has bloomed in the canal colonies. The precious water constitutes the very life blood of rural population and acts as a magnet to the farmers of the congested districts of the Punjab. The beneficial effects of canal irrigation are manifold. These may be both quantitative and qualitative, viz:-

(1) Growth of Population: The increase in the total population of Hissar from 1951 to 1961 was 47·84 percent as against 21·28 percent of the natural rate of growth. The rate of increase varies from the new canal colonies to the old canal irrigated and rainfed areas (Table 7.i):

Table 7.i

Percentage Growth of Rural Population (1951 to 1961)

New canal colony	Old canal areas	Rainfed areas
Over 75	45 - 75	Under 45

The rapid gain of population in the Bhakra canal irrigated area is due to the exceptionally high rate of inmigration.

(2) Increase in Cropped Area: It has been realised that most

of the increase in cropped area within the last decade took place in the areas comprising the Bhakra canal belt (Table 7.ii):

Table 7.ii

Total Cropped area in acres, 1951-56 and 1956-61

Assessment Circle	1951-56	1956-61	Percentage Increase
1. Nali (Sirsa, New Canal)	198,884	375,368	88·74
2. Nehri (Hansi, Old Canal)	293,702	332,954	13·36
3. Loharu Bagar (Rainfed)	123,004	129,240	5·06

The canal irrigation materially played a dominant role in the increase of cropped areas by bringing under cultivation those lands that hitherto remained uncultivated due to lack of water supply in the form of fallowland or wasteland. Furthermore, irrigation increased the intensity of cropping and maturity.

(3) Increase in Yields: The yields per acre increased but are below the project report of 1953 by 25 percent in the case of food grains and 40 percent in the case of cotton. The increase in output is primarily on account of the availability of water supply which provided an impetus to the farmers to change the techniques of farming (Table 7.iii):

Table 7.iii

Average Yield per acre of the Principal Crops in lbs, Hissar

	Paddy (Rice)	Wheat	Gram	Cotton
1950-51	815	621	308	204
1960-61	1489	1346	712	232
Percentage increase	82.70	116·75	131·17	13·73

Source: Statistician Agriculture Department, Chandigarh

The following suggestions can help in the realization of the yields prescribed by the Bhakra Canal Board:-

(i) The use of fertilizers should be increased. It raises certain problems, such as financial and additional water supply.

(ii) The present agricultural practices need an overall change as these influence the yields to a considerable degree. The introduction of organic manuring, better seeds, more careful weeding, bunding, etc., is needed.

(iii) The water supply should be assured as there are wide variations in canal discharges from year to year (Table 7.iv):

Table 7.iv

Discharges of Barwala Branch in cusecs at the head, Hissar

Season	1954-55	1955-56	1956-57	1957-58	1958-59	1959-60
Summer	191	301	352	457	412	480
Winter	102	181	55	198	201	235

Source: Annual Irrigation Reports, Chandigarh

(iv) Apart from the use of fertilizers for increasing the yield per acre, it is obvious that the change over to irrigated farming will require a certain amount of additional investment by the farmers. To begin with, earthwork will have to be undertaken in order to bring the water to the fields. Some further expenditure will also have to be incurred on livestock, implements and farm buildings. It has been found, for instance, that on an average about 15 days of work, for a pair of bullocks, is involved per acre of land in the irrigated area, while 5 days of work is required for unirrigated areas (Raj, 1960) or two pairs of oxen are enough to cultivate an unirrigated holding of 30 acres, while the same needs a tractor with a plough of 7 tillers when the intensity of irrigation has been stepped up to 100 percent (personal experience). There is likely to be an increase in the requirements of the ploughing force in the newly irrigated areas. It requires plenty of finances in the possession of the farmers. To overcome the difficulty of finances the state should advance liberal loans for making the improved tilling resources accessible to the poor farmers.

(4) Increase in the value of production per acre and sale value of an acre has been observed (Table 7.v):

Table 7.v

Average value of production of crops per acre in Rupees in the Bhakra canal irrigated areas, Hissar

1952-53	1960-61	Absolute Increase
5.92	121·01	115·09 Rupees

Source: The Board of Economic Inquiry, Punjab

Connected with the Bhakra canal is the phenomenon of an appreciation in the land values. There has been a great activity in the land sale transactions and the average sale value per acre has gone up by five to six times during the last decade.

(5) Change in Cropping Pattern: It has been seen that the share under wheat, cotton and fodder increased and under millets declined because of assured water supply (Table 7.vi):

Table 7.vi

Percentage Shares of Different Crops in the Bhakra canal irrigated villages in Hissar, 1950-51 to 1961-62

Crops	Unirrigated 1950 - 51	Irrigated 1961 - 62
Wheat	1·2	12·6
Cotton	-	7·9
Sugar-cane	-	1·6
Maize	-	2·0
Rice	-	3·9
Gram	62·5	32·7
Bajra	13·2	7·2
Wheat-Gram	-	10·2
Fodder	1·3	8·1
Jowar	18·4	7·6
Oilseeds	2·6	3·7

It will be seen that in the cropping pattern visualized for the areas irrigated by the Bhakra canal the share of commercial crops increased and agriculture has become more diversified. The diversity in farming has an ample utility as it keeps the farm labour engaged and soil fertility and moisture conserved through crop rotation.

(6) Increase in Marketing Surplus: There is a considerable increase in the agricultural produce marketed by the farmers after meeting their domestic requirements (Table 11.iv). It encouraged the growth of wholesale agriculture produce business centres.

(7) Increase in Road Milage: Roads are a necessity when canals are opened, so that the colonists can sell their surplus produce and send it away. The network of metalled roads increased (Fig.68).

The canal irrigation increases the scope of well irrigation by raising the water table and improving its quality. It has been observed in the areas served by the Bhakra canal. The canals have given a greater security to the cultivators to fight famines and droughts with greater force. The cultivator who has a share in a canal does not worry so much about late monsoon or the early cessation or the long breaks between two falls. The mental happiness by assured water supply makes the cultivator bring about all possible improvements in his soil. Canals have brought out the happiest results and stabilised the annual farm income of the farmers. The half fed and ill clad people of the area are now having comparatively more nutritious food and better clothing. Their social, cultural and dietary habits are undergoing change and they have better means to meet their day-to-day requirements of life. The canal irrigation has not only stepped up the margin of profit but also helped in freeing labour for more useful purposes. The resulting economy of labour (manual and draught) has helped to produce more for the increasing population through increased intensity of cultivation.

Canal irrigation has not only fulfilled the needs of the individual cultivators but has also met the needs and brought a prosperity to those who are indirectly dependent on agriculture. In fact the entire community of Hissar has been benefited by the extension of irrigation facilities. Within the villages, increased agricultural output has added to the scope of employment and has even necessitated the inflow of labour. The handling of grain, transport and marketing provided employment to villagers of the rainfed areas within the district who formerly had hitherto been moving to distant places in search of work particularly in famine years. It has attracted shopkeepers to the rural areas. As a result some villages are developing into small towns. Increased agricultural production is the pre-requisite of industrialization. Industries like flour mills, rice mills and cotton ginning mills are growing in Hissar. It has improved the literacy and the standard of living of the farmers.

Lastly, the effect of irrigation on agriculture would depend on the nature and volume of the fertilizers used. Here are two points which need to be particularly kept in mind. To start with, we might say that the use of chemical fertilizers depends to a large degree on the availability of water. The damage done to crops when there is a failure of water supply is greater when chemical fertilizers have been used than when they have not been. If, therefore, the water supplied by an irrigation system varies considerably, the fluctuations in yield are likely to be greater. However, it is also true that the use of fertilizers yields economy in the water requirements of crops. It has been found that an application of 40 lbs. of nitrogen per acre in the form of sulphate of ammonia saves 6 inches depth of irrigation water in the case of cotton crop and the application of 25 lbs. of the same per acre to a wheat field gives normal yields with only one irrigation, thus saving 3 to 6 inches depth of irrigation water (Department of Agriculture, Punjab). Fertilizers can, therefore, be used to save water but if, despite this, the available water supply proves short, the effect on farm production is likely to be more serious than if fertilizers had not been used at all.

In concluding the effects of canal irrigation in Hissar, it can be said that water supply is the most important primary environmental factor which controls the changes in the demographic and agricultural structure.

Injurious Effects: One of the serious drawbacks which canal irrigation causes is the waterlogging. No irrigation supply can add to the sub-soil water table, if crops like cotton, maize, wheat and great millets are grown. These transpire almost as much water as is given to them. In the case of rice some irrigation water may find its way to sub-soil water. The rise of the sub-soil water table is not due to the water supplied to the fields, but is on account of the excessive seepage and percolation from the unlined canals, distributaries and water courses. To remedy the evil of excessive seepage it was found necessary to incur a considerable investment on the relining of the old systems and on the laying of a comprehensive system of drainage channels. The lining of the water courses with a mixture of clay and cow-dung should be left to the farmers. These measures would remedy, if not entirely, the evils of waterlogging of which there were serious complaints in the past. These would also increase the water allowance and the intensity of irrigation. Several other remedial measures have been adopted to combat waterlogging and to reclaim the area affected thereby. The major measures are, namely, lowering of the water table by pumping out the sub-soil water, rice cultivation with the application of gypsum, suitable crop rotation like rice followed by gram and increasing the intensity of irrigation to dissolve the salts. Simple demonstrations at village level are needed to fight against waterlogging. To prevent the further formation of "kallar" (saline efflorescence) it is necessary to educate the cultivators for the judicious use of water, the adoption of scientific crop rotation, levelling of the fields, care of the water courses and to avoid the unlimited flooding of the cropped lands.

Malaria is another bad consequence of high canalization and bad drainage. The lowlying ditches never dry up. These act as the harbouring places for mosquito breeding (a large number of such depressions were observed in the Hansi area at the time of field work). Due care is now taken to remedy this by the construction of new drainage channels and by draining and spraying the existing ditches. It is gratifying to record that conditions are improved to such an extent that it has become difficult in the Medical Colleges of the Punjab to get a malaria case for demonstration (Superintendent Medical College, Patiala: personal communication).

<u>Reclamation of the Wastelands</u>

[redacted] The land-use survey of Hissar shows that there is a scope of land reclamation. The arable waste-land to the tune of 10·05 percent of the total area in 1950-51 was available. Although nearly half of it was brought back to cropping during the fifties, yet in the beginning of the sixties 5·11 percent of the total area was estimated as cultivable waste, of which more than 50 percent was lying in Hissar and Bhiwani tahsils. The reclamation of wasteland proved useful in many ways:

Firstly, it increased the food production. Taking a minimum increase of production of half ton per acre (State Agriculture Department), there has been an additional production of about 80,000 tons of food grains bringing crores of rupees of income from the wastelands in 1950's. The same prospects are for the 1960's.

Secondly it has increased employment and economic activity and the wilderness has been converted into smiling green fields.

Thirdly it has helped the better utilization of the canal water. By way of water rates the state exchequer gained lakhs of rupees.

Fourthly, it solved the problem of the Punjab government in the resettlement of refugees and landless tenants. Most of these wastelands were evacuee property allotted to refugees in 1950-51. These persons could not settle on lands because of unculturable conditions. The owners, therefore, were in great economic plight. After reclamation thousands of such people have come to settle on their lands and have started irrigated farming very successfully.

Conclusion

In fact, Hissar presents a greater degree of variety of meteorological conditions in rain unfavourable for agricultural economics. The effect of these conditions leads to an unsteady tone of development of agriculture. Cultivation without irrigation is an uneconomic attempt and is impossible. Irrigation becomes an inescapable need for sustained and successful agricultural operations in Hissar.

With the population swelling year after year, irrigation has to have a new purpose. This new purpose of irrigation is to develop a comprehensive system of irrigation towards increasing production. The approach towards irrigation development has, therefore, to be oriented accordingly. In the changed context, all development of irrigation should work backwards from agriculture into irrigation, and not from irrigation into agriculture, and these should not be revenue oriented. The outlook now has a necessity, that is to be production oriented and more attention should be paid towards maximising production from the available irrigation sources.

The lack of irrigation facilities leads to a drag on the farmer's incentives. He remains hesitant to provide other inputs like improved seeds, manure, fertilizers, pesticides, etc. If irrigation facilities are assured to the farmer, he can undoubtedly be made to shake off his reluctance to provide the other inputs required to increase agricultural production. Stepping up irrigation, therefore, is basic for any progress in this direction. The future planning of irrigation must accord to the knowledge of the two important facts, namely, the problems connected with irrigated farming in the irrigated lands and the relative requirements of irrigation in unirrigated lands. A correct appraisal of these fundamentals will lead to the wholesome planning of irrigated farm economics and where further irrigation facilities need to be introduced. On the whole, there is great room for the extension of irrigation in Hissar.

PART III

THE DEMOGRAPHIC FACTOR IN THE STRUCTURE OF AGRICULTURE

Introduction

Man gets nearly all of his food from the soil, less than one percent of what he eats being fish (Pearson and Harper, 1945). Thereby the land-use is affected by the various aspects of population. The physical attributes of an area become resources when people are able to use them. The relation between population and land-use is reciprocal, for instance the changes in population pattern influence not only the utilization of the land, but the latter with changes in the agricultural controls to a great degree determines the pattern of population. As the population of Hissar still is, to a large extent, formed of farmers, this relationship is a close one.

The ultimate significance of data on food and agriculture is realized only when such data are placed in conjunction with population records. Only those demographic characteristics of the population which are of relevance to the present land-use or which are likely to influence the land-use in future need to be stressed for deriving practical conclusions.

The detailed population maps have been constructed by using enumerations up to village level for the years 1951 and 1961. These maps form the grounds of the analysis set out in the ensuing section. For determining the man-land ratio, economic density and the intention of farming the village data have been computed for assessment circles. This has been done for correlating the population with land-use for which the data by assessment circles is used. As the emphasis of this study is on the areal differences in the various aspects of the rural population influencing the land-use, the urban population is set aside.

CHAPTER 8

RURAL POPULATION:

Distribution and Growth for 1951 and 1961

In 1951, 83·96 percent, and in 1961, 84·41 percent of the total population was classified as rural. This huge concentration of population in villages confirms the deep rooted relation between land and people. Furthermore, these figures reveal that man-land relation has been confirmed rather than changed. The intercensal growth of rural population exhibits the startling growth during the 'fifties (Table 8.i):

Table 8.i

Intercensal Growth of Rural Population - Hissar, 1901-61

Years:-	1901	1911	1921	1931	1941	1951	1961
Percentage Increase or Decrease:-	-	6·84	-1·94	10·06	10·96	10·18	48·63

The situation in 1951 helps one to appreciate the great changes in numbers and distribution that have taken place since. These changes showed a fairly close relationship to the increasing agricultural productivity, and the extension of canal irrigation. The high rates of inward migration were related to the surge of agricultural activity in the receiving areas. The operation of what may be called the economic differentials played a major part in the inward drift of agricultural population to the flood plain. The penetration of new adventurous farmers to the Hissar district has offset the traditional agricultural economy.

Distribution (Fig. 69)

The distribution of population has been altered considerably and at the same time total numbers have greatly increased within Hissar over the 'fifties reflecting changes in the evaluation of natural endowment. The distribution of rural population is here set against the background of the land forms, soils, irrigation and urban areas. On the whole the tremendous rural concentrations are confined to the level, intensively cultivated and the best irrigated alluviums (cf. Figs. 8, 44, 62 and 69). On the other hand very light soils are less fertile and naturally less attractive. Similarly the areas of heavy soils attracted less farmers because of their difficult workability without sufficient moisture. Light soils also support less population owing to the scarcity of water supply. In the near future the areas of heavy and light soils will have more concentration on account of the induced idea of utilizing the ground water in the flood plain and the overall extension of irrigation. The clusters can be visualised in the vicinity of the towns due to the employment opportunities.

Density of Rural Population (Fig. 70)

The validity of the control of water supply and soil capability can be gained by analysing the correlation between these and the density of population. The matter of water as a factor affecting population density takes on more meaning. The significant amount of discrimination among soils on the basis of their potential productivity and ease of handling comes afterwards. It is true that water and soil may appear to outweigh the other elements in influencing the density of population. It is not too implausible that in so far as perennial water supply is absent over vast areas and varies in amount and reliability in others, so it is faithfully reflected in very uneven density (cf. Figs. 62 and 70).

The high and very high densities (300-400 and over 400) are attained in the old irrigated areas of Hansi, Hissar and Bhiwani tahsils. These extraordinary densities are made possible by the superior resources of water and soil.

The areas of average density (200-299) are traceable in the flood plain and the areas of Bhiwani, Hansi, Hissar, Fatehabad and Sirsa tahsils to which irrigation has been extended with the Bhakra canal or the improvement of the old canal system has been implemented (cf. Figs. 59, 60 and 70).

The areas of low density (100-199) are concentrated in the rainfed areas of the district embracing the south-west margin and the north-west sector. The economy of these regions may be diversified with the increasing intensity of irrigation. These may be able to provide lure for inmigrants. It is expected that demographic instability is likely to occur in the foreseeable future in these areas.

The areas of very low and minimum density (50-99 and under 50) are very few. It is a clear index that most of the factors necessary for the production of food are available, but the most significant one, that is water supply, is short. Finally, it can be stressed that from the same lands very high yields can be procured if some means of irrigation are made available supporting more people.

Absolute Change in Rural Density, 1951 to 1961 (Fig. 71): The numerical change in the rural density during the 1950's can be well appreciated from Fig. 71 by recognising seven categories:-

(a) Maximum Addition		Over 120	persons	per	square	mile
(b) Considerable	"	90-120	"	"	"	"
(c) Average	"	60-89	"	"	"	"
(d) Low	"	30-59	"	"	"	"
(e) Very Low	"	15-29	"	"	"	"
(f) Minimum	"	0-14	"	"	"	"
(g) Decrease						

Maximum to average addition took place in areas to which canal irrigation was extended recently, such as the flood plain and in the areas where the old system was improved and extended.

Very low and low rate of addition has been observed in the rainfed areas of Bhiwani and the old irrigated areas. Minimum rate of increase can be noticed in the Hansi waterlogged strip which has been partially abandoned by the cultivators. There are some places which registered actual decrease in the density of population. The decrease is not due to the higher death rate but is of outmigration which is local in character.

Growth of Rural Population, 1951 to 1961 (Fig. 72): The greatly accelerated increase in population is the result of the overspill from the overcrowded areas of the Punjab. The favourable position of Hissar undoubtedly reflects the opportunities offered there to those in search of agricultural pursuit. For detailed analysis of the regional pattern of the percentile intercensal growth of rural population four categories have been recognised

(Fig. 72):

A. Categories of Colonization:

(i) Maximum Growth: Over 175 percent

(ii) Considerable Growth: 70-175 percent

B. Categories of Variable Increase:

(iii) Marked Growth: 50-69·99 percent

(iv) Moderate Growth: 30-49·99 percent

C. Category of Relative Stagnation:

(v) Low Growth: 15-29·99 percent

D. Categories of Crisis:

(vi) Minimum Growth: 0-14·99 percent

(vii) Decrease

There is a continuous belt of maximum growth straddled by areas of considerable growth. It is confined to the flood plain and the north-western part of Sirsa tahsil. The area which was formerly lying as an arable wasteland, bloomed into agricultural life on account of the extension of canals. It acted as a magnet and brought a rush of people from the adjoining thickly populated areas of the Punjab. It is a belt of rapid colonization.

The areas of marked growth are mostly found in the northern part of the district where inmigrants are still pouring in, and it is hoped that these will show a considerable growth during the census of 1971.

The areas of moderate and low rate of growth can be seen either in the old irrigated areas or the areas to which irrigation was extended during the late 'fifties.

The rainfed areas of Bhiwani showed moderate to minimum increase owing to the unfavourable water supply conditions. These keep the area in the grip of crisis.

The villages showing decrease are there, due to the fact that inhabitants migrated to other nearby villages for better canal water opportunities.

There exists a close relationship between the relative increase 1951 to 1961 and the size of settlement in 1951. The relative increase has been tremendous in the settlements of small size in 1951 (Fig. 73). It is a natural phenomena, that only those villages will expand which have the potentials to do so with a rich resource base. The concentration of such villages can be observed in the flood plain. The villages of large size in 1951 experienced a low rate of growth because of the non-availability of arable land for inmigrants. These are found in the old irrigated areas. The same is the fate of the villages of the rainfed areas.

Population Increase and Land Use: Hissar's increasing population, raises for the first time in acute form, various questions concerning the land-use. What is the best use to which each portion of land shall be put? Shall it be used for food farming or for commercial farming? Can Hissar any longer afford its wasteland? These questions hardly arose prior to the 'fifties when there was plenty of land but not too many people. Today there is much more land under intensive and permanent cultivation. Much more food is needed than ever before to feed the increased population, including an ever-growing number of nonagriculturists in rural and urban areas. There is, therefore, a great need to increase food production and to provide improved marketing facilities. Land-use and farming methods are only two problems of Hissar, the significance of which has been increased by the considerable growth of population. Population increases caused the intervals between successive cropping to be progressively shortened. The resultant consequences are the increasing intensity of cropping and the cultivation of the soil to the point of exhaustion by the ignorant farming communities. The problems have become more difficult and serious when farmers turned more land to commercial crops. These problems need serious thought that the population increases which took place during the 'fifties, are bound to occur during the 'sixties on account of considerable agricultural potentials. Therefore, it is essential to determine the man-land ratio and population pressure for making suggestions towards the well guided land-use.

CHAPTER 9

MAN-LAND RATIO AND POPULATION PRESSURE

The rural density calculated on the basis of the total rural land area and total rural population (Fig. 70) irrespective of the land's suitability for agriculture is of limited value. The simple relation of rural population with total land area is not a good index for establishing the population pressure, it is cropped area that matters. Therefore, the need arises for alternative methods of eliminating the errors implicit in comparison with Overall Density (Fig. 74, Total Population/Total Area) and Rural Density (Fig. 75, Rural Population/Rural Area). These offer a superficial general view of the demographic condition of different areas without any utility for the land-use analysis. To overcome their errors here an approach to this has been made by calculating the Agricultural, Nutritional and Economic Densities (Figs. 76, 77 and 78).

Agricultural Density (Ferenczi, 1938 and Trewartha, 1953)

The comparison between the agricultural population and cultivated area (Fig. 76) provides a little better approach to the question of land-use in the peasant agricultural countries where heavy reliance is on farming. The cultivated area takes no account of double cropping, but it does include fallow land. It does not take into account the proportional agricultural productivity of the soil. Therefore, agricultural density cannot be used reliably for the scientific planning of land-use. Furthermore, agricultural density alone no longer suffices to characterise the alimentary and other conditions of the agricultural population in areas which are even a little more advanced from the economic point.

Nutritional Density: A refinement of agricultural density may be the man-crop ratio (Fig. 77, Rural Population/ Cropped Area), the cropped area excludes fallow land, but includes the area not matured and increment due to double cropping of land. It is also not a realistic measure to ascertain the degree of influence of population on land-use and no longer serves the purpose of measuring the nutritional conditions of the population.

The patterns revealed by Figs. 76 and 77 are very similar, as indeed one would expect on account of the great dependence of the economy on agriculture. In mapping the same five broad categories have been carried through both the maps exhibiting the agricultural and nutritional densities. Discussion may therefore be confined to the areas of difference.

The Contrasts in the Agricultural and Nutritional Densities: To analyse the differences two categories have been derived:-

(a) Areas of low Agricultural Density in comparison to Nutritional Density: Agricultural Density is low in relation to nutritional density in the south-west of Bhiwani and the south-east of Sirsa tahsils despite the heavy reliance on agriculture on account of the high percentage of cultivated area to cropped area.

(b) Areas of High Agricultural Density in comparison to Nutritional Density: These embrace the flood plain of Hissar and Sirsa tahsils. In these areas the agricultural density is more than the nutritional density because of the lower percentage of the cultivated area to the cropped area.

Economic Density (Population Density in relation to Land Quality or Productivity) (Fig. 78).

In the preceding discussion, it has been found that rural, agricultural and nutritional densities are inadequate to measure the population pressure in so far as they ignore contrasts in land quality and productivity. One may think that the areas with very low to moderate densities have low population pressure. Yet they may be limited by low yields. It will be observed that rural, agricultural and nutritional densities are low in the rainfed areas of Bhiwani tahsil. On the other hand the population pressure is very high. In these areas a minimum potentiality exists to support more people under the present conditions (cf. Figs. 75, 76, 77, 78 and 79). The outcome of additional population in the rainfed areas would be depression of the nutrition standards.

The densities so far discussed may be adequate for some kinds of international or national or provincial or regional comparisons. These are mostly used by the politicians or economists or sociologists or geographers. It is not advisable for an agricultural geographer to explore the question of population pressure added by these in relation to land-use. It is obvious that besides the figures representing the factor of agriculture, other economic data must be brought into play, to furnish the means of comparing the demographic and economic positions of different parts. The best way is to reduce the heterogeneous land to homogeneous terms in a sense of productivity, to determine the production of food per standard unit of surface in calories and to compare the production with the standard physiological food requirements per capita of population.

These may help to conclude the carrying capacity of land, economic density, population-supporting potentials, migration tendencies and ultimately the influence on land-use. One of the most interesting problems in the agricultural geography of the developing countries is how to ascertain the carrying capacity of arable land under traditional agricultural systems. Here an attempt is made by taking into account the quality of land, the type of irrigation, average food required to support one man and the land required to produce that food. The requisite adjustments have been made in the technique of estimating the Standard Nutrition Unit and the Standard Unit of Production as detailed in the Appendix I.

Uniformity is characteristic of food consumption throughout the region. It is familiar and indisputable with slight variations in the dishes. The cereals are important in the daily food. Wheat is the staple food of the people over vast areas. Therefore, it has been substituted for all other food crops for the supply of the required human fuel in calories. The two figures arrived at in Appendix I, 6·75 maunds of whole wheat/person/annum to support him in health and full activity and 12·24 maunds of food per standard acre in terms of wheat left for human consumption and ingestion offer a sound base to estimate the optimum carrying capacity, the population pressure and future additional supporting capacity of the Hissar district on a regional basis. These figures have been derived after giving proper weight and allowances. Finally, one standard acre which produces 12·24 maunds of wheat after taking into account the food disappearances has a capacity to support 1·81 persons and the net area sown reduced to one standard square mile can feed an Optimum Population adequately of 1158 persons at the prevailing level of production.

When the total population, rural and urban, is taken into account, the existing average population pressure comes to 741 persons per standard square mile. Hissar district as a whole has still a food surplus for 869,499 persons (1961). In fact, the situation varies a great deal as each part of Hissar is not an area of similar population pressure. The knowledge of the existing regional pattern of population pressure is of great significance in the development of irrigation to be followed by the scientific land-use and the redistribution of population.

The rural population has been chosen as a base to show the regional variation in the economic density (Fig.78) and to estimate the absolute potentiality of absorbing additional population (Fig. 79). In the following discussion both the maps have been analysed in combination.

Areas falling into the categories under 799 persons have the potential of absorbing a high to very high number of persons and areas over 999 persons per standard square mile have reached more or less the level of Optimum Population or over it. The latter have low potentials for supporting more population until the water supply conditions and the soil management techniques are improved. Obviously the land-use is directly related to the population pressure as the higher the population pressure the maximum of the arable land is under food crops and the lower the population pressure the commercial the farm economy.

Areas of Exceptionally High (over 1200) and Very High (1000-1200) Economic Densities:

The whole of the Bhiwani tahsil excluding the Haryana Sharqi assessment circle has practically approached the level of optimum population. In the Amrain Bagar assessment circle it is above the optimum level. It is not desirable from a social and nutrition view point. The maximum population pressure is on account of the low productivity of the land. The advantage of low agricultural and nutritional densities in these areas has been overshadowed by the limited food production. The present position is such that the land produces little surplus over the requirements of the rural population. The potentiality of supporting additional population is very low to exceedingly minimum. The conditions become extremely adverse when rain fails. The existing population pressure is supported at a knife edge even under the regime of normal rains. The area can support the subsistence crop economy.

Areas of High Economic Density (800-1000):

The assessment circles of Nali and Bagar in Hissar tahsil fall in this category. In the former, the marked population pressure is due to the average quality of land. In the latter, it is due to the low water allowance and the sandy soil. These have a moderate to low capacity to carry an additional number of people at the moment. However, in the near future with the improvement of water supply and soil, these may be able to produce more food for more people.

Areas of Moderate Economic Density (600-799):

This category includes the Nali, Nehri and Bagar assessment circles of Fatehabad, the Bagar assessment circle of Sirsa and the Haryana Sharqi assessment circle of Bhiwani tahsils. These areas can support a considerable additional number of population and are able to grow cash earning crops.

Areas of Low Economic Density (Under 600):

The assessment circles of Rohi and Nali in Sirsa, Barani and Nehri in Hissar and Hansi tahsils are embraced by this scale. The rural density in Hissar and Hansi areas is high but the population pressure is low due to intensive irrigation and productive soil producing food in excess. In Sirsa areas the rural density is moderate, similarly the economic density is low. In the newly irrigated areas the low population pressure is not due to the productivity of the land but is on account of a vast potential arable land having a low population base. On the whole these areas can absorb roughly an additional equal number of people and have ample space to grow commercial crops. It is suggested to encourage commercial cropping in these areas. It may help in increasing urbanisation and industrialisation based on agricultural raw material leading to the shift of rure to urbe decreasing the pressure on land and improving the standard of living of the farmers.

Relative Changes in Population Pressure, 1951 to 1961 (Fig.80)

In Fig. 80 two segments can be observed, one where pressure decreased and the other where it increased relatively.

Areas of Decreased Pressure: These include most of those areas where new irrigation facilities have been extended and the old ones improved. The improvement in water supply increased the productivity of soil at a higher rate in proportion to the growth of population.

In the flood plain the decrease is at a slow pace because of the rush of inmigrants and the slow progress in the improvement of the productivity of soil which is mostly heavy and arable waste. In the old irrigated areas of Hansi tahsil, the decrease is at a low rate on account of the insignificant improvement in irrigation facilities.

The population pressure decreased more significantly in the areas where the irrigation improved impressively. The assessment circles of Nehri, Barani and Bagar of Hissar, Bagar in Fatehabad and Barani in Hansi are covered by this category. The Rangoi and Barani assessment circles of Fatehabad experienced a significant decrease in population pressure despite the rapid growth of population on account of the increased acreage of productive land and the rapid extension of canal irrigation.

Areas of Increased Pressure: The population pressure increased in the assessment circles of Rohi in Sirsa and Nehri of Fatehabad tahsils owing to the significant growth of population in proportion to the increasing productivity of the land and the intensity of irrigation. Similarly, in Bhiwani tahsil as a whole leaving aside the Haryana Garbi assessment circle the population pressure increased due to the little improvement in the productivity of the land to the corresponding increase in population base. On the whole in the block of increased population burden the constant increase of population has outpassed the food production.

Outlook into Future Planning Based on Population Pressure

After the discussion of the prominent features of the economic density, it is perhaps permissible to indicate at least some of the ways in which the various population pressure maps can contribute to the future agricultural and irrigational developments based on geographical facts rather than on uninformed hopes and aspirations. It is clear that the areas of very high population pressure need improvements in seed breeding, soil management and the moisture supply; the areas of moderate population pressure need orientation in water allowances and agronomic practices and the areas with low population pressure may be devoted to commercial cropping and to absorb more population successfully without any deterioration in the nutrition standard. Furthermore, the latter may be able to provide employment to the floating population of the areas of distress at a low cost of travel.

CHAPTER 10

NET-MIGRATION AND THE TENDENCIES OF MIGRATION

Introduction

Two demographic processes have long been going on in the world, one is the natural growth of population, the excess of births over deaths, now commonly referred to as the population explosion, and the other is the movement of people from place to place, that is, migration. Hissar experienced both, the latter at a significantly higher rate (28·10 percent) than the former (20·53 percent) in the rural population during the 'fifties. The regional pattern of migration is magnificently varied in degree within the boundaries of Hissar.

The impact of migration on the land-use depends, in a large measure, on the number and traits of the migrants and the ties they maintain with the land of origin. Permanency in migration and the progressive nature of the farmers have healthy effects on the agricultural prosperity and stability. Farmers from other parts of the Punjab have brought new ideas and crops and acted as reformers in bringing about changes in the regional traditional type of farming practices in Hissar within the last decade. A classic example is provided by the migration of the Jat and Kamboj sikhs and the Mali farmers to the flood plain. They brought with them the knowledge of intensive and commercial farming. To some degree they have been instrumental in the extension of the area under cash crops. On the whole the migration into the Hissar district is of a permanent nature comprising a large number of enterprising farming communities familiar with irrigated intensive farming.

A comparative study of the migration in different parts of Hissar, shows a clear gradation of types according to the degree of obstacles that have to be overcome. The lower the costs and better the economic opportunities, the greater is the migration. The relationship of migration to economic conditions is generally such as to bring about migratory increases of population in areas of relatively great opportunities, and migratory losses in areas of scanty opportunities. Briefly, net-inmigration and net-outmigration are linked with agronomic and socio-economic imbalances in Hissar: firstly positive inducements to migrate into the economically attractive areas, such as the flood plain and the new Bhakra canal irrigated areas, having plenty of arable land and low population pressure, secondly on the other hand, austerity and hardship, often due to the limited unreliable water supply and the very light sandy soil supporting nearly optimum population, or even over in the rainfed areas of Bhiwani tahsil, compel the people to outmigrate.

During the early 'fifties the vast areas of the Ghaggar flood plain were sparsely populated. These are potentially one of the richest food grain growing areas of the Punjab, forming a broad belt of lightly exploited wasteland awaiting water supply. The contrast with the area in the north was extreme where lay the areas of vast reservoirs of man-power being heavily populated. In Hissar, communications in the beginning were scanty and insecurity was prevalent. The will and might of the colonising power forged these widely heterogeneous regions together into one integrated economic framework in which initiative, free movement, expert leadership, plenty of water supply and systematic development became possible.

By the end of the 'fifties Hissar emerged at breakneck speed as the Punjab's foremost producer and exporter of grains, oilseeds and cotton.

The astounding feat of colonisation was to no small extent due to migrants only; but the state initiative was also there, primarily in the form of canal and road development and secondarily in the form of education, medical, electricity, marketing and drinking water facilities. These opened the safety valve of migration. The migrants moved quickly and were tentatively guided by the signals of prosperity. It was not just the pressure in the other districts of the Punjab that drove the people to Hissar, but they were attracted by the agricultural prosperity in the new area. The migrants moved to Hissar to contract for agricultural occupation, not so much as single individuals, but more collectively in groups.

Data on migration, whether in or out, are quite inadequate for Hissar. Census administration does not make any provision to record, as such, migration movements that occur on inter-village level. Therefore, the comprehensions of the magnitude and direction of the in or out movements of the people are indirectly derived. To ascertain the direction of migration streams, the probable extent of net-migration, the age and sex group of the migrants and male-selective or female-selective migration, the various techniques have been used in the following discussion. These facts piece together a fairly coherent discussion on migration, even in the absence of direct census information on inter-village migration.

Intensity of Population Pressure in 1951 (Fig. 81):

The intensity of population pressure for 1951 has been calculated as follows:-

$$\text{Economic Density} \times \frac{100}{\text{Carrying Capacity per Standard Square Mile of Net Area Sown.}}$$

The population pressure of 1951 was dynamic thereafter on account of the extension of irrigation facilities in turn increasing the productivity of the soil (see Fig. 80). The intensities used in Fig. 81 exhibit the possibilities of direction of migration within Hissar. The higher the intensity the more the outmigration and the lower the intensity the more the inmigration that is likely. The population pressure is low in the new and old irrigated areas. In the former it is minimum, accounting for the excessive inmigration. In the rainfed areas or partly irrigated areas it is very high leading to outmigration. These indicate the areal inclination of migration-potential just as the atmospheric pressure indicates the gradient of wind blow. When the intensity of population pressure (1951) is analysed in relation to the number and the rate of increase in population 1951 to 1961 (cf. Figs. 81, 71 and 72), these show a very fine correlation, i.e., the lower the intensity of population pressure falls, the higher the rate of growth of population.

Probable Net-Migration: The residual method (Siegel and Hamilton, 1952; Osborne, 1964) can be used in measuring the balance of the movements of all migrating groups and an estimate may be readily made for a small areal unit. Thus for Hissar as a whole:-

(a) The Actual Statistics, the actual rate of growth (rural population) = 48·63 percent

(b) The Vital Statistics, the natural rate of growth (rural population) = 20·53 percent

Regional Rate of Net-Migration = 28·10 percent

The observation of Fig. 72 in conjunction with the regional rate of net-migration reveals that the magnitude of inmigration was marked to exceptionally high in the newly irrigated areas of the flood plain and the Rohi assessment circle of Sirsa and low in the Bagar assessment circles of Sirsa, Fatehabad and Hissar tahsils. The outmigration was from the old irrigated areas of Hansi and the rainfed areas of Bhiwani tahsils.

The traits and destination of the migrants have been gathered by personal observations at the time of field work. It is found that migrants are Jat and Kamboj Sikhs, Malis and ejected tenants. They have concentrated mostly in the flood plain.

The keys to Figs. 71, 72 and 81 suggest a six-point scale of migration intensity:

Sr. No.	Scale of Migration Intensity and Areas covered by each	Absolute Increase in Density 1951 to 1961 Fig. 71	Growth of Population 1951 to 1961 Fig. 72	Intensity of population Pressure 1951 Fig. 81
1.	Exceptionally Heavy Net-inmigration (Flood Plain and Bhakra Canal Area)	Over 120 persons per square mile	Over 175 percent	Under 45 percent
2.	Very Heavy Net-Inmigration (Straddling the above scale)	90-120	70-175	Under 45
3.	Moderate Net-Inmigration (Old Irrigated Areas)	60-89	50-69	45-69
4.	Approximate by Average (Old Irrigated Areas)	30-59	30-49	45-69
5.	Moderate Net-Out-migration (Old Irrigated Areas)	15-29	15-29	70-99
6.	Heavy Net-Out-migration (Rainfed areas of Bhiwani and waterlogged villages)	Under 15	Under 15	Over 100

After looking at the above scale and Fig. 81 an exception can be observed, that is, the upper flood plain. It does not fit in the scale. In this area the population pressure in 1951 was high, but during the 'fifties there was a considerable growth of population. It is the direct result of the expansion of the irrigation facilities, and the availability of the cheap arable wastelands attracting the migrants.

Age and Sex Group of the Migrants: Since the beginning of a regular census of population, the tendency of individuals to report their ages in round numbers, especially in numbers ending with 0 or 5, has been familiar to persons who have occasion to use population figures. This clustering of the population at certain ages is particularly characteristic of the census reports of illiterate persons (Figs. 82 and 83). The comparability of Figs. 82 and 83 reveals that inmigration took place in age groups of 20-50 (males) and 20-40 (females). It has been generally assumed that by a proper grouping of ages the extreme fluctuations may be cancelled (Fig. 84). Finally, Fig. 84 shows that the inmigration took place mainly in productive age groups of both sexes. It is of great significance for agricultural activities by reference to males and for the growth of population in respect of females. The migration has changed the overall age and sex composition of the rural population (Fig. 86). Besides the productive age group of females for the rest of the groups the male selective inmigration exceeded females affecting the sex ratio.

The public health measures have been greatly intensified during the last decade with a resulting decline in the infant mortality. The mortality of productive mothers relatively declined due to better maternal care. The old age group experienced a significant amount of deaths in 1956-60 as per 1951-55 (Fig. 85). A portrait of the main rural population components is provided by the age and sex pyramids (Fig. 87). These exhibit that population is predominantly young. The wide base of the diagrams indicates that the high rate of natural growth is prevalent which may be a distinctive feature of an agricultural community. The narrow apex reveals the short span of life.

Male-Selective or Female-Selective Migration

There is an overall deficiency of females in the population of Hissar. To begin with, there are several complex factors underlying this, such as, firstly, males and females are not born in equal numbers, and secondly they do not die in equal numbers. These facts explain the overall deficiency of females. The birth and death differentials can justify the minimum areal contrasts in sex ratio and sex changes, but cannot account for the maximum contrasts which are found in the maps of Hissar (Figs. 88 and 89). Eventually, the magnitude of migration into the district is of much significance for producing the appreciable spatial contrasts in sex ratio (Fig. 88), and absolute change in sex ratio 1951 to 1961 (Fig. 89).

The female ratio is exceptionally low in areas where male selective inmigration has taken place and high in areas from where male selective outmigration has taken place. The majority of the villages in Hissar belong to the category of 800-899 females per 1000 males. It corresponds with the regional average of 861.

Villages of less than 700 females per 1000 males are far fewer in number. Their concentration is in the flood plain or along the new canals. These coincide with the areas of considerable percentile intercensal growth in rural population (cf. Figs. 88 and 72). The exceptionally low sex-ratio is the outcome of a considerable male-selective inmigration to these villages during the 'fifties.

Villages falling within the category of 700-799, are concentrated in the flood plain and the Rohi assessment circle of

Sirsa tahsil. It is also due to the male-selective inmigration which started comparatively earlier than the former category. In certain cases families might have migrated before the enumeration of 1961 on account of settled conditions increasing the number of females per 1000 males. In the old irrigated areas of Hansi and the rainfed areas of Bhiwani tahsils, there is a minimum number of villages of this category. Generally speaking in these villages the sex ratio is not low. As in most of the cases it is above 750 and mostly comes close to 799. The sex-ratio is low in a block of villages in the south-west of Bhiwani which comes under the proposed scheme of the Dadri Lift irrigation. The male-selective speculative inmigration has taken place to these villages. The people started to settle down without families and bought cheap lands in anticipation of it being a prosperous area in the near future.

Villages with a sex-ratio of 900-1000 are found in the old irrigated and the rainfed areas which received the small share of irrigation during the 1950's. From all these areas male-selective outmigration took place. In the old irrigated areas the people did not find it economical to work on the same plot of land. They left their villages either to find jobs or to find out a piece of irrigated land elsewhere within the district. In the rainfed areas it is difficult for all the productive male members to earn sufficient livelihood. Consequently the majority of the males joined the armed forces or left their villages for earnings elsewhere, maintaining a very high sex-ratio.

Villages of more than 1000 females per 1000 males are few. These are mostly in the sandy unirrigated areas. From these areas the males left home in search of employment resulting in a very high sex-ratio comparing with the western countries.

The study of the areal contrasts in the absolute change in sex-ratio (Fig. 89) is of great significance in evaluating the migration tendencies. For the comprehension of the trend of migration, the categories of significance have been selected for analysis. These are as follows:

Areas of Absolute Increase:

(1) Over 100 females added in 1961 to 1951:- these villages are concentrated in the flood plain. The family heads found the conditions suitable for habitation and moved their families permanently before the census of 1961. In such cases female migration to these areas took place during the last decade. Some of these villages are located in the areas where pressure over land was not considered economical, may be in the old irrigated or rainfed sandy areas, male members migrated to other areas to find better avenues of earning raising the sex-ratio.

(2) 50 to 100 females added in 1961 to 1951:- Similarly as in the former, in this category too, the inmigration of females or outmigration of males started late in the north-west and south-east parts of Hissar respectively.

(3) The areas where 0-49 females have been added to the number already existing in 1951 are scattered all over. The addition may be attributed to the improved maternity facilities, differentials of birth and death rates in both the sexes and the insignificant rate of female or male-selective migration tendencies.

Areas of Absolute Decrease:

(4) The areas having a fall under 49 in the number of females per 1000 males are found all over the region. Besides other vital causes, it may also be to male-selective inmigration to a lesser degree.

(5) The villages having a decline in number over 49 are concentrated in the northern section of Hissar. It is primarily due to the male-selective inmigration which started during the late 'fifties and brought down the sex-ratio. In the south the decline is mostly found in areas where male-selective inmigration in speculation of the extension of irrigation facilities took place or in areas to which irrigation was extended at the end of the last decade.

To sum up, the number of inmigrants is impressive, but is indeed concentrated in the north. The progressive inmigrants are bound to bring changes in the land-use and the social awakening amongst the native farmers practising the traditional farming techniques.

CHAPTER 11

i. FUNCTIONAL ANALYSIS OF RURAL POPULATION

The primary occupation of the rural population is agriculture and other means of livelihood have not been developed as yet in Hissar. Obviously, agricultural prosperity is a sound basis in influencing the social and economic status of population and functions of the area. Hissar has the largest percentage of the working population in agriculture. The high percentage engaged in agriculture (Fig. 94) is usually an indicator of the absence of other occupations and the low degree of literacy (Figs. 90 and 91). Except in the canal irrigated areas, elsewhere the agricultural population is dependent on subsistence and grain farming, in which labour input is much larger than the return from the land, with the result that more and more of the population work on the land to support the outstanding population pressure.

The analysis of the occupational stratification of the rural population may be the key for understanding the mode of farming. The enumerations of 1961 up to village level have been arranged for each assessment circle and used for the appraisal of the regional activities in Hissar. Percentages of each working group to total workers have been computed and represented in Fig. 92 and the following conclusions arrived at:

(1) Broadly speaking, Hissar can be divided into three regions having a variable intention of farming, viz:-

(i) The Region of Subsistence Farming: It embraces the south and the south-west of the district covering the rainfed areas. Agriculture is the mainstay of life carried through the inferior grain cropping. Therefore, the absence of other occupations may be observed.

(ii) The Region of Commercial Farming: It comprises the Rohi and the flood plain. In these areas the proportion of the hired agricultural labourer is significant and the female participation in farm economy is of insignificant degree.

(iii) The Region of Diversified Commercial Farming: It commands the old irrigated areas of Hissar covering the north-east sector of Bhiwani, the whole of Hansi and the north-east of Hissar tahsils. Besides agriculture, the household industries and other allied occupations have gained importance due to established farm economy associated with the old irrigation and marketing facilities.

(2) In the south and south-west the dependence on agriculture is exceptionally high and it is comparatively low in the old irrigated areas. On the whole, Hissar in general is much more heavily agricultural in economic structure.

(3) The female participation in agriculture in the south and south-west and the east is considerably high because of the social and economic variants (Fig. 95). The distributional pattern of Fig. 95 may give a clue regarding the distribution of the farming communities. Jat sikhs and Rajputs do not allow their womenfolk to work in the fields. On the other hand, Hindu and Bagri Jats, Bishnois, Kamboj sikhs and Malis do encourage the females to share the responsibilities of farming in the field.

(4) The ratio of the hired agricultural labourer is high in the north of Hissar owing to the progressive farmers, the large size of the holdings, the productive soils, the availability of

irrigation, transport and marketing facilities. The percentage does reflect accurately the extent of the exploitation of hired labour in the villages (Fig. 96).

Fig. 93 portrays the ratio of the non-agricultural to the agricultural active force. It gives support to the hypothesis that with subsistence farming the ratio is higher, and with commercial farming the ratio is lower. Three empirical divisions in the distribution pattern may be drawn:-

(a) Areas of very high to exceptionally high ratio (1:13 to 1:29): these include the rainfed areas of the south and south-west. The subsistence farm economy is the common feature. The question of the people engaged in other occupations such as commerce, trade, transport, household industries and services does not arise. The pressure of population over land is exceptionally high leaving behind little marketable agricultural surplus.

(b) Areas of medium to high ratio (1:7 to 1:12): These embrace the Barani assessment circles of Hansi, Hissar and Fatehabad tahsils. These areas are in a state of change with the developing irrigation and roads. It is hoped that in the near future the ratio may come down with the commercialising trend in the farm economics.

(c) Areas of very low to low ratio (1:2 to 1:6): These comprise the old irrigated areas of the east and the newly irrigated areas in the north and north-west. The pressure of population is low and the irrigation facilities are well developed. Therefore the farm economy is of a diversified commercial type. Under such circumstances the farmers can produce enough surplus for marketing. Such a situation provides a considerable incentive to the people to adopt the occupations helping the marketing, processing, handling and transporting the agricultural surplus.

ii. GROWTH AND FUNCTIONAL ANALYSIS OF URBAN POPULATION

According to the census of 1961, Hissar has 11 towns with 240,998 urban dwellers in all. It is 15·59 percent of the total population indicating the predominance of rural economic structure, though there are growing signs of urbanisation.

Generally speaking the existing urban development in Hissar is feeble due to the low agricultural productivity, the low income in the rainfed areas and the upper hand of rural growth in the newly colonised areas. Before towns can emerge and grow it is necessary that the agricultural system with which they are associated shall have developed powers of feeding a non-agricultural population by providing them with agricultural raw material. In an agrarian economic structure, the increase in the urban sector is the evidence of an increasing efficiency of the agricultural population. The increasing efficiency in agriculture and urbanisation are two sides of one movement. The areas self-supporting in food supplies have a low proportion of urban population because their agricultural system will not support a higher urban dwelling and a better distribution of rural population. The rising efficiency in agriculture causing increase in output, increasing percentage of non-agricultural population, rising material civilization, and rising culture all go together and at times more or less in that order in an agrarian economy. The urbanisation arises on the economic side from the pre-farm manufacture of agricultural requirements and from the post-farm transport, marketing, processing, manufacturing and servicing of the agricultural produce.

In fact, the urbanisation in Hissar represents the transformation of the slow moving life of the agricultural villages into a more communal organization. From the social point of view the towns have a great significance as [redacted] progressive ideas radiate from them. Towns can be said to form the main stream of culture and progressive ideas seeping into the texture of the social life of the villages. For the progressive social and economic life of an area, the urban growth is absolutely essential.

Intercensal Growth: The intercensal growth of urban population exhibits the same tendency as the rural growth with slight variations: (Table 11.i)

Table 11.i

Intercensal Growth of Urban Population, Hissar. 1901 to 1961.

Years:	1901	1911	1921	1931	1941	1951	1961
Percentage Increase:	-	11·33	11·25	11·50	12·01	14·54	43·71

The growth has been rather slow and halting up to 1951, due to epidemics and the lack of economic opportunities in the towns for the business community. The decade of 1951-61 recorded a spectacular increase, faster than ever before, in urban population amounting to 43·71 percent, partly of a natural increase (22·02 percent) and partly of the net-inmigration of people to the marketing centres (21·69 percent).

The balance between rural-urban population observed minor changes since 1901. This shows that the changes in urban population vie with the growth of the rural population. The intercensal variation in the proportion of urban to total population remained between 0·35 percent to 1·54 percent up to 1951 with positive tendency, hence afterwards it attained a negative trend on account of the excessive rural growth (Table 11.ii):

Table 11.ii

Intercensal Variation in the proportion of Urban Population, Hissar. 1901 to 1961

Census Year	Urban Population as Percentage of Total Population	Percentage Variation
1901	10·99	-
1911	11·93	+0·94
1921	13·18	+1·25
1931	13·53	+0·35
1941	14·50	+0·97
1951	16·04	+1·54
1961	15·59	-0·45

Up to 1951 the pace of urbanisation was comparatively high due to the low rate of growth in the rural areas, but during the last decennium it was much lower. The decades of 1911-21 and 1941-51 are worth mentioning, in the former the deaths due to plague epidemics took heavy toll of life in the countryside and people shifted to towns to take refuge, in the latter the refugees from Pakistan (West) preferred to settle in towns rather than in the underdeveloped countryside of Hissar (Table 11.iii):

Table 11.iii

Rate of Urbanisation, Hissar, 1901 to 1961.

Census Year	Absolute Change in Total Population per decade	Absolute Change in Urban Population per decade	Degree of Urbanisation: Percentage of column 3 to 2
1	2	3	4
1901			
1911	26,179	10,467	+39·98
1921	12,768	11,731	+91·88
1931	81,802	13,917	+17·01
1941	107,597	24,408	+22·68
1951	36,119	21,290	+58·94
1961	500,242	73,302	+14·65

Absolute and Relative Growth of Towns, 1951 to 1961 (Fig.97): The period of the 'fifties is considered as a decade of boom for the towns commanding the areas of improved irrigation facilities. There has been an overall increase in the size of the towns at a variable rate. The higher percentage and numerical increase have been observed in the towns commanding the areas irrigated by the Bhakra canal system. The low rate of increase is in the towns located in the old irrigated or rainfed areas. These towns could not induce inmigration. The percentile increase in Bhiwani is very low (11·53 percent), it is even below the natural rate of growth. This shows that Bhiwani has experienced outmigration to a considerable degree. The tremendous increase in the size of towns has been due to net-inmigration associated with the exceptional rise in the level of business. (Table 11.iv):

Table 11.iv

Arrivals of agricultural commodities in the Mandis of Hissar in maunds

Averages of the years	Bhakra Canal Irrigated Area Sirsa	Hissar	Dabwali	Tohana
1951-54	426,834	718,929	484,619	237,738
1959-62	1,976,982	2,480,404	1,468,761	582,453
Percentage Increase in Arrivals:	363·17	245·01	203·07	145·00

Averages of the years	Old Irrigated Area Bhiwani	Hansi	Rainfed Area Loharu
1951-54	428,710	665,709	97,585
1959-62	755,759	725,201	145,850
Percentage Increase in Arrivals:	76·29	8·94	49·46

Functional Status of Towns, 1961 (Fig. 98): Percentages of each group to total workers calculated for mapping (Fig. 98) to ascertain the idea of the amount of specialisation of function of each town. All the towns of the north within the jurisdiction of the Bhakra canal fall in the category of commerce and trade. That of trade specialisation, appreciable percentage is engaged in transport and the processing of agricultural raw material in household industries and manufacturing. Hissar itself emerges as an administrative town because of the extraordinary concentration in services being a district headquarters. Manufacturing and commerce come afterwards.

The manufacturing function of Bhiwani is apparent as it is the oldest industrial town in the Hissar district having textile mills and allied industries. Commerce is second in order linked with the manufacturing and handling of the agricultural marketable products needed for local industries. Hansi is the oldest town of Hissar and performs the functions of commerce, manufacturing and administration. Loharu in the extreme south is neither a commercial nor a manufacturing town. The crowded agricultural function of Loharu leaves a limited urban field on account of the unproductive hinterlands.

On the whole the main function of the towns is to handle the agricultural marketable surplus. The prosperous expansion of the towns is closely related to the pattern of farming in the hinterlands of each. The towns do not grow up themselves. The countryside sets them to functions that must be performed in a central place, such as marketing, processing, and manufacturing of the agricultural raw material. Hissar is one of the richest districts of the Punjab having ample potentialities for agricultural development. The future urban development depends on the extension of irrigation and communication grids which may tap the potential areas of the south-west and the flood plain. The potentials of expansion of the towns of the north are considerably greater than the urban settlements of the rainfed and old irrigated areas of the east and south. In future more towns will crop up in the Bhakra canal irrigated area. The unregulated markets will attain the status of towns. After the development of unregulated markets it seems the urbanisation in Hissar will fulfil the principle of spatial dispersion in relation to economic development.

PART IV

THE USE OF THE LAND

INTRODUCTION

The technique of the compilation of the agricultural returns all over India is the same with slight regional variations. However, within Punjab there is a homogeneous system of collecting agricultural data for all districts. Furthermore, in Hissar the compilation of the agricultural returns is on similar lines for all the areal revenue components. The returns are compiled by the State Revenue Department for the revenue assessment on crop-irrigation basis. This is the only direct tax on peasant-proprietors or land-owners, though hearth tax is levied by village councils for local administration. In view of this, the importance of the revenue assessments by keeping them up-to-date is obvious.

The returns are easily accessible and the present work might not have been contemplated and completed if access to the returns had been restricted. It must be remembered, too, that the data now included in the agricultural returns are sufficiently comprehensive to provide answers to all questions relating to the land-use and the cropping pattern. These can be used to trace the recognisable changes in the agrarian set-up of Hissar to the changing circumstances.

The returns are recorded in the "Lal-Kitabs". The inventories are made by the village accountant (Patwari) and circle officer (Kanugo) in a very careful and painstaking way.

Thereafter the statements pass to tahsil, district and land record offices in a consolidated form for further compilation. The agricultural returns used in the ensuing land-use analysis are abstracted from the Lal-Kitabs of 19 assessment circles and 88 sample villages.

To begin with the analytical processing of the returns, there are some features which have a direct bearing upon their treatment, that is, their validity and use. These are summarized as follows:-

(i) The comparability of the agricultural data are maintained because of a consistency in recording by the trained persons on the spot. The returns have a considerable degree of breakdown and continuity. The government service in India have long gathered and published valuable data on the details of land-use in this great low latitude country, data comparable in accuracy and scope with those gathered in the more advanced countries of the western world (Wellington, 1929).

(ii) Some error may creep into the Agricultural Statistics by the time the figures reach the Director of Land Records Office in rounded form after passing through many hands. Therefore, the use of the published notorious land-use returns is avoided and the abstraction is done from the direct source, that is, Lal-Kitab. This is of great utility for the critical analysis.

(iii) The coverage of the returns is complete in time and area.

(iv) The reliability of the returns can best be resolved by comparing the returns with other contemporary independent data gathered from other sources and compiled by the organizations other than the revenue department. To start with the comparison was carried out in the intercensal changes of net area sown, intensity of irrigation and rural population. The distributional patterns bearing similarity were observed. Furthermore, the annual fluctuations in harvested area coincided with the annual variations of rainfall prior to the expansion of irrigation. The comparisons may be allowed to speak for themselves because of the strict comparability.

(v) The question of corruption and deliberate false-recording must be faced. There is spot checking by the higher revenue officials at various stages. Further cross-checking is carried out by the canal officials. These reduce the possibility of false entries to a considerable extent. Finally, possible limitations in the accuracy of the records has been borne in mind throughout the present work. Cross-checking at the time of processing has been done and any discrepancies and omissions which were found have been repaired. These were very few.

(vi) The unchanged boundaries and areas of the assessment circles and villages throughout the period of study greatly assists comparability.

(vii) Intercropping is frequent, whence a source of error arises. In mixed cropping it is difficult to estimate minor crops which are altogether ignored. Too much reliance cannot be placed on their numerical values. The acreage under these is of insignificant extent in Hissar. The intermixture cropping of a considerable significance is wheat-gram. It is recorded separately. Thus the impact of this ambiguity in minor inter-cropping is not pertinent to the statistical and cartographic appraisement of the returns.

The land-use facts for villages and assessment circles are set forth in three major statistical tables viz:-

(a) Land-Use Table: No.1.

(b) Summer (Kharif) Crops Table: No.2.

(c) Winter (Rabi) Crops Table: No.3.

The land-use classification is without perplexing and elusive problems, being effective and meaningful. Each category has been defined sufficiently for immediate recognition. The acreage returns of crops take a note of irrigated, rainfed, cropped and harvested areas. For observing regional patterns of land-use the decennial average is used (1951-61) to allow for the annual erratic fluctuations. For estimating the direction, intensity, volume and combination of change the quinquennial averages are used, such as, 1951-56 and 1956-61. This overcomes some of the irregular deviations that are discernible over a considerable area of Hissar. These may be related primarily with the periods of adverse weather that are liable to disrupt normal cropping in the more exceptional years in either way particularly in the rainfed areas. The changes worked out here will be strictly speaking for the impact of the Five Year Plans (1951-56 and 1956-61) and the expansion of irrigation.

CHAPTER 12

THE PATTERN OF LAND UTILIZATION

It has already been observed that the water supply and the nature of soil divergencies play primary roles in conditioning the present land-use and crop production in Hissar. The human and economic factors are also responsible for the land-use and farming types distribution. In analysing the problems of land-use, one should bear in mind that earth is the inert and man the active factor in the partnership. It is man who wants to make a living out of land. Therefore, it is he who determines the use to which he wishes to put the land one way or the other. Hence, it is natural that different types of living which are represented by social values and institutions will create different patterns of land-use conditioned by variable agro-climatic circumstances. The influence of physical factors is usually subtle and interwoven with human and economic forces from which it cannot be easily separated for the statistical investigation of the present changes in agricultural land-use. Their role will be apparent in the evolution of land-use patterns in the following analytical studies.

The existing pattern of land-use has been resulted from a process of land exploitation which is due to the increased water allowance and the growth of population. With the population increase each pattern of land-use has been extended into all physically suitable areas with the help of expanded irrigation facilities. Agriculture is the only means of survival for the majority of people. Thus, a fundamental thing for future planning is the detailed evaluation of the existing use of land.

Classification of Land

The agricultural returns available in the Lal-Kitab under Table No.1 are generalised in five categories to which the total land area geographically accessible is put for use. It will be useful to explain the various terms used in these statements, so as to convey their exact meaning. The area figures according to records are in acres (640 acres = 1 square mile). The five categories are as follows:-

(1) Forests, cover any land classed or administered as a forest under legal enactment. The area figures given in this report exclude the cultivated lands within the forests.

(2) Area not Available for Cultivation includes land under bare rocky outcrops, beds of streams, ponds, settlements, canals and roads. It may be referred as the non-agricultural land.

(3) Cultivable Wasteland denotes land considered by present judgements as cultivable but not actually cultivated; that is, all grazing and other lands not included under forests. It is left untilled on account of physical and socio-economic limitations. But some proportion of it could in no conceivable circumstances be brought under tillage without reclamation such as the waterlogged land. The village commonland is also left uncultivated and is included in this category in the returns.

The lands which do not receive any sowing for up to four successive harvests (two agricultural years) are taken out of the category of current fallows and thereafter are designated as cultivable wasteland. Though different conditions pertain in other parts of India, Hissar has no land to cultivate except land already known to have been cultivated. Any cultivable land without physical defects would have been taken up long ago because of population pressure and low productivity of land.

Cultivated Area consists of

(4) the area actually sown during the agricultural year. It may be referred to as net cropped area or net area sown, and

(5) the current fallow includes land left unsown to regain fertility and also that which remained uncropped in the short-term for want of moisture and economic reasons.

(6) Topographically Cultivable area is an additional term used by the author to measure the relative extent of cultivation and potentialities for the future extension of cultivation. It is that area which is physically cultivable.

Existing Land-Use in 1951-61

Forests: Floristically, for climatic reasons Hissar could not carry true forests. Further, it is a flat and easily workable alluvial plain more suitable for cultivation than for forests. In 1961-62 returns the area under forests was only 299 acres. This tiny state-controlled forest lies near the town of Hissar and its area has been virtually halved during the 1950's by clearance for a State Experimental Agricultural Farm. On the whole, tree plantations are essential for Hissar. These will act as wind breaks and will save the fine and loose particles of soil from being blown away by the strong winds and from the deposition of the coarse material comprising sand. The main impediment which does not favour the development of trees is the meagre rainfall. The best possibility of growing more trees is deemed to be by planting along roads, canals and water-courses.

Cultivated Area (Fig. 99): Not only in Hissar but in all the Monsoon Lands, it seems that the term Agricultural Land is usually taken as land under cultivation. This fact indicates that in these regions land utilization has not developed for livestock raising. As far as self-sufficing economy is concerned, people here would have been unable to produce sufficient food for themselves under such an increasing pressure of population.

The most striking feature exhibited by Fig. 99 is, that in the major part of Hissar more than 85 percent of the geographical surface is under the plough. This predominance is not confined to Hissar, but is quite common in the Punjab Plains generally. The main reasons are the favourable physical conditions, that is, the flat land, the fertile and easily workable soil with excellent irrigation facilities in the old irrigated and the newly irrigated areas and the population pressure in the rainfed areas.

Some discontinuous patches of the highest and the lowest proportion break the uniformity in the distribution of the cultivated land. The rainfed areas with a considerable proportion are not on the whole more prosperous, rather it is the light, sandy, easily-workable soils and the low productivity dictate the need for more land under till to sustain the existing population pressure. The maximum acreage can be ploughed as the considerable participation of females solves the labour problem.

The share of land under cultivation is low in the upper section of the flood plain and the Nehri assessment circle of Hissar tahsil, that is, under 75 percent and 80 percent of the total area respectively. In the flood plain the workability of the stiff clay soil with insufficient moisture makes it difficult to extend cultivation to even physically suitable fields and the major part is left as a cultivable waste. In the Nehri assessment circle of Hissar tahsil, during field work it has been observed that the land in patches is not within the commands of the canals because of the sand-dunes. Such types of land are left untilled.

Current Fallow (Fig. 101): Within the cultivated area, the percentages which are occupied by the current fallow and the net area sown show a wide regional variation.

In ordinary sense, the current fallow acreage is linked either to the failure of rains or to the inadequate water allowance in canals at the sowing time. On the other hand, in areas like the flood plain, the excess of moisture due to excessive floods makes it impossible to sow and plough these lands at the proper time. Another reason may apply in the large size of holdings, where most of the land may be left uncultivated due to the limited finances, man and draught power. The regional variations in the magnitude of these factors individually or collectively lead to the range of values from 6·58 to 26·75 percent of the cultivated area.

Certain areas with marked concentrations of current fallow can be seen on the map and others with less. The flood plain can be readily distinguished from the rest of the countryside. Two categories of marked contrasts can be recognised, viz:-

(a) Areas of Excessive Proportions of the Current Fallow: More than 15 percent of the cultivated area is left fallow in the flood plain and in the south of the upper flood plain. Uncertainty in the water supply from rains, canals and annual floods, stiff clay soils, large size of holdings and low population pressure are responsible for this. The presence of the "dakkar" land in the flood plain is an important reason for the high degree of fallowing. The intensity of cropping depends upon the ability of the farmer to handle this type of land at the right time. The soil has put a limit upon the extent of land which can be tilled and in which moisture can be conserved within a short period. Even a small negative departure in the amount of fall at the time of ploughing or sowing renders large areas unsown. Holdings being large, all the fields cannot be ploughed and cropped within a few days of sufficient moisture derived from the natural supply. The low population pressure, shortage of labour and draught force are the other subsidiary variables responsible for it to some extent. Furthermore, it is clear sign of the less developed irrigational facilities in relation to the moisture need of the soil, for instance, stiff clay soil requires more water to make it fit for ploughing and to assure the maturity of crops.

(b) Areas of Low Proportions of Current Fallow: The magnitude of fallowing in the old irrigated and rainfed areas is low. The texture of the soil has undoubtedly been an outstanding consideration. Where the soil is sandy in texture and includes insufficient finer material to bind together the sand particles, it can be worked with extreme ease with a small amount of moisture falling at intervals. Furthermore, in the old irrigated areas the irrigation facilities are extensively developed, the agricultural density of population is high and the female participation in the field is high and the size of holdings is small, consequently the percentage of fallow land is low. The combination of an all the year round growing season and the excellent irrigation facilities with the fertile loam make it feasible to grow a variety of crops, leaving little room for resting the land.

On the other hand, in the rainfed areas fallow is limited, despite the agro-climatic limitations, on account of an exceptionally high population pressure. The shortage of labour is not a problem because of the great participation of womenfolk in the field.

Cultivable Wasteland (Fig. 102): The higher the percentage of the cultivated area, the lesser the amount of the cultivable wasteland (cf. Figs. 99 and 102). The comparison between the shares of 1951-52 and 1960-61 establishes the fact that in Hissar the proportion of the cultivable wasteland is tiny:

	Hissar	Punjab	
1951-52	10·04	9·89	percent of the total area
1960-61	5·35	4·97	percent of the total area

Now it is mostly the waterlogged area which forms the major part of the cultivable waste. The rapid decennial decrease in this category is due to the extension of canals, increased population pressure, migration of the enterprising farmers into Hissar and the favourable climatic conditions during the second half of the last decade (see Chapter 3).

On Fig. 102, two distinct categories of distributional pattern can be observed:

(a) Relatively High Proportion of the Cultivable Wasteland, that is, over 11 percent of the total area. This category covers the upper section of the flood plain, the Rangoi and the Nehri assessment circle of Hissar tahsil. In the upper flood plain and the Rangoi area it is linked with the special circumstances created by the division of the Punjab in 1947. The state took some time to allot the arable lands which the outgoing muslim population had left, among the displaced persons coming from West Pakistan. In the meantime some of these areas developed weeds and bushes, which it was not easy to eradicate with simple implements of the ordinary cultivators. Furthermore, allottees did not enthuse to take possession of these lands because of unfavourable environments for agriculture and habitation. These unsown lands for the first two years were shown in the revenue records as the current fallows and thereafter were transferred to the cultivable wastelands. Further, the waterlogging and flooding rendered extensive areas unprofitable for cultivation. The stiff clayey soils with inadequate irrigational facilities make it difficult to plough the whole of the topographically cultivable area. In the Nehri assessment circle of Hissar tahsil, the waste ratio is high due to the physical handicaps for the expansion of irrigation.

(b) Absolute Low Proportion of the Cultivable Wasteland: This group includes the areas having under 8 percent of the total area under other fallows. Here much of the present cultivable waste is land which is the village commonland. In Hansi tahsil some of it is waterlogged land.

Land Not Available for Cultivation (Fig. 100): It is clear from the relief and drainage system of Hissar, that there is a limited area under rocky hills and river beds. However, the major part of this category is under canals, roads, railways and rural settlements. The extension of this type of land is associated with the socio-economic changes. Henceforth, it can be suggested that the volume of this category of land directly used for economic development is an ideal index for looking at the economic progress of the rural areas.

The map suggests three areal categories:-

(a) Category of Higher Percentage (over 5 percent): This covers the old irrigated areas. Further, it has been intensified due to the expansion of the canals. The size of the settlements is comparatively much larger in the east of Hissar (see Fig. 73).

(b) Category of Medium Proportion (3 to 4·99 percent): This category covers the lands to which irrigation was extended during the early 1950's. The flood plain is the major component of this category. The size of the settlements is small as the region is in a stage of rapid change. The bed of the Ghaggar stream makes up some small part of the total.

(c) Category of Low Ratio (under 3 percent): It covers two types of areas. Firstly the land to which irrigation was extended during the late 1950's and secondly the areas which are dependent on rain for farm production. In the former less land is as yet under permanent structure and in the latter the least amount is. The extension of roads and settlements correspond to economic progress, which these areas are lacking. It is hoped that the area under permanent structures will be enhanced during the 1960's because of the expansion of canal irrigation to areas where it is feasible.

Net Area Sown or Net Cropped Area (Fig. 103): This does not take into account the double cropped area. The higher the percentage of the current fallow, the lower is the percentage of the net area sown (cf. Figs. 101 and 103). Fig. 103 suggests for two empirical divisions:-

(a) Areas of High Percentage (over 85 percent): These cover the old irrigated parts and the tracts of light sandy soil. In the former the high density of population, the intensity of irrigation and the productive soil leave little chance for current fallow. In the soft loams of Sirsa tahsil the soil is easily workable and the recent expansion of irrigation has made it possible to sow the land to its maximum extent with the least effort. On the other hand in the rainfed areas of the south-west of Hissar the easily workable soil with low physical productivity to sustain the maximum population pressure led to the maximum utilization of the cultivated area.

(b) Areas of Low Percentage (under 85 percent): These include the flood plain and its adjoining areas where the soil is stiff clay and heavy. A sufficient amount of moisture is needed to till this soil and to mature crops on it. At present it is lacking to some degree. Consequently, less area is sown to ensure maturity by conserving the moisture in the fields which could have been feasible for the cultivator to perform with his means. Further, some area is flooded heavily and is left unsown in the bed of the Ghaggar stream. The density of the human base is moderate. The shortage of working force may be considered another variable as a limiting factor at the sowing time.

Factor Analysis of Changes in Land-Use, Rainfall and Irrigation for the period 1951 to 1961: The standard method of correlation coefficient amongst the selected variables has been used to achieve precision and the economy of description for Hissar as a whole. Each factor in turn accounts for as much of the original variation amongst the observations of land-use as possible during the last decade. The factors may be considered as the mathematical expressions and if the study of every element is taken individually then the task may look vast and time consuming. We take a major step forward if we can establish the existence, as a generic form, of an element complex, an elementary integration of two or more dissimilar elements, closely dependent on one another (Richard Hartshorne, 1963). Thus basically the analysis may be pondered as the identification of the inter-correlations which exist among all the variables. It has been estimated through a statistical interpretation that there is a fairly straightforward marked to very marked strong relationship in the changes of these variables (Table 12.i):

Table 12.i

Matrix of Correlation Coefficient

	x Rainfall	y Irrigation	z Net Area Sown	w Current Fallow
x Rainfall	*			
y Irrigation	0·70			
z Net Area Sown	0·76	0·89		
w Current Fallow	-0·80	-0·92	-0·96	*

Based on the statistically derived correlation coefficient figures five generalizations may be elicited. Firstly, with the variations in rainfall the net area sown and the current fallow changed with a marked positive and negative tendency respectively. Secondly, with an increased acreage under irrigation the net area sown increased and the current fallow declined portraying a very strong positive and negative correlation respectively. Thirdly, rainfall and irrigation have a quite high positive correlation. Fourthly, the net area sown and the current fallow are very highly correlated having a negative tendency. It is an expected occurrence under the present changing socio-economic variants. Fifthly, the high values of the correlation coefficient in the matrix are suggestive of the definite positive or negative correlation of higher degree. Furthermore, the part played by irrigation is more significant in bringing the swing in the land-use.

<u>Changes in the Land-Use, 1951-56 to 1956-61</u>

The impact of canal irrigation and of the growth of population are reflected in land-use changes over the decennium. Variation in land-use is an ideal index for measuring the stage of agricultural development in an area. The climatic effect on the changes in land-use has been observed in Hissar as the quinquennium of 1956-61 (18·18 inches of rainfall, quinquennial average) was climatically a normal period and comparatively a period of rainy years than 1951-56 (average 14·85 inches). The rainfall variation can bring limited temporary changes in land-use as observed in the rainfed areas. The dramatic and permanent changes can happen only due to some dynamic aspects such as the expansion of irrigation, the influx of the progressive farmers, the improved farm techniques and the growth of population.

The seasonal water shortage and the unsuitability of the shallow water table for irrigation have dominated the history of land-use in Hissar with a considerable degree of stability and erratic fluctuations. In recent years the irrigation and land-use are finely adjusted to the availability of surface water. The extent to which the traditional land-use has been altered by recent changes towards a commercial economy is closely linked with irrigation and the initiative of the cultivators. The chain of circumstances gives an individuality to the changes in land-use of the flood plain, the Rohi of Sirsa tahsil, the old irrigated areas of the east and the rainfed area of the south and south-west.

The most noticeable change in the field of land-use in Hissar during the last decade has been the variation in the amount of net area sown and the current fallow. The early 'fifties marked by the culmination of a period of subsistence farming, when arable land was widely left fallow. Thereafter, the intensification of irrigation, and the needs of the growing population with the rising standard of living gradually shifted the emphasis in farming from self-sufficing to commercial economy. Henceforth, the current fallow decreased tremendously with the increase in the net cropped area. The period is thus one of rapid change in agricultural land-use showing the variable magnitude of regional variation. On the whole the change is the spontaneous reaction of irrigation in conjunction with the increased demands of growing population at a faster rate than ever before. Relatively little modification in land-use is a signal of little change in the rural economy.

Net Changes: The changes have been summarized in Figs. 104 to 107. It is apparent from the comparison, that the expansion or reduction corresponds to the swing in irrigation and population base in relation to limits imposed by the physical environments. The relative picture of regional contrasts reveals the more outstanding modifications and permit the comparison of the nature and degree of change characteristic under different situations. The distributions indicate how far the net area sown has supplanted the current fallow. The purpose served by the additional net area sown is to support the increasing population. Brief notations on the maps follows:

Changes in Non-agricultural Land (Fig. 104): It is evident that the relative increase is considerable in the flood plain where the increased agricultural production has brought an economic prosperity in conjunction with the expansion of roads, canals, and settlements leading to a corresponding increase in area under uses other than farming. In areas to which irrigation has been extended during the late 1950's, it is moderate on account of the delayed economic development. In the old irrigated and rainfed areas increase is minimum, in the former because of the stabilised agriculture and in the latter due to the subsistence poor farming.

Changes in Cultivable Waste (Fig. 105): Most of the striking features are the considerable decrease in the whole of Sirsa tahsil, the reason being the enterprising migrants reclaimed the land and brought it under cultivation because of the incentive induced by the changing socio-economic conditions. Moderate decrease has been observed in the old irrigated areas due to the little available cultivable wasteland. In the upper section of the flood plain and the Nehri assessment circle of Hissar tahsil, although the wasteland acreage is exceptionally high yet decrease is minimum, owing to the restrictions imposed by the requirements of large capital investment, labour and moisture to reclaim these wastelands. The tenants had little incentive for the development of wasteland. This state of affairs continued up to the early part of the 1950's. However, with the implementation of the land reform measures, the induced feeling of secured ownership to tenant owners and the introduction of canal irrigation on a large scale, the wastelands were brought under regular cultivation gradually in the flood plain.

Changes in Current Fallow (Fig. 106): The increasing development of irrigation and plant breeding have made possible to grow a wide range of crops on different soils. The acreage under the current fallow declined considerably in the newly irrigated areas. In the old irrigated and rainfed areas the decrease is at a small rate.

Changes in Net Area Sown (Fig. 107): The most direct explanation of Fig. 107 lies of course by reference to the percentage change in the current fallow, the intercensal change of population and the changes in the canal irrigation (cf. Figs. 107, 106, 72 and 63). The visual correlations can readily be made. It appears that with the increase in the water allowance in the flood plain the net area sown increased. Further, the exceptionally heavy growth of population provided the working force to till the new lands. The areas to which irrigation has been extended during the late 'fifties, perceived a moderate increase. The increase is minimum in the old irrigated and rainfed areas.

An instructive conclusion is that the maximum change in land-use occurred in areas where radical change in physical environments has been expedited by man chiefly through the provision of an additional water supply and the reclamation of the cultivable wastelands. Least change has happened on both the best and poor lands which have either long been under irrigation or long without it. The areas in the transitional stage of moderate change are, where irrigation has been extended during the late 1950's. These maps show how much the land-use changes are dependent on water allowance conditions. Indeed, the contrasts in the land-use in the areas having different intensity of irrigation are more marked than those attributable to soil. Of course, irrigation is not the only consideration, but the farm size, economic status of the farmer, tradition and personal idiosyncrasy all play a secondary role in the variation in land-use. Still, the basic elements of physical environment have continued to exercise the strongest influence in fashioning the general pattern of the agricultural landscape.

Volume of Change (Fig. 108): The technique of determining the index of the volume of change is given in Appendix II. Fig. 108 is a summary: it provides a comparative view of the areas where land-use patterns have been relatively dynamic, and by contrast they have been relatively stable. The outstanding change took place in the flood plain which has observed the rapid changes in the socio-economic structure. The old irrigated and the rainfed areas are the most stable ones from the agricultural viewpoint during the period under observation. Undeniably areas of both maximum and near minimum agricultural potential are included in the category of relative stability, the former is near to the level of optimum exploitation and the latter is least due to agronomic limitations.

In strong contrast to these areas of rapid and slow change are the series of prominently semi-dynamic units straddling the flood plain and the old irrigated areas. It is anticipated that in these areas the change will be high during the present decade on account of the expanding irrigation since the late 1950's.

As by-products of the analyses of volume of change, three illuminating facts are observed, viz:-

(i) The largest percentage increase is made in the net area sown varying from under 10 to over 25 percent.

(ii) The largest percentage decline has been observed in the current fallow ranging from under 5 to over 20 percent.

(iii) The land-use combination change is uniform all over the district, that is, the net area sown and the non-agricultural land observed increases and the rest of the categories of fallowing showed a tendency of decrease. This combination is an ideal yard-stick to interpret the agricultural prosperity and efficiency with a variable index: the higher the index figure the more rapid the changes are in the farm economy, and vice versa.

Extent of the Cultivated Area and the Possibilities of Future Extension (Fig. 109): By comparing the total cultivated area with the topographically cultivable land, the areal percentage exploitation of land can be assessed. These proportions are useful not only in finding the real extent of agriculture, but the future and economic potential of an area can be ascertained. The land which lies outside the general domain of agriculture, have been put aside as these have neither present nor potential contributions to cultivation. The extent of cultivation is low in the upper flood plain and the Nehri assessment circle of Hissar tahsil. It is maximum in the old irrigated areas of Hansi tahsil and the soft loams in the north of the flood plain in Sirsa tahsil. On the whole the Fig. 109 gives an impression of an exceptionally high percentage. The regional variations are linked with the same reasons which have been contributed for the distributional pattern of the cultivated area (cf. Figs. 109 and 99). The intensive use of the topographically accessible area for cultivation is not because of the availability of labour or favourable agro-climatic base but is mainly induced by the easy workability of soil and the low productivity of land over the major part of Hissar.

The greatest possibilities of extension of agriculture are in the upper flood plain and the Nehri assessment circle of Hissar tahsil. Elsewhere scope is limited for the extension of the cultivated area but there is considerable room for improvements in the present areas of cultivation through changed techniques and methods of farming. With the reclamation of wasteland, which is making a steady headway, the density of cultivation is liable to increase during the 1960's.

The extension of cultivation is not a matter of significance at present besides achieving the local gains. The intensity of cropping, extent of maturity and increasing production from the existing cultivated area are the problems of paramount importance in the agricultural economy of Hissar. These need a serious thought by the planners. Under-utilization of land is no problem in Hissar, but the problems of under-productivity and the risk of crop failures are taxing the rural population. A useful gain would be to overcome these problems, at any rate in the foreseeable future.

CHAPTER 13

THE REGIME OF LAND OWNERSHIP, LAND TENURE AND THE SIZE OF HOLDINGS

The ownership of the land and the land tenure systems adjust to the environment but are related more directly, however, to the social-judicial organization of the rural population. The influence of religion in governing the size of an individual holding is even more powerful and is at the root of one of the greatest problems of agriculture pertinent to the small-fragmented holdings.

The Regime of Land Ownership: An element of collectivity has survived in Hissar chiefly as the common grazing lands of the villages. The individual ownership replaces community ownership when the agricultural land becomes scarce under the pressure of growing numbers of people. Agriculture as the mainstay of occupation implanted in the minds of the farmers the idea that those who own land own wealth. Individual ownership in India, is associated with the breakdown of the joint family system, sedentary cultivation, and the overspill of people from the densely populated to the less populated areas. The proportion of the state-owned land is insignificant in Hissar, as it has been utilized to reward military and civil service to the country or state and to rehabilitate refugees and those ousted by the Bhakra-Nangal project.

The systems of land ownership vary within Hissar with a basic distinction between the old canal colonies and rainfed areas on the one hand and the newly-developed, canal colonies on the other. In the newly colonized areas of the flood plain landlord ownership may be observed. However, on the whole the peasant-proprietorship predominates. In these systems of ownership which are recognised as superior and inferior proprietorship respectively, certain clans enjoy a superiority over the large body of the cultivators who till the land. The superior proprietors or landlords are the descendants of the former rulers, revenue assignees, big state officials and holymen. The more numerous cultivators of the land are the inferior proprietors who have permanent and heritable rights. Others (occupancy-tenants and tenants-at-will) have a transferable right of cultivation, subject to a fixed rent in kind; but the ownership of land has been vested in the superior proprietors. The dualism in the latter is not beneficial for land-use and crop production. On the whole, the inferior owners have been the most valuable element. The superior owners are the relics of an earlier society on account of the land reform measures. The occupancy-tenants have been declared owners with a right of proprietorship on the surplus areas of the landlords after paying a value of the land fixed by legislation. Hence, the number of inferior proprietors increased. It is one of the brightest aspects for increasing farm efficiency, as the owner himself reaps the whole benefit. Under the new situation these tenants may have some psychological satisfaction of having been freed from the age-old bondage which might induce them to increase production. The economic urge is present, but the means are not. These means will have to be provided as early as possible in the form of financial and technical aid to avoid the under-utilization of the cultivated land which India cannot afford.

The landlord by tradition and habit is not disposed to make any contribution to agricultural development. He has not the qualities or the mental make-up of the farm entrepreneur. He is interested in squeezing the maximum out of the tenants' pockets by spending the minimum on the development of his land. The use of land is best in the case of the peasant-proprietors. Although their holdings are much smaller than that of the landlords, yet their income from cultivation and expenditure on their farm are greater than that of the landlords.

The picture of the climbing of the agricultural ladder of ownership so far delineated seems very different, discouraging and dismal in comparison to the advanced countries like America. This does not, of course, deny that in the toilsome farming operation in Hissar, there are the very lucky few who have succeeded in acquiring, by rare chance, both a workable area and a superior grade of land. A shift in the socio-economic status from the occupancy-tenant to full owner of a small plot has taken place. It is based on the fundamental idea of socialistic pattern that land belongs to the tillers. This shifting is undoubtedly to their great gratification and satisfaction provided the economic size of holding is acquired. It has been observed that the very small holdings now emerging are not useful from an economic point of view.

<u>The Land Tenure System, The heart of Agricultural Efficiency</u>

The proper utilization of land can hardly be realized, and agricultural output cannot be raised, unless the actual cultivators of the land have the incentive to raise the yield. They will not have the incentive unless they are able to reap the benefits of increased production due to their additional input. About 35 percent of the total area is worked by the tenants-at-will, nearly 6 percent by the lessees and the remaining 59 percent by the owner-cultivators in Hissar. So far as 59 percent of the cultivated area is concerned, there is no reason why the owner-cultivators should be lacking incentive to increase production because any benefit from improved farming will go to their pockets. The same is true of lessees who pay a fixed amount of money to the owner. Therefore 65 percent of the cultivated area should have an efficient farm economy. It can be inferred that the low productivity of their lands is mainly due to factors other than tenancy.

Area Cultivated by Owners (Fig. 110): In the old irrigated areas of Hissar, where there has been an absence of landlord tenure, 60 to 80 percent of the area is cultivated by the peasant-proprietors. Further, in the rainfed areas it is over 80 percent, in spite of the large size of holdings. The low productivity and easy workability of soil do not permit the owner to parcel his land to others on share for cultivation.

In the recently colonized areas the land under personal cultivation is under 40 percent. It is mostly in the flood plain where landlord tenure is prevalent. Furthermore, it is difficult to handle the silty clay soil at the proper time. In turn these initiate for the parcellation of plots to the tenants-at-will. However, numerous absentee landlords, despite the imposition of the upper ceiling on their land holdings, are still in possession of a considerable acreage of cultivable land. They have started working as owner-cultivators by using tractors and a hired work force. They are grappling with their holdings and they have worsened the land productivity. In the areas falling within the category of 40 to 59 percent, the holdings are large. Some part of the land is leased out to tenants.

Regime of Land Tenancy: Though Hissar is par excellence an area of cultivating proprietors, yet about 41 percent of the cultivated area is worked by the tenants-at-will and lessees. The hereditary tenancy has ended after 1958. Prior to 1958 the area worked by the occupancy-tenants varied from 0 to 50 percent of the total cultivated area in Hissar having significant differences in the regional distribution (Table 13.i):

Table 13.i

Occupancy-Tenants Cultivation as a percentage of Cultivated Area, Hissar, 1952-53

Percent	Category	Tahsils	Description
0 - 1	Exceptionally Low Proportion	Bhiwani	Rainfed area having low productivity
2 - 9	Low Proportion	Hansi and Hissar	Old irrigated areas with small size of holdings
10 - 20	Moderate Proportion	Fatehabad	
30 - 50	Very High to Exceptionally High Proportion	Sirsa	Area having the regime of landlord tenure

The traditional systems of land tenancy are based on the sharing of actual produce. Despite the recent developments of irrigation, transport and legislation, a crop-sharing system still dominates. Insecurity must have made money a scarce commodity and a risky investment. It may be added that with colonization in the north, the landlords prefer to give their land on batai to harvest the maximum benefit of the increased production with canal irrigation rather than to get the fixed areal rent in kind or cash.

Area Cultivated by Tenants-at-Will (Fig. 111): The lands worked by the share-croppers stand on a different footing in respect of farm efficiency. The share-croppers pay half of the crop produced as rent - even more in certain cases. They can be ejected from land at any moment the owner pleases. They are, therefore, not at all anxious to put in additional effort for enhancing the output from the fields. It has been observed personally that tenants-at-will take less care in preparing the land for the crops and avoid the sinking of money in land because of insecurity. Since these lands represent 35 percent of the tilled area of the region, the lack of incentive is a great problem. If the productivity of these lands is to be increased, the system of land tenure must be such as would give the share-croppers an inducement to increase the output. It must be guaranteed that tenants-at-will cannot be ejected from land at the simple will of the owner, and also that this rent is fixed in terms of cash or kind.

Fig. 111 illustrates the share-croppers' cultivation. The percentage is low in the old settled areas where holdings are small and land is primarily cultivated by the inferior proprietors. The proportion is high in new canal colonies, where the land owners, having large holdings, can afford to parcel their land to tenants.

A striking phenomenon with reference to regional differences in the prevalence of farm tenancy in Hissar is that the more productive the area and the bigger the size of holdings the higher the proportion of poverty-stricken tenants. In the rainfed areas, the yields are too low to be shared by both landowner and a tenant. At present, most of the land generally cultivated by the tenants belongs to absentee owners or landlords having holdings too large to be easily controlled. As a result much of the land is given to the tenants. Canal irrigation also tends to encourage the leasing-out of the land, as the canal-irrigated farm of a smaller size can enable a family to derive a livelihood more easily.

The share-cropping rate in kind which the tenants-at-will pay to the owners varies from area to area with the type of irrigation, the variable conditions of agreement, and the quality of land. The prevalent rent is one-third of the produce fixed by legislation. It varies from one-third to one-half of the produce depending on the high-handedness of the land owners and the degree of necessity of the landless class dependent on agriculture.

The observation of the compiled statistics of the tenancy demonstrated the following decennial changes between 1952 and 1962. Firstly, in the old irrigated and rainfed areas, the percentage of the area cultivated by share-croppers decreased considerably. Secondly, in the newly colonized areas the percentage of the cultivated area worked by share-croppers increased. Thirdly, occupancy-tenants as an independent class ended, but have since been considered as owners of the land.

Area Cultivated by Lessees (Fig. 112): The tenants who take the land at lease pay cash rents, settled beforehand irrespective of the agricultural production afterwards. The rates vary according to the land capability and the type of irrigation. The relative merits of cash rents can be well recognised: tenants work harder when paying a fixed cash rent, hoping to make something over and above the normal produce. In the case of lessees intensive cultivation is the practice. Lessees accept land on lease in those areas where the land is productive, or where the owners can afford to spare some portion of their holding to let. However, the more secure form of tenancy is the permanent leasing system. Curiously enough, the permanent type of tenancy is not common in Hissar as owners do not like lessees to have the usufructuary right in exchange for the collection of a small fixed amount of rental from year to year, irrespective of the changing productivity of the land.

Fig. 112 shows the area cultivated by lessees and the pattern presents expectable features. There are more lessees in the lower flood plain in Sirsa and the Nehri assessment circle in Hissar tahsils. These seem to be associated with large holdings of owners and favourable potentials for farming. The lower proportions in the old irrigated areas and the upper flood plain are because of small holdings worked by the peasant-proprietors. In the rainfed areas it is low due to the poor productive base.

Volume of Change in Lane Tenure, 1952-53 to 1961-62 (Fig. 113):

The impact of land reform measures and policies is reflected in the percentage of the cultivated area involved in changes in land tenure. The recent ideologies appear to lay greater stress on security and social control as the necessary basis of improvement of social living and agricultural efficiency.

In the new canal colonies the change is great; that is over 20 percent of the cultivated area has been involved in change in land tenure. The cultivated area tilled by the owner-cultivators increased considerably. In the Rohi and Bagar assessment circles of Sirsa tahsil the area worked by the tenants-at-will and lessees decreased from 37 to 9 percent and 6 to 2 percent respectively during the last decade. In the lower flood plain in Sirsa tahsil, the area under owner-cultivators, tenants-at-will and lessees increased from 30 to 37 percent, 37 to 46 percent and 13 to 17 percent respectively. These percentages reveal that the relics of the <u>biswardari</u> land tenure are still prevailing in the lower flood plain. Naturally, land owners are interested in getting a share of the crop rather than rent because thereby they expect to get more benefit through the improving irrigational facilities.

In the Nehri assessment circle of Hansi tahsil, the areas cultivated by owners and tenants-at-will increased from 53 to 68 percent and 18 to 28 percent respectively, and the area leased declined from 20 to 4 percent. In the rainfed areas of Hansi and Bhiwani tahsils, the volume of change is under 10 percent, as the agricultural economy is already highly stabilized, based on peasant proprietors. On the whole, a slight increase has been experienced in the areas cultivated by the owners with the corresponding small rate of decline in the area cultivated by the tenants-at-will and lessees.

Trends in Land Tenure, 1952-53 to 1961-62 (Fig. 114): In Fig. 114 the numerator represents the categories of increase and the denominator shows the categories of decrease ranked in a descending order of importance. These trends and arrangements of land tenure reveal that over the major part of Hissar the area cultivated by owners (ACO) observed an increase, with a corresponding decrease in the areas cultivated by occupancy-tenants (ACOT), tenants-at-will (ACTW) and lessees (ACL). It is a favourable situation for providing an incentive to the cultivator to increase the farm output. The categories of $\frac{\text{ACO}}{\text{ACOT, ACTW, ACL}}$ and $\frac{\text{ACO, ACL}}{\text{ACTW, ACOT}}$ combinations in the changing land tenure are of great significance in improving the efficiency of land-use and productivity on account of the presence of incentive. The category of $\frac{\text{ACO, ACTW}}{\text{ACL, ACOT}}$ has bright aspect as the owner cultivation has upper hand in swing. The other categories need some careful investigation because of the upper hand of the tenants-at-will cultivation in change. As sooner or later, the farm depletion is bound to come due to the superiority of areas cultivated by the tenants-at-will. The low farm efficiency will be usual. Lest this may happen, it is worthwhile that the state should examine the various possibilities of the escape from the situation in the areas covered by the last two categories. The idea of joint-management farming should be given a serious thought in which the cultivators other than the owners should have the security and right to exert influence in the soil management with an aim of sharing the major part of the increased production.

Finally, the controversy of land tenure and ownership can be solved by the peasant-proprietorship with collective farming, both may exert on the efficiency of land-use. Since the more persons there are having a voice in the matter, the more difficult will it be to arrive at any unanimity of opinion. It is the collective-farming which leads to complexity within the illiterate and poverty stricken tiny owners having a great love for their inherited piece of holding. Under such circumstances the active part of the state in every respect is desirable to make the scheme a success.

Size of Holdings

The size of farm is a matter of great importance to success in agriculture for devising an economic cropping pattern. In theory the standard is fixed by economic conditions in accordance with the nature of farming attempted. In practice it is found that in different countries the standard varies enormously in accordance with the pressure of agricultural density on the cultivated area and the laws of inheritance. Even granting homogeneous physical conditions, it is clear that variation in capacity, resources and ambitions of the farmers will create pressure for farms of corresponding size. In India a definite standard size of farm most suitable to definite types of farming cannot be maintained because of the increasing pressure on land and the working of the Hindu Law of Inheritance. These result in the splitting-up of the larger proportion of cultivated holdings which fail to conform to any reasonable economic standard. This evil of sub-division is a common experience of countries where similar conditions have prevailed. The sub-division is effected in such a way as to secure an equal proportion of good and bad land in each plot, and often it leads to a division into small narrow strips. Every holding becomes sub-divided when the cultivating proprietor dies and leaves more than one child, and as the face of the country is open and without hedges, the division is easily and speedily made (Sleeman, 1915). Thus the field map which fairly represents an estate one year will never represent the same after a decade or more. In fact it becomes a map showing the waves of the ocean. The new amendment in the Hindu Law of Inheritance, that is, all members of the family - even females - being entitled to have a share in patrimony, may further help in the progressive reduction of the size of farm. Consequently, there is no such thing in India as a permanent farm. Sub-division and fragmentation of land occur as each generation enters into its patrimony. These evils are realized by everybody and their effects are not hidden by putting a large proportion of land outside the possibility of effective cultivation or economical development. The problem of splitting has been solved to some degree by consolidation of the holdings. The agrarian reforms effected an appreciable reduction in the number of plots, but yet the reforms frequently left holders with fewer plots of the different classes of land still in different places. The main purpose of consolidation is to consolidate cultivation so as to save time and labour, and at the same time to get a larger return for the effort and capital applied. It has further been observed through personal experience that the individual cultivator tries to consolidate his own cultivation, giving out or exchanging the inconveniently-placed plots on lease and taking in their place other more convenient plots on rent. It suggests that the cultivator has realized the evils of fragmentation and the utility of consolidation.

An enquiry was conducted by the Board of Economic Inquiry in 1924 and repeated in 1939 into the size of cultivators' holdings in the Punjab. Ninety villages were examined in Hissar. The observation of the figures shows that during the fifteen intervening years, the average size decreased by 4·5 acres from 18·9 to 14·4 acres for the sample villages. The average sizes for 1952-53 and 1961-62 as derived from the revenue records are 12·4 and 8·6 acres respectively for Hissar as a whole. There is thus a general downward slide from the higher rungs of the ladder, chiefly due to sub-division, as there are now more heirs to take a share in the paternal property. The average cultivator's holding in Hissar is of medium size but, what is more important, it is going down every day due to the great increase in population. There is no sign of the population increasing at a slower rate in the immediate future, nor is there any great possibility of either shifting large numbers from agriculture to other occupations, nor of increasing the land under cultivation to any considerable extent. The other aspect of great significance is that there is a great regional disparity in the average size of cultivators' holdings varying from 3 to 50 acres within Hissar. Hence, it is desirable to have a careful agricultural planning on the basis of the regional pattern of the average size of holdings and their capability.

The spirit of Hindu Law and of Indian agriculture favour a wide distribution of the land, and its cultivation by the peasant-proprietors. It presents grave difficulties to effective cultivation even with existing techniques. Furthermore, it offers a fundamental obstruction to the introduction of improved technical methods or economic organization calculated to increase the quantity and value of the outturn and to cheapen the production cost. Therefore, it is essential to understand the present areal pattern of land distribution in the form of size of holdings, to make some suggestions for the maintenance of small holdings with improved technical and economic equipment, as the owner may face the competition of farmers elsewhere, and needs to maintain his family in comfort.

Under the instructions of the Planning Commission, a census of the land holdings was conducted in 1961 in India, along with the population census. The detailed figures are given in a percentaged form as treated from the numerical data (Table 13.ii):

Table 13.ii

Cultivating Households, Hissar District (1961)

(Percentages of the total cultivating households of the District, based on 20 percent sample)

Size of Holding	Sirsa Holdings	Sirsa Hired Worker	Fatehabad Holdings	Fatehabad Hired Worker	Hissar Holdings	Hissar Hired Worker	Hansi Holdings	Hansi Hired Worker	Bhiwani Holdings	Bhiwani Hired Worker
Below 5 acres:	2·40	0·52	1·69	0·16	2·18	0·59	2·32	0·32	1·13	0·16
5-14·9 acres:	6·85	1·67	6·90	2·82	9·15	2·34	8·40	2·70	4·99	0·91
15-29·9 acres:	7·48	8·64	6·10	5·31	6·76	5·15	6·43	8·12	5·80	1·94
Above 29·9 acres:	7·76	33·15	3·59	10·42	3·03	6·20	2·66	6·74	4·38	2·14

The observations derived after scanning the above table may be summarized thus:

(i) Very large-sized holdings are owned by the cultivators in Sirsa on account of the landlord tenure. Second in importance is Bhiwani because of low agricultural productivity, low density of agricultural population and the easy workability of soil.

(ii) On the whole, 53·99 percent of the households hold above 15 acres of land. It shows that the good parcels of cultivated land in Hissar are held in holdings of economic size having a reasonably good standard.

(iii) Medium size holdings (5-14·99 acres) exist in a higher ratio in the old irrigated areas having the peasant-proprietor land tenure.

(iv) The ratio of small-sized holdings (below 5 acres) is very small.

(v) The percentage of hired workers employed is at the maximum in the holdings of 15 acres and above, where agriculture is capitalistic in large-size farms. The highest percentage of hired workers is in Sirsa and the lowest in Bhiwani (see Fig. 96). In the former the farming is commercial because of recent colonization, and in the latter it is of self-sufficing nature because of rainfed cultivation.

In summary, more than 53 percent of the households held large-sized, and more than 36 percent medium-sized farms. These figures tend to establish the good size of farms in Hissar. Furthermore, 58·65 percent of the hired workers are employed by the cultivating households having farms of 30 acres and over, and 29·16 percent in farms of 15-29·9 acres.

Cultivators' and Owner-Cultivators' Land Holdings (Figs. 115 and 116): The returns of land tenure available in Table No.7 of the Lal-Kitabs may be grouped into two broad classes, such as, the cultivators and the owner-cultivators. In addition to the tenant-cultivators, the former overlaps the latter. The size of holdings is determined by the amount of rainfall, nature of soil, intensity of colonization, regime of ownership and land tenures and religious taboos. The differences between the holdings of cultivators and owner-cultivators are primarily on account of two variables, namely, willingness to spare land to parcel either by owner-cultivators or absentee-owners and willingness to take land on rent or share in addition to that owned, or the needs of the landless class tenants dependent on farming. Landless tenants are more enticed to the new canal colonies. The owner of the small-sized farm is interested to take productive land on rent rather than sandy land.

There are only a few areas of contrast between the holdings of cultivators and owner-cultivators (Figs. 115 and 116). In the Nehri assessment circle of Fatehabad and the Bagar in Sirsa tahsils the owner-cultivators' holdings are bigger in size than those of the cultivators because owners can manage themselves their medium-sized holdings of soft sandy and light loamy soils. In the Rangoi assessment circle of Fatehabad and the Nali assessment circle of Hissar tahsils the owner-cultivators' holdings are small compared to the cultivators due to the stiff clayey soil which is difficult to handle in a short time, but is productive if tilled in time. In the lower flood plain the owner-cultivators' and cultivators' holdings are of medium size. The size of holdings is amll in the Nehri assessment circle of Hansi because of the higher agricultural density. The size of holdings is large in areas of low rainfall and sandy soil. The inferior grains are sown without any intensive ploughing. In these areas a yoke of oxen or a plough with a single camel can keep about 25 acres of rainfed land up to the local standard of agricultural efficiency.

Conclusion

The size of land holdings is under a constant process of change. These changes in size and in land tenancy, which have been stipulated by land reforms, are not healthy. The allotment of land to the occupancy-tenants has not been useful. It has been found that the area is acquired mostly by those tenants who are not interested in farming because of the tiny size. They are not interested for the development of the land and consequently much of the area is becoming unproductive. They have got few resources and it is difficult for them to follow a scientific way of agriculture. Thus it is a loss to the nation with a negative effect on agricultural efficiency.

In most of the area under consideration a majority of the cultivators have holdings with low production capability, which imposes stringent limitations on the amount of income for the farm family. This situation is further accentuated by the difficulty of making substantial increases in capitalization. Though the small holder can spend more time per unit of area at work adding to the value of his land, especially looking after the farm intensively, yet the produce from these farms will scarcely support the cultivators' family at the subsistence level. Increased productivity through greater capitalization cannot be expected from the investment of small savings due to the diminishing returns and the agro-climatic limitations. Moreover, the size and the potentials of the farms limit the amount of capital that could be economically employed under any conceivable circumstances.

It is clear that the institutional organization of agriculture places strong impediments to improved efficiency and increased production. In the present nation wide predicament, the main difficulty with which India is confronted is the steady worsening of the agrarian situation through the continual sub-division and fragmentation. The ever-increasing population pressure on land resources has intensified the seriousness of an already acute problem.

A two-pronged drive may be suggested to accomplish the better results in the long run through maintaining the economic size of holding. Firstly, unusual legislative action is needed to fix a minimum size below which the sub-division of farms should not be allowed. Secondly, the extra family force of the farming communities calls for more alternative opportunities to be created in commerce and industry.

CHAPTER 14

THE UTILIZATION OF NET-AREA SOWN

The extent to which the net-area sown has been cropped is dependent on human traditions and initiative, the possibilities of irrigation or dry-farming and the methods practised. The paucity of cultivated land in relation to the growth of population dependent on it, and the extension of irrigation facilities have caused a shift in cultivation from a single-cropping to double cropping regime in many parts of Hissar.

In India there are two principal crop-seasons in a year. The "Kharif" crops (summer) are sown in June-July and harvested in October. The "Rabi" crops (winter) are sown in October-November and harvested in March-April.

The land with good irrigation facilities can bear two crops over a number of years. Consequently the acreage of crops sown in any area in any year is more than the net-area sown. The kharif and rabi sowings correspond respectively to the burst and retreat of the monsoon. There is a tendency for the acreage of rabi crops to rise with the normal and well-distributed rainfall and to decline with uncertain fall. The kharif area is not affected where there is either early cessation or long dry spells, and it remains unaffected even in the case of a belated monsoon. On the other hand, a normal rainfall tends to leave the field ready in good time for rabi preparations. An early cessation of the monsoon is a disadvantage because it is not then possible to preserve soil moisture for five to six weeks before the tight sowing season for rabi crops. Hence, a successful season of monsoon is the limiting factor for the acreage under rabi crops; or for agriculture in general, because the important cash crops like gram, wheat and oilseeds are the rabi crops. The normal monsoon is still one of the major determinants affecting the use of the net-area sown because of a high dependence on dry-farming (Fig. 117).

On the whole, land allocation decisions made by peasants vary from year to year. The re-allocation is done in response to the variations in rainfall, water allowances in canals, the growth of population and the expected relative returns from different crops. The allocation of land to various crops is thus a matter of crucial importance both from the point of view of increasing peasant incomes, and of ensuring the adequacy of the flow of different food-stuffs and raw materials into the markets. It is of course the decisions on allocation which lead to a variation in cropping pattern.

Intensity of Cropping (Fig. 118)

Intensity of cropping refers to the number of crops grown on the same areas in any one year, for example, if one crop is grown on a field in one year, the cropping intensity is 100 percent; if two crops a year are procured, the intensity is 200 percent. The extent to which the cropping has been done on the net-area sown, is portrayed in Fig. 118. The most direct explanations of the variation in the areal distribution of cropping intensity lie of course by reference to the impulse of irrigation facilities and the agricultural density of population (cf. Figs. 118, 62 and 76). The intensity of cropping is primarily related in a positive way to the intensity of irrigation. It should not be thought, however, that high agricultural density has caused high intensity of cropping. An increase in population no doubt calls for more production, which is only possible by intensive cultivation, of which double cropping is a form, but double cropping in its own turn increases the carrying capacity of the land and hence induces an increase of population. Therefore, reciprocity in agricultural density and intensity of cropping can be established. Other variables which obviously exert an influence on intensity of cropping are the successful monsoon and the nature of soil. Stiff clay soil is only suitable for one crop a year, preferably rice. Light sands and waterlogged soil are unsuitable for rabi crops. On fertile loams with canal irrigation double cropping can be developed (cf., Figs. 118, 44 and 62). Lastly, the size of holdings has a bearing on the intensity of cropping, i.e., the small productive holding has more intensive cultivation. Extensive double cropping is often due to agricultural skill and enterprise of the farmers, in association with favourable environments. It is practised in highly manured, well watered and fertile stretches of land. It is really a sign of the high standard of cultivation and land-use efficiency which ensures the raising of a variety of crops through rotations without soil mining.

In all assessment circles of Hissar, total cropped area exceeds net-area sown because there is always a part of the kharif area which is resown during the rabi, significantly in irrigated areas to utilize the left over soil moisture of the kharif crops. The intensity of cropping varies in Hissar from 104 to 146 percent exhibiting a great regional disparity depending upon the degree of variability in the determinants enumerated above.

Fig. 118 suggests a division of Hissar into three empirical regions:

(i) Areas of Low Intensity (100-119 percent): These include the rainfed areas of the south and south-west, the flood plain and the soft loam of the Rohi assessment circle of Sirsa tahsil. Cropping is dependent on the rainfall in the rainfed areas. The amount of rainfall during the last quarter of the rainy season determines the extent of such kharif area as can be resown for the rabi. As the rainfall is highly variable the proportion of land cropped more than once is low. Moreover the soils are light and sandy and do not return a profitable second crop in a year. Besides the rainfed areas, others of low intensity are where the intensity of irrigation is under 45 percent. In the areas having intensity of irrigation under 35 percent, the intensity of cropping falls correspondingly below 110 percent. The clayey soil of the flood plain can be handled once a year with the help of the present available moisture. In the irrigated areas the amount of the canal water, which begins to decrease in September, can command only a limited land thereafter. Other factors are the appreciable size of land holdings and low density of agricultural population.

(ii) Areas of Moderate Intensity (120-140 percent): These comprise the old irrigated areas of Fatehabad and Hissar tahsils. Obviously, fertile and easily workable soils with better irrigational facilities (30 to 60 percent intensity of canal irrigation) are the reasons for it. Apart from these facts, land holdings are of smaller size, which tends to force the numerous farmers to sow the maximum possible land during both crop seasons.

(iii) Areas of High Intensity (Over 140 percent): These are the old irrigated areas of Hansi and Bhiwani tahsils. These have a very high intensity of irrigation. These areas comprise the fertile loams, having small holdings, peasant-proprietorship and very high agricultural density. These give a forced incentive to the farmers to exploit the soil to maximum extent.

Changes in Cropped Area, 1951-56 to 1956-61 (Fig. 119)

The recent changes in the extent of double cropped area have been mainly because of the expansion of canal irrigation and the intercensal growth of rural population, since lands depending on rain produce only one crop. Besides these two vital factors, the growing of cash crops, the nature of the soil, the size of the holdings, incentive and initiative of the peasant-proprietors are the other factors in determining the changes. The annual fluctuations in the double cropped area are discernible due to the annual variations in the amount and distribution of rainfall and canal discharges. The long term changes are linked with the changes in the intensity of irrigation and the agricultural population over the same period. It is quite obvious that the kharif crops cannot be succeeded by a second crop of rabi in the same field if there is a soil moisture deficiency. On the other hand if the moisture is excessive then the soil might suffer making it difficult to plough the fields for rabi crops. Finally, the changes in the intensity of cropping are associated with the changing efficiency of soil moisture and soil management-factors closely linked with the efficiency of the farmer.

It will be interesting to compare the changes in the intensity of cropping, irrigation, and the growth of rural population (cf. Figs. 119, 63 and 72). There is a considerable increase in the intensity of cropping in the flood plain corresponding to the increase in irrigation facilities, the inmigration of enterprising farmers and the changes in land tenure. On the whole, everywhere the minor change in the intensity of cropping, having a positive tendency, has been due to better rainfall regime in the second quinquennium of the 1950's and to the introduction of new farming techniques and seeds.

Fig. 119 shows the percentile quinquennial changes in cropped area. Four conspicuous categories can be recognized:

(i) Category of Minimum Increase (under 15 percent): It includes the rainfed areas of Bhiwani and the old irrigated areas of Hansi tahsils, the reason being that the least has been done here to augment the soil moisture base. In the rainfed area of Sirsa tahsil the change is insignificant because of the extension of irrigation during the late 1950's.

(ii) Category of Low Increase (15-34 percent): It comprises the rainfed areas of Hissar and Bhiwani and the soft loams of Sirsa tahsils.

(iii) Category of Moderate Increase (35-55 percent): It covers the old irrigated areas of Hissar, Fatehabad and Bhiwani tahsils, where the water allowance and network of canals were expanded in the second half of the 'fifties.

(iv) Category of Considerable Increase (over 55 percent): It represents the flood plain which needs no explanation as it is a highly changing area of Hissar in the field of farm economy.

The increase in the intensity of farming must be balanced by improvements in farming practices if it is to yield its full benefit of increased output. Although the cropped area increased the yields are still low. Apart from the shortage of water, the most important factor at present responsible for low yields is probably poor soil management.

Intensity of Harvested Cropping (Fig. 120)

To have a realistic view of the double cropping, the total area cropped which has been matured during the year has been taken into account. The ratio of harvested cropped area to net-area sown is calculated and mapped in Fig. 120. From this three themes stand out. Firstly, the regional variations in the intensity of harvested cropping in Hissar are smaller than in the intensity of cropping, the percentages of the former being 85 to 115 percent and that of the latter 104 to 146 percent. The difference in the intensity of harvested cropping and intensity of cropping corresponds to the incidence of crop failures. Secondly, in the north-east the intensity of harvested cropping is above 100 percent of the net-area sown because of old irrigation facilities. In the south-west and north-west it is below 100 percent due to unreliable moisture conditions and the lower intensity of irrigation. Thirdly, despite the exceptionally high intensity of irrigation in the old irrigated areas the crop failures are still a problem owing to the erratic fluctuations in the moisture supply from natural and artificial sources.

This study may contribute to the future planning of irrigation schemes, the proper redistribution of water allowances, and the regulation of canal discharges. Careful thought is needed to overcome the crop failure crisis and to bring a feeling of security within the district.

Changes in Harvested Area, 1951-56 to 1956-61 (Fig. 121)

Fig. 121 illustrates the changes in the harvested area and this is a better guide than the cropped area to the overall effects of irrigation and rainfall. The harvested area increased more rapidly than the cropped area everywhere. The evil of crop failures decreased in Hissar except in the rainfed areas, which still suffer.

The most considerable increase is in the flood plain (over 100 percent). An appreciable increase is observed in the areas surrounding the upper flood plain (60 to 100 percent) where irrigation facilities were introduced during the early 'fifties. Furthermore these tracts lie at the head of the distributaries and so get a more assured supply of water.

Moderate improvement (40 to 59 percent) took place in the areas of Sirsa, Hissar, Hansi and Bhiwani tahsils having a moderate intensity of irrigation. The low rate of swing (under 40 percent) is either in the old intensively irrigated areas of Hansi or in the rainfed areas of Bhiwani tahsils. In the former the success of the present was already high and in the latter no improvement can be envisaged because of the lack of water supply. Whatever changes occurred in the rainfed areas are due to the normal rainfall conditions and the adoption of dry-farming techniques by the farmers.

Utilization of the Cropped Area in Crop Seasons (Figs. 122 and 123)

The direct explanation for the great seasonal cropping contrasts lie in great differences in the proportions of seasonal intensity of irrigation (Figs. 64 and 66), soil moisture deficiency for the respective seasons (Figs. 41 and 42) and the standard agronomic soil types (Fig. 44). After comparing the maps of relevance with Figs. 122 and 123 the following conclusions have been derived:

Firstly, the moisture deficiency is excessive in summer and at its minimum in winter. Therefore, over the major part of Hissar the rabi proportion predominates, with over 50 percent of the cropped area. Further, the kharif crops require more moisture to mature and are less remunerative than the rabi ones. Therefore, farmers prefer to leave land fallow for the rabi crops.

Secondly, in the rainfed areas, the area under the kharif crops is over 70 percent despite exceptionally high moisture deficiency, on account of the unsuitability of soil for the rabi crops, and the comparatively high moisture deficit in winter. The available moisture of the monsoon is utilized for the quick maturing, drought-resistant millets, raised with efficient dry-farming techniques.

Thirdly, in the flood plain the excessive moisture limits the timely sowing of the kharif crops and the fear of damage from floods is another limitation for kharif acreage. Another check on the expansion of kharif cropping is the difficult workability of the "dakkar" lands within brief periods. The farmers conserve the summer moisture for the rabi commercial crops.

Fourthly, in the old irrigated areas, of Hissar and Hansi tahsils the coverage under the kharif crops is 50 to 60 percent. Actually it is more than rabi, but the difference is not as much in the case of the rainfed and the newly colonized areas.

Fifthly, the amount of monsoon rainfall is not adequate and it is highly variable. Thus there is a little scope for many kharif crops to mature without irrigation. The water in the canals is limited. The crops other than millets and pulses require more watering more frequently. As a result, only a limited area of the land can be served with water. Quite a high percentage of the cultivated land is left fallow during summer so that it may be ploughed intensively to conserve moisture for the succeeding rabi crops, finally increasing the acreage under winter crops.

Sixthly, during winter the rain is nearly 25 percent of the annual fall and the growing period is of longer duration. Even then there is a little check on the growth of plants. This is partly because of small water requirement to corresponding low potential evapo-transpiration and partly due to the drought-resistant nature of the rabi crops with low duty on canals. Even when the amount of rainfall is small and the water in the canals is limited, a complete failure of the rabi crops is rare. The winter dew and the high relative humidity with low temperatures help in balancing the soil moisture deficit.

Hissar can finally be divided into three zones on the basis of the preceding discussion: the newly irrigated areas with rabi as the main cropping season; the old irrigated areas, where kharif cropping is slightly more important than the rabi; and the rainfed areas, where exceptional importance is attached to the kharif crops.

<u>Changes in the Cropped Area in Crop Seasons, 1951-56 to 1956-61</u> (Figs. 124 and 125)

Over the greater part, the area under kharif crops decreased, and the farmers started to leave the land fallow for the rabi crops. In the rainfed areas, the increase is partly on account of the dry-farming techniques and the use of better seeds which penetrated into the daily life of the farmers and is temporary partly because of the normal monsoons during 1956-61. In a small strip of the upper flood plain in the north-east the increase is due to rice cultivation - the area of which increased over the period from 18 acres to 1637 acres. In the old irrigated areas, where the intensity of irrigation was low in the past but has improved, this fact, and the expansion of cotton mills at Hissar and Bhiwani towns, gave farmers an incentive to grow more cotton, increasing the kharif acreage. The reclamation of the wasteland in the Hissar tahsil also led to some increase in kharif acreage.

The rabi acreage increased everywhere, primarily due to the reclamation of the cultivable wastelands, decrease in the kharif acreage and the growth of the rural population. Furthermore, the rise is linked with the increasing winter irrigation, due to the conversion of the seasonal canals and inundation channels into perennial canals, to the expansion of the existing networks and to the flow of new systems. There is an areal variation in the degree of change, which is exceptionally high in the flood plain, high in the old irrigated areas and moderate in areas where either the irrigation was already intensive or was provided during the late 1950's. In the rainfed areas the positive swing is moderate to high.

<u>Harvested Area in Kharif and Rabi Crop Seasons</u> (Figs. 126 and 127)

Figs. 126 and 127 depict the share of the kharif and rabi harvest and the comments on these distributional patterns follow:

Leaving aside the rainfed areas, the ratio of the kharif harvest is under 50 percent everywhere. In the former it is over 60 percent because of the importance attached to drought-resistant crops. In the old irrigated area of Hansi and Hissar tahsils, despite the favourable moisture conditions, some share of the kharif crops fails to mature, on account of the fluctuations in canal regimes and the sensitive nature of some of the kharif crops to drought. Correspondingly, the percentage of the rabi harvested area is very high in the newly irrigated areas, due to the interest of the farmers to grow the cash earning food pulse and cereals.

It is interesting to note that crop failures are least in irrigated areas in the rabi crop season and are of significance in rainfed areas (cf. Figs. 127 and 123). The crop failures are common in the kharif season in irrigated areas and less in rainfed areas (cf. Figs. 126 and 122). These interesting variations are due to the drought-resistant crops grown in the corresponding seasons.

The areas having extreme differences in kharif and rabi cropping require scientific planning. The planners should give thought to the development of subsidiary occupations other than farming to utilize the farmers' working hours more efficiently. The irrigation engineers should lay out the new canals and regulate the existing canal discharges if they can in such a way as to reduce or eliminate the present higher rate of kharif crop failures. The agronomists should try to evolve new techniques and seeds which could stand the dry spells in summer and could mature on light sands in winter with the existing moisture supply.

Changes in the kharif harvested area and the rabi harvested area have also been mapped (Figs. 128 and 129) and these make in a slightly different way a number of the points that have emerged above. These clearly reveal the impulse of increasing irrigation in securing and increasing the magnitude of the harvest.

Crop Failures (Figs. 130, 131 and 132): The area where seed fails to germinate, or where the crops dry up, or get destroyed by the calamity of the seasons are shown as failed in entirety in revenue records. Crop failure is a "normal" calamity in the Indian farming. Much of the capital invested and labour input are wasted every year due to the inclemency of weather. When the climatic conditions are favourable at the sowing time, seed is put in the soil, operating day and night covering large areas. It happens almost every year that some areas do not get favourable conditions during the growth period of the crop, particularly at the flowering and ripening stages. This results in outright withering. When it happens over a vast area of semi-arid tracts, very distressing conditions ensue. The extent to which crops sown have matured, can be calculated by computing the harvested area as a percentage of the cropped area. This may be referred to as the intensity of maturity (Figs. 130, 131 and 132). The annual intensity of maturity in Hissar varies from 63 to 86 percent (Fig. 130). The total cropped area never matures as a whole and crop failures are even unavoidable in the old irrigated areas. Intensity of Maturity is an index of stability in agriculture. Irrigation favours a high index, drought depresses it.

The extent of maturity can be improved by introducing drought-resistant varieties, by dry-farming techniques and chiefly by improving and assuring the water supply. In the rainfed areas the percentage maturity of crops is below 75 percent. In the old irrigated areas of Hansi and Hissar tahsils the annual intensity of maturity is over 85 percent. This is a measure of the substantial contribution of irrigation facilities in bringing security to agriculture in Hissar. The Rohi assessment circle in Sirsa tahsil is worth notice. Here the high intensity, above 85 percent, is because of soft loams, supporting more rabi crops whose maturity is more reliable than the kharif crops.

The contrast in kharif and rabi extent of maturity (Figs. 131 and 132) is due to the higher rate of potential evapo-transpiration and the maximum duty of crops on moisture in the former crop season compared with the latter. This disparity may be overcome either by improving the farm techniques and the water supply or by encouraging the farmers to shift field-usage towards rabi food cereals and food pulse. The latter process, it is suggested, will have the quicker and more productive results, wherever it is possible.

PART V

THE UTILIZATION OF THE HARVESTED AREA

Introduction

It is interesting to note that there is a wide gap in the percentages of three important sets of crops, viz:-

(i) Food Cereals and Food Pulses

(ii) Fibres and Oilseeds

(iii) Fodders

The existing distribution gives an impression of unbalanced, subsistence farming (Table V.i):

Table V.i

Seasonal Crop Combinations in Hissar, 1951-61

Percentages of the Total Harvested Area

Serial No.	*Categories	Kharif	Rabi	Total
1.	Food Cereals and Food Pulses	28·52	48·47	76·99
2.	Fibres and Oilseeds	3·53	3·95	7·48
3.	Fodders	13·15	0·99	14·14
4.	Vegetables, Etc.			1·39
	TOTAL	45·20	53·41	100·00 Percent

* Note on Categories:- The categories accord with those of the revenue records and statistics:

1. Food Cereals and Food Pulses include all the major crops grown for human consumption either for subsistence or sale, that is gram, bajra, wheat, jowar, urd, moong, moth, barley, rice and maize.

2. Fibres and Oilseeds: These are essentially grown as cash crops. Cotton is the fibre crop. The important oilseeds are sarsoon, toria, taramera and alsi.

3. The main fodder crops grown for livestock are cluster-bean, chari and bajri (small millets), egyptian clover and green maize.

4. Sugar-cane, which is grown in a very small quantity, is included under the head of vegetables etc. Vegetables and fruits, though dietetically important, occupy only very small acreages, to the disadvantage of the human nutrition standards in Hissar.

The great significance of food cereals and food pulses in the agricultural economy of a Jat farmer is undeniable and he is proud of his food crops. This is reflected in a popular legend: The Jat farmer stood on his grains heap and said to the driver of the King's elephant "Will you sell this donkey?" In the later section, it will be observed that the dominance of food crops in Hissar reflects the adjustment of farming primarily to agro-climatic and secondarily to socio-economic variables.

The considerable importance of food cereals during kharif is because of the bajra (pearl millet) a widely grown drought-resistant crop. It is an inferior food grain and can survive in drought stricken areas having low rainfall and poor soils. The other important kharif food cereal is jowar (sorghum) which is linked with the dietary habits of the farmers. The kharif food pulses hold a secondary place in the cropping pattern. Although the loams and climate are suitable for cotton it is not an important crop. The limitation of inadequate irrigational facilities is present. Rice and maize are the minor kharif food cereals and are quite inferior to wheat as a food. They need more moisture. The importance of the canal water for kharif fibre crops is strong. The importance of fodder crops is greatest in kharif cropping because of the facts that these can be grown without, or with the minimum of irrigation, and because the winter months call on the kharif fodder supply.

The considerable significance of gram during the rabi season overshadows all the crops of the year and gives a tremendous importance to the rabi food pulses over those of kharif. Most of the crop is sold to obtain cash. The second in importance is the superior food cereal wheat. Such a great dominance of gram and wheat is due to the huge food requirements of the increasing population both here and in other parts of India. The cool and semi-arid climatic conditions prevailing from October to March are quite well suited to these crops. These crops are less demanding than the kharif fibre crops and rabi fodder crops. Oilseeds are more important during the rabi season because of their less demanding nature on soil and canal water.

The regional variation in individual crop distribution will be evident while going through a set of maps showing the distribution of crops in order of importance.

CHAPTER 15

THE DISTRIBUTION OF CROPS (Food Cereals and Food Pulses)

Food cereals and food pulses play a major role in the cropping of land under cultivation. It is due to their importance in providing cash and feed, both as grain and straw for human beings and livestock. They adjust to semi-arid environments and require little attention - relevant considerations when the moisture scarcity and shortage of labour prevail. They are generally less demanding and less exacting in their soil and moisture requirements than fibre crops and are favoured by both natural and man made conditions suitable for semi-arid farming. Thus, these tend everywhere to displace the fibre crops in Hissar. Furthermore, it is said that the cropping of some food pulses and food cereals is unavoidable. It is difficult to evolve a useful rotation without a large acreage under them to maintain the soil fertility and to overcome the limitations of moisture, especially in the semi-arid region where soil is usually deficient in nitrogen and deficient rain is a common calamity.

On an average nearly 77 percent of the harvested area is under food cereals and food pulses (Fig. 133). In many units it exceeds 80 percent, the chief exceptions being those areas where fibre crops or summer crops are important. The share of over 85 percent is to be observed in the Rohi circle of Sirsa tahsil, the south-west rainfed areas and the Barani circle of Hissar tahsil. The Bagar circles of Sirsa and Fatehabad tahsils with 95·46 and 96·61 percent respectively have the highest proportion. On the whole food cereals and food pulses dominate the agricultural activities in Hissar having a great seasonal contrast in their areal distributional pattern.

The Proportion of Kharif Food Cereals and Food Pulses (Fig. 134):

The salient features which emerge are:

(i) Kharif food cereals and food pulses predominate on the light sands of the rainfed areas of south and south-west where proportions exceed 50 percent in Bhiwani and 40 percent in Hissar tahsils.

(ii) In the irrigated areas of Bhiwani, it is above 40 percent because of the liking of the farmers for bajra and jowar as food.

(iii) In the Rohi circle of Sirsa tahsil it is under 20 percent, due to the suitable agronomic conditions for remunerative rabi food cereal and food pulse and the dislike for kharif food cereals by the farmers in their daily food.

(iv) Elsewhere this set of crops is less significant than the rabi counterparts, the reasons being the same as for the Rohi circle.

The Ratio of Rabi Food Cereals and Food Pulse (Fig. 135):

(i) The rabi proportions predominate in the north and north-west having a share of over 60 percent.

(ii) In the old irrigated areas the rabi food cereals and food pulse overshadow the kharif counterparts.

(iii) It is on light sands having low moisture content in the south and south-west that these lose importance because of unfavourable agro-climatic conditions.

The proportion of kharif food cereals and food pulses decreases from south and south-west to north and north-west but a contrary situation prevails in rabi due to the variable requirements of growth for individual sets of crops. The major controls are soil and moisture, particularly leading to the possibility of harvesting the matured crop. The amount of return in cash also plays its role. In the south and south-west the soil is light sandy and moisture deficiency is great. Both contribute to the highest proportion under the drought-resistant food cereals and food pulses being in kharif cropping. The food cereals and food pulse of rabi are much more sensitive to drought and the excessive seepage of soil. In the north, north-east and north-west the soils are soft to medium loams with less moisture deficiency, making them suitable for supporting rabi food cereals and food pulse which provide both food and cash where the cultivation of fibre crops is not profitable.

In the ensuing section the individual food cereals and food pulses are discussed systematically according to their relative importance.

Gram (Cicer arietinum, chick-pea a winter food pulse):

Gram is the principal food pulse grown for cash returns. It is an important source of nutritive, livestock food especially for bullocks which take a fair proportion of the produce. Its consumption as a human food is, however, much less than other food cereals and pulses within the district boundaries. Gram is a leguminous pulse, used by all classes of people as a vegetable in green form and a pulse in a dry form. Its flour is used by the poor class of people mixed with wheat, bajra or jowar. The plant is cultivated for edible seeds, which are very nutritious, but are susceptible to pests in store.

Hissar is one of the largest producers of gram in the Punjab. Gram has the biggest share in the arrivals of different agricultural commodities in the important regulated markets of Hissar (Table 15.i):

Table 15.i

Share of Gram per 100 Maunds of the Arrivals of Different Agricultural Commodities in the Important Mandis of Hissar, 1959-62

Markets:	Hissar	Sirsa	Dabwali	Uklana	Bhiwani	Hansi	Loharu
Gram (mds)	42·03	60·51	63·14	52·45	34·28	29·13	11·48

The arrival of gram in the markets leads to a conclusion, that the lower the intensity of gram cultivation in the hinterlands of the markets the lesser the arrival and vice versa (see Fig. 137).

Gram is an important and cheap source of protein, and being a legume, it is also of considerable utility in enriching the soil productivity through the fixation of atmospheric nitrogen. Eventually, not only the crop gives a fair cash return, but the soil fertility for the following kharif crops is enhanced. A rotation of food or fibre crop followed by a legume like gram can be safely recommended to the cultivators in Hissar.

The average yield of gram per acre in Hissar is about 640 lbs. which is rather low. It can be raised by the use of improved agronomic practices and improved seeds. The research work on gram has been in progress in the Punjab to evolve improved varieties for cultivation under different agro-climatic conditions. It is likely that the modern varieties bearing more pedicles, resistance to drought and blight may turn out to be better here.

Requirements: Gram thrives on well drained sandy or medium loams. It can be raised on clay-loams also, provided good irrigation and cultivation are given. In heavy soils, however, it makes excessive vegetative growth which adversely affects the seed-setting and thus lowers the yields. It is very sensitive to alkaline soils. Thus soils having alkalinity or high water table are not suited to gram cultivation. Rich soils are reserved for wheat, so gram is left with light soils. It can be successfully grown on poor soils under low rainfall conditions, where it is not possible or profitable to raise a wheat crop. It is essentially a crop of the rainfed areas, but is also grown under irrigated and good rainfall conditions on fertile soils.

Gram is sown in the first fortnight of October and is harvested in late March. The crop is sown after the preparation of soil with post-monsoon ploughings. It needs little care and less ploughings than wheat. A good local proverb on the subject of the care of gram and pulses may be quoted:

Chhola ki jane vah	(Gram needs little ploughing;
Mah ki jane gha	Pulse does without weeding;
Jat ki jane rah	Like a jat farmer they can travel rough).

If moisture is sufficient in the soil, the crop is sown broadcast, otherwise with a drill. The crop can do without irrigation and rainfall until late January because of the well developed lateral roots of the plant extracting moisture from upper layers of the soil. Further, dew at night and low rate of potential evapotranspiration are also helpful for its growth without irrigation.

In spite of the low rainfall in Hissar much of the crop is unirrigated (Fig. 136). Whatever irrigation is done, it is either at the time of sowing or during the months of December and January to reduce the incidence of wilt and also to increase the yield. In light sandy soils of the south it survives without irrigation and in the Bagars of the south-west Hissar and the Rohi of Sirsa irrigation is very low. In the flood plain the irrigation for gram cultivation is of great significance because of the heavy soil and the availability of water from wells and canals. In the old irrigated areas of the east, it is exceptionally high due to the heavy loams and the higher intensity of canal irrigation. The aim of irrigating the standing crop before flowering is to increase its yield and to reduce the incidence of failure. On the whole, the major bulk of the crop is matured without irrigation.

Distribution: On an average 38 percent of the harvested area is under gram. The regional variation in the share is noticeable, ranging from 21 to 60 percent. The principal gram-growing areas are in the north and north-west of Hissar, chiefly Sirsa, the upper flood plain and the Bagar of Fatehabad tahsils. It indicates the maximum concentration of the crop in areas having light porous loams and low intensity of irrigation. Hissar falls under four categories as far as the importance of the crop is concerned (Fig. 137):

(i) Areas where the Importance of Gram is Low (under 30 percent): The lowest proportions are found in the rainfed areas of Bhiwani and the old irrigated areas of Hansi and Hissar tahsils. In the former the soil is too light sandy, and moisture is too low and unreliable for successful farming without gram wilt, hence pearl millet (a drought-resistant grain) is preferred in summer. In the latter, on account of loamy soil and availability of moisture, farmers will naturally sow wheat rather than gram. In the old irrigated area of Hansi because of a high water table the acreage under gram is less, the chances of a successful harvest are meagre. Furthermore, in the irrigated areas the acreage under perennial crops (cotton and sugar-cane) is nearly 10 percent; thus much of the land is not made available in October for the sowing of gram.

(ii) Areas where the Importance of Gram Cultivation is Moderate (30 to 34 percent). These include the old irrigated areas of Fatehabad and Bhiwani tahsils. The soil and climatic conditions are such that gram cultivation can be done easily, even then the importance is not of high magnitude because the same conditions are more suitable for wheat and oilseeds, with which gram cannot compete for cash returns. At the same time the area devoted to perennial crops is nearly 10 percent. It is never made accessible to gram sowing in October. The moderate importance for gram cultivation achieved by this area is due to the moderate intensity of irrigation responsible for sparing a significant acreage for gram.

(iii) Areas of High Gram Importance (35 to 45 percent): These comprise the Barani areas of Hansi and Hissar tahsils and the flood plain. In the former because of light loams and low intensity of irrigation, a high proportion of the area is devoted to gram rather than to wheat. In the latter, the moisture of summer floods is conserved, for gram and the rice fields are recropped with gram.

(iv) Areas of Greatest Gram Importance (over 45 percent): These cover the Rohi and Bagar circles of Sirsa and Fatehabad tahsils. The small amount of rainfall, porous sandy loams and low intensity of irrigation are responsible for the dominance of gram.

Millets, or Summer Food Cereals

Dry farming is practised in the areas having scanty supplies of water and light soil to raise large quantities of food and fodder which were habitually grown in the struggle for existence. Millets in some form are probably far and away the most economical and productive accessory food and fodder crops for such areas. Millets are irrigated, especially in areas with well developed agricultural practices and irrigational facilities, during the dry periods of the year, and tolerably high yields are then obtained. All of them, markedly drought-resistant and maturing quickly, can be grown without irrigation in semi-arid areas, having a rainfall below 20 inches. These mature in from 3 to 4 months and are kharif crops. The preparation of land and cultivation are simplicity itself. Bajra and jowar are the two important millet crops of Hissar.

Bajra (Pennisetum typhoideum - Pearl millet or bulrush millet):

Bajra has a bold seed and is the inferior food cereal of Hissar. It occupies 25·78 percent on an average of the harvested acreage. The crop ranks second among the food and non-food crops after gram. It is an important kharif harvest of Hissar, especially in the south and south-west, where it is a food of the people with wheat. It is considered as a nutritious and heat-giving food during winter.

The present average yield of bajra is very low (246 lbs. per acre). There is scope for stepping up its production by the use of improved seeds and by following improved manuring and cultural practices. Yields as high as 2000 lbs. of grain and 4000 lbs. of dry stalks per acre have been procured at the Agricultural Research Station, Ferozepore (Punjab).

Requirements: Bajra as an inferior grain does well on sandy loam or loamy sand or sands and well drained soils. In Hissar it is a catch-crop of the poor lowland areas covered by the sandy billows having low and unreliable rainfall varying from 10 to 15 inches. Being a hardy and narrow-leaved crop, it competes quite favourably with other kharif harvests and can succeed with comparatively low soil moisture or least irrigation. Prolonged drought spells delay its ripening, certainly lowers the yield, and may lead to crop failure. It has not the power to arrest growth when the soil is too dry, resuming growth when rain comes (Cobley, 1962). High temperatures are necessary for its growth. As is well known, this crop is very fastidious about its climatic requirements, the dry years usually give a good crop of bajra. It cannot stand a continuous rain and demands a long interval of sunshine in between two falls. It always prefers lighter falls and does not do well in heavier downpours. Heavy showers are disastrous to germinating seeds or young seedlings and later when the crop has made some progress it is checked in growth and turns yellow during heavy continuous falls. If heavy rains come during inflorescence the pollen is washed away and many of the female flowers are not fertilized and therefore the heads of the grain are partially empty (Mollison, 1910).

In Hissar the temperature and soil requirements are congenial for bajra, but the fluctuations of moisture depress the yields. Under more favourable conditions the varieties in Hissar excel in yield the rest of the Punjab. The beneficial crops from the view point of moisture conservation to be interplanted with bajra are pulses, which by covering the soil retard the excessive evaporation and maintain the fertility of soil exhausted by the former. It is a deep-rooted drought-resisting crop quite suitable for the poorer sandy soils where sorghum does not do well. It plays a very important role in the economic development of the cultivators' holdings in utilizing the poorer soils.

More than 90 percent of the bajra acreage is matured under the rainfed conditions, but the importance of irrigation for bajra varies within Hissar (Fig. 138). In the rainfed areas of Bhiwani, the whole of the matured crop is unirrigated and in the Bagar circles of the south-west Hissar the watering is done to under 5 percent of the bajra harvested area. On the whole, more than 75 percent of the crop is matured without irrigation over a great area. In the areas where irrigation exceeds 25 percent of the bajra acreages, it is due to the availability of water and the importance of the crop as a food and fodder crop.

In the south and south-west, it is a chief food cereal. It is sown after several ploughings and farm yard manure is also applied, as a fine seed bed ensures good germination. In its early life thinning and weeding are practised to increase its growth and yield. In the north-west and north, it is sown after doing one or two ploughings without manuring. No weeding and thinning are conducted in the fields which raise bajra as a fodder crop because vegetative growth is preferred over grain for livestock.

Sowing takes place with the onset of monsoon because most of the crop is to be raised on rainfed fields. The first fortnight of July is the best sowing period but it continues even up to late August. If sown at the proper time the crop is harvested in October. The sowing is done with drills in plots raising the grain crop. In the drill sowing, the seed germination is assured as it settles in the moist seed bed and the efficiency of weeding and thinning is quickened.

Because of its susceptibility to bird damage, the crop must be watched. The farmer uses a sling shot as a protection. The bajra crop ripens by the end of September and harvest is another busy time. The cutting of ears by hand in the standing crop is the practice, a task calling for much labour. It is done mostly by the family members. The gathering is done in time to avoid the shattering of matured grain. It suffers from less biological hazards than all the other food cereals. It can be easily stored in bins. It normally suffers very little insect damage in storage and remains palatable. It is thus an excellent famine reserve as finger millet (<u>Eleusine coracana</u>) in Uganda (McMaster, 1962).

Distribution: Fig. 139 reveals primarily the agro-climatic preferences and secondarily the tribal associations of bajra. Broadly speaking, two divisions can be immediately discerned as far as the importance or ranking of the crop is concerned. These are south and south-west as the major area of production, and east, north-east and north-west as the minor region. This division coincides with the line separating the very light sands from the medium loams as well as the areas of maximum and minimum undulations (cf. Figs. 139, 44 and 8). Therefore the distribution is determined by the character of the soil and the form of the surface. The regional status of the crop may be summarized under four zones of variable importance:

(i) Areas of Low Intensity (under 15 percent): The Rohi assessment circle of Sirsa, the flood plain and the Nehri assessment circle of Hansi tahsils specialize in superior grains like gram and wheat, pushing bajra to backwaters in harvested crop-occupancy. In Hansi area, the fibre cash crop gets importance due to fertile loams and the higher intensity of irrigation, giving a set back to bajra. In the flood plain the rice cultivation and fodder crops weaken bajra's case. The rival claims of superior [redacted] rabi crops [redacted] probably constitute a primary check factor to devote substantial acreage to bajra in these areas. The cash returns are much higher and the intermittent labour demands are somparatively low in the rabi food cereals. Bajra is least recognized by the majority of the farmers as their staple food because wheat is a better substitute.

(ii) Areas of Below Average Intensity (15 to 24 percent): Although the rainfall is below 15 inches and the soils are sandy loams, bajra is not so important in the old irrigated areas of Bhiwani, Hissar and Fatehabad and the Barani circle of Hansi tahsils. Firstly, the low recognition of bajra in cropping is due to the cultivation of superior cereals and fibre crops. Secondly, it has not contributed in the dietary habit of the farmers. Thirdly, most of the crop is used as a green fodder, hence, it faces a tough competition from other superior, fodder crops like chari and guar, which are more nutritious for livestock than bajra.

(iii) Areas of Above Average Intensity (25 to 35 percent): These occupy the Barani circles in Hissar and Fatehabad tahsils in the north and the Bagars of Sirsa and Fatehabad and the Haryana-West circle of Bhiwani tahsils in the south-west. The physical conditions are almost similar to those outlined above. The lesser irrigational facilities have made it difficult to grow superior food cereals and fibre crops on light soils. Furthermore, in the south-west the presence of undulations and the tribal associations for food increased its importance.

(iv) Areas of Maximum Intensity (over 35 percent): These comprise the Bagars of Hissar and Bhiwani tahsils. In the former the intensity of irrigation is very low and in the latter it is completely negligible. The soil is light sand having poor production potentials for rabi food cereals, but suitable to raise inferior food cereals to sustain the exceptionally high economic density of population. The land is physically accessible to bajra cultivation, thus, the crop has a first claim in this zone. Initially, the physical factors are involved for the considerable concentration of bajra but the socio-economic variables, like the dietary habit, the highest economic density, cannot be overlooked which encouraged the farmers to grow bajra intensively.

<u>Wheat (Triticum sativum)</u>

Wheat is one of the chief rabi food cereals of India. In Hissar it is second in importance after gram in rabi crop season.

On an average, during the 'fifties 10·10 percent of the harvested area was under wheat. It is the principal food cereal grown for human consumption, and its straw is an important source of livestock feed throughout the year mixed with green fodder or ground gram. This is not only the superior grain of Hissar but also a large proportion is sown with the aim of selling.

Requirements: Wheat is grown under a variety of soil and climatic conditions in the Punjab. Unlike rice, the monsoon food crop, wheat is a plant which does not require a great deal of moisture and a clay pan in the soil. For heavy yields, the supply of nitrogen must be adequate in the soil, a requirement which is mostly met in Hissar by green manuring, by fallowing and by adopting crop-rotation of legumes rather than by direct manuring. It does not require a rainfall of more than 10 inches during the growing period. However, the moisture in the soil should be sufficient for the plant growth without any check. It is a very delicate crop and is very sensitive to drought. It thrives well on all types of soils except very light sandy, alkaline and water-logged ones. The best-suited soils are medium well drained loams having good crumb structure. It is a crop which mainly depends on soil aeration and irrigation facilities. Besides sufficient moisture and organic matter in medium loams, temperature is an important factor in wheat production in the Punjab, which limits the growth in both directions. After the cessation of the monsoon, the sowing of wheat is regulated by the point reached in the cooling of the seed bed. Towards harvest, the crop has to ripen under a rapidly rising temperature when hot dry winds are frequent. At both ends, therefore, the growth period is limited by temperature, a fact which suggests growing the early-maturing varieties. Sometimes during the period from mid-December to mid-February the temperature falls too low followed by frost so that the growth of the plant is stopped. Thus the growth period of wheat is increased by nearly two months. It has been observed that the cultivators pay little attention to the temperature factor in adjusting sowing techniques accordingly and in selecting a suitable variety because of a lack of demonstrations at village level. These tendencies are probably one of the causes of poverty in yield and quality of wheat. To some extent, therefore, wheat growing is a gamble with temperature. The intensity of irrigation in winter is low and irrigational facilities are not fully extended and developed in the vast stretches of fertile loams having important potentials for wheat husbandry. The drought-resistant dwarf wheats are chiefly raised from the wheat plots in Hissar due to low, unreliable and uneven distribution of rainfall and irrigation facilities.

Favourable season based on the results of the record years of wheat production: During July and August of the fallow period sufficient precipitation is required (6 to 8 inches) to enable good preparatory tillage. The months of late September, October and November are usually dry, and canal water for the sowing of wheat is essential. The growth is regular provided a precipitation of about 2 to 3 inches is fairly distributed over the months of December, January, February, March and April. Absence of frosty nights is desirable. At the ripening period the season should warm gradually, with the result that the filling and ripening of the grains are normal. Absence of showers at threshing period is appreciated. It is seen that circumstances in Hissar are quite favourable on an average in areas where irrigation facilities are in plenty for high yields, but elsewhere the water supply is the limiting factor bringing the yields below normal.

It appears, with the exception of soil, that the rest of the conditions for wheat are to be modified and the cultivation practices are to be adjusted to environment to have good yields. There is an ample scope for raising wheat yields in Hissar, which, on an average of 1060 lbs. per acre, are the lowest in relation to the wheat producers of the world. The immediate problem in the wheat production on the alluviums of Hissar is the development of the means by which the present extensive system of agriculture can be intensified. For intensive cultivation the indigenous varieties should be replaced by new varieties which respond successfully to better soil conditions. Besides suitable varieties, other requirements are improvements in water supply and organic matter in the soil. The increase in production brought about by these means is extraordinary. The necessary steps to increase yield are four. Firstly to stop evaporation by proper hoeing, mulch formation, and pulverizing with hot weather soil-turning ploughing (the greater the soil-turning capacity the better the mulch formation and smaller the evaporation). Secondly, the maintenance of surface drainage is essential and the soil should not be allowed to wash out the fertilizing ingredients. Thirdly, the wheat is a soil exhausting crop, especially with regard to nitrogen content, and therefore rotation with legumes is desirable to bring back the soil productivity. During field work the green manured fields with cluster-bean has been seen for rabi wheat preparations. The mulch of vegetative accumulation on the soil holds back the monsoon water which is of much value for wheat. It is a sign of progressive farming and the enlightenment in the countryside, resulting from the personal initiative of the farmers, it needs to spread and to be spread by the relevant departments to improve the wheat husbandry. Fourthly, judicious irrigation can do a lot in improving the yields per acre.

With the spread of intensive cultivation of wheat, a further improvement in production will become possible, by saving the irrigation water. Additional organic matter will increase the retentive power of the soil, and drought-resistant varieties will be grown comparatively with little water. By these means, the requirement of water for wheat can be curtailed and the additional rainfed areas can be brought under irrigation. Under present conditions, when the canal water is assessed by the area irrigated, there is little inducement for cultivators to economize. Regulated irrigation can alone raise wheat yields by 25 to 30 percent. With 10 acre inches of water applied in three irrigations with 24 seers of seed per acre, the wheat yield can be pushed up to 2050 lbs. per acre. It cannot be raised beyond it as discovered at the Indian Agricultural Research Institute, Delhi. Distribution of irrigation has been recommended as: 4 acre inches at sowing (soaking dose); an irrigation of 3 acre inches 50 days after sowing; and another irrigation of 3 acre inches 50 days after the second irrigation, preferably at the ear emergence stage. From personal experience it has been gathered that the first two waterings should be heavy, the second coinciding with the frost period to weaken the effect of low temperature, while the last one should be a light one because the heads of the plants are heavy and the stalks and roots are weak. Hence, it is desirable to spread the third watering into two of one and a half inch acre each in March to have good yields and to save the seed deterioration from suddenly rising temperatures.

Being a supreme crop among food cereals, considerable attention is paid to wheat cultivation. It is grown under irrigated and unirrigated conditions (Fig. 140). The intensity of irrigated wheat acreages varies from 0 to 98 percent. The primary cause for the existing disparity in the application of irrigation to wheat plots is the areal variability in the intensity of irrigation in winter. In the old irrigated areas of Hissar, Hansi, Bhiwani and Fatehabad tahsils, it is above 90 percent. It shows a considerable importance and necessity of irrigation for wheat husbandry in the semi-arid Hissar. Furthermore, the rainfall in winter is below 3 inches and its unreliability makes irrigation essential. In the Rohi circle of Sirsa the intensity of irrigated wheat acreages is below 50 percent because of low water allowances in canals in winter. In the flood plain it is below 90 percent due to the retentive nature of the soil in which the flood water is conserved. In the former the dry farming techniques are intensively practised to carry over the monsoon water for rabi cropping, hence the kharif crop season is least important. In the rainfed areas the irrigation practices are negligible.

On the whole, it can be visualised that irrigation is the primary need in Hissar for wheat to improve its status in crop combination and concentration. The excellent irrigational facilities developed in Hissar have off-set the deficiency and uncertainty of rainfall. In fact the history of development of irrigation and the increase in acreage of wheat run concurrently. The Rohi circle has great potentials to increase production and acreage as it has still low intensity of irrigation in winter. It can be inferred that Hissar has a rich potential base for wheat production provided the water supply is assured and intensified and the agronomic practices are changed and improved.

Because of the deficiency of rainfall, the land for wheat is tilled thoroughly prior to sowing for conserving the maximum moisture of the monsoon period. More than ten ploughings are done in the unirrigated lands starting from August. Even in the irrigated areas four to five ploughings are usual. Wheat sowing starts in the last week of October and continues up to the middle of November. The crop which is sown after mid-November gives very poor yields because of the temperature factor on both ends. On the other hand, too early sowing is equally unprofitable because of the high temperatures after the retreating monsoon. Such a situation is injurious to the development of tender wheat plants. If the moisture is enough in the soil, then the sowing is done by broadcast, but usually the sowing is conducted with the help of seed drills so that the seed may settle in the moisture zone of the soil for its effective germination. Afterwards weeding is easier, improving the moisture conditions and yields. Most of the harvesting is finished by April.

Distribution: The wheat acreages as demonstrated in Fig. 141 are the familiar and expected ones in relation to the intensity of irrigation and the soil capability. Wheat acreages are confined to the areas which have either good irrigational facilities or good soil structure and texture to conserve the monsoon moisture. The intensity of cultivation varies within Hissar from under one to over 15 percent of the harvested area. The wheat distributional map suggests a division of the area into four empirical parts for future improvements and planning, viz:-

(i) Areas of Least Importance of Wheat Acreage (under 2 percent): In this category there are two zones of varying importance. One covers the whole of the light, sandy, rainfed area of Bhiwani tahsil having a complete absence of irrigation. The potentials for the future expansion of moisture supply in any form are meagre due to the unfavourable contours and the ground water conditions. Wheat is sown in fields near to ponds and village wells in small patches to which artificial irrigation is certain for assuring maturity.

The second zone includes the Bagar circles of Hissar, Fatehabad and Sirsa tahsils on the south-western margins, devoting only 1 to 1·99 percent of the harvested acreages to wheat. Comparatively less fertile, light soils and least irrigation facilities are responsible for very low acreage. During the winter the rainfall is very low and unreliable, the water allowance in canals fluctuates and the excessive seepage of the soil is a common feature, all the facts combined discourage the wheat husbandry. Only those fields where water supply is assured and is adequate are sown with wheat. A major part of the land is either devoted to gram or the land is left fallow in the rabi season to be cropped with bajra. The situation in this zone may improve in the near future with expanding irrigation but not at a higher rate because of the soil limitations, which may take time to be improved with canal water.

(ii) Area of Low Importance of Wheat Acreage (2 to 4 percent): This comprises a narrow strip covering the Haryana-West circle of Bhiwani tahsil, where wheat achieved some significance due to the improvement in the old irrigational facilities during the 'fifties. The status of wheat can be raised provided the farmers are enlightened enough to divert their sorghum fields to wheat farming by leaving the former fallow in summer.

(iii) Areas of Moderate Importance of Wheat Acreage (5 to 10 percent): The Nehri and the Barani circles of Hissar and Fatehabad tahsils, the Barani circle of Hansi and the Rohi circle of Sirsa tahsils are included in this range. Generally, the percentage is more than the previous one, but the proportion is not significant for areas having loams exceptionally suitable for wheat. The present low share is the outcome of limited moisture supply. It is the potential wheat region of Hissar and is expected to be the flourishing wheat-growing area with the development of adequate irrigation during the 'sixties.

(iv) Areas of High Importance of Wheat Acreage (over 10 percent): The highest proportion is found in the Nehri circle of Hansi tahsil (14·54 percent), because of the exceptionally high intensity of irrigation and fertile loams. After it comes the flood plain, where canals, wells and the summer flood moisture conserved in soil are the source of irrigation. The tribal associations of the farmers for wheat in their daily food also make the wheat cultivation of considerable significance.

Jowar (Sorghum vulgare)

Jowar ranks second in importance among millets and third in food cereals in Hissar. On an average, there is 4·21 percent of the harvested area under Jowar. This figure suggests it be put in the category of minor crops. However, within Hissar its proportion varies from under 1 to over 18 percent of the total harvest. Therefore it is both a subsidiary and a minor crop. In the rainfed areas its grain is used as a human food with bajra, but in the irrigated areas it is an important source of livestock sustenance.

Jowar is an important grain and forage crop in India. In the Punjab state, except at high elevations where maize is important for grain and forage, elsewhere jowar is the dependable grain and forage of the kharif season. It is grown throughout Hissar as it can withstand dry conditions and can produce better than other crops besides bajra under the prevailing agro-climatic conditions. It is also of great value in areas where the rainfall is not certain, because it resists wilting and practically remains dormant during drought periods, resuming growth as soon as there is sufficient rain to wet the soil. The greatest single merit of jowar is its resistance to drought. The plant produces a very efficient rooting system which develops quickly and extensively and taps large areas of the surface layers of soils (Cobley, 1962).

Jowar grows well on a variety of soils. The deep fertile loams are the best, but fair crops can be produced on heavy clays if well drained. It is frequently grown on lands too poor to grow wheat. These seldom produce a satisfactory Jowar crop. In the areas under irrigation, it is grown in rotation with legumes, like egyptian-clover, and under rainfed conditions in rotation with gram. It tolerates alkali or salty soils better than most crops, but is reputed to be "hard on land". Cotton, maize, wheat and other crops, when grown on fields that have produced a crop of jowar the preceding year, usually yield less than on fields preceded by legumes. There are several reasons for the low yield of crops which follow jowar. In the dry regions the most important factor may be the complete exhaustion of the soil moisture by jowar. Another is the formation of the poor physical condition of the soil as a result of large clumps being held together by the many fibrous roots of jowar. The continuous growth of the plant exhausts both the available moisture and plant food, hence it is not a recommended crop in rotation. It is a crop which is neither very exacting in soil requirements, nor is it so fastidious to water - a little extra or a little less than normal does not affect it to a very great extent.

In spite of various drawbacks, jowar continues to be the most dependable and nutritious grain and forage. The improvement of the crop has received a good deal of attention from the Fodder Research Section of the State Agricultural Department of the Punjab. Improved varieties have been developed, and recommended to the farmers for cultivation. These set good seed and give large yields of forage per acre. A dwarf variety has been introduced which is completely covered with husk and therefore suffers the least from the depredations of birds. Jowar yields less than bajra, 205 lbs. of grain per acre, but the performance varies with seasons as 134 lbs. in 1951-52 and 421 lbs. in 1952-53 were the average yields recorded.

More than 60 percent of the harvested jowar is irrigated (Fig. 142), a fact revealing the insufficiency of rainfall and the importance of the crop. It is unirrigated in the rainfed areas of the south.

Distribution: The actual distribution of jowar acreage in Hissar reflects the competition of the kharif crops like bajra less fastidious to agronomic conditions than jowar, and cotton requiring more water but giving good cash returns, or the farmers preference for leaving land fallow for rabi crops like wheat, gram and oilseeds rather than to exhaust the soil with jowar cultivation. Eventually the status of jowar remains low, but it still predominates in some areas as an important food cereal and forage crop. It shows the insistence of the cultivators to grow it because of the tribal associations, despite its exacting nature.

The distributional pattern of jowar may be grouped into four notable categories (Fig. 143):

(i) Category of Least Importance (under 2 percent): In the rainfed areas of Bhiwani and the south-western Bagar circles the conditions are not favourable for jowar cultivation.

(ii) Category of Low Importance (2 to 4 percent): This covers the Rohi and the Nali circles of Sirsa, the Barani and the Nehri circles of Fatehabad and Hissar tahsils. The major part of Hissar is included in this category. The low proportion is of great importance as the higher proportion of it is irrigated. In the Nali circle rice, and in the Nehri circles cotton, replace jowar. In the Rohi and the Barani circles farmers adjusted farming practices to environments and prefer to grow wheat in the former and bajra in the latter. The farmers avoid this crop because of the danger of soil moisture exhaustion and the depletion of soil fertility in areas having low intensity of irrigation and light soil.

(iii) Category of Moderate Importance (5 to 10 percent): In the Nehri circle of Hansi jowar attains the status of a subsidiary crop. Primarily the higher intensity of irrigation and its value as a food cereal and forage crop are responsible for the significant acreage.

(iv) Category of High Importance (over 10 percent): This comprises the West and East Haryana circles of Bhiwani and the Barani circle of Hansi. The dietary habit and agro-climatic conditions are responsible for the maximum acreage of jowar.

Food Pulses (Kharif Crop Season)

Pulses are of considerable importance in the cropping pattern of an Indian farm for soil fertility, growth and health of the farmers. The cultivators of India have been provided by nature with a great variety of pulses. These crops are a necessity in the rural economy of India, because they supply the proteins, possess root-nodules, and the bacteria which fix varying amounts of atmospheric nitrogen. In the farm homes, dieticians recommend the use of more pulses for balanced diet. These are consumed as a cooked pulse (dal), adding both substance and variety to the cultivators' diet. These are considered as a poor man's meat.

These are cheap but good sources of vegetable proteins, and are a good substitute for the paucity of costly animal protein in the farmer's food. Pulses are rich in carbohydrates and starch, in addition these contain a small amount of fat. Pulses are not only nutritious for human beings, but for livestock too. The livestock feed is partially remedied by the produce from pulses. Some of the pulses are used as green fodder. The major part comprising the dried stem, leaves and seed coats fall to the work and milch cattle. Farm experts recommend the growing of pulses in farms for increasing the soil fertility and reducing the evaporation and soil erosion. Pulses belong to the family of legumes which play a useful agricultural role in increasing the nitrogen content. Further, the well developed root systems of pulses increase the aeration of soil. From the point of view of soil management these constitute an important chain in crop-rotation. The green manuring of pulses is beneficial, but is not practised in Hissar. The pulses generally need less moisture than the companion crops and may survive when others are drying. These act as "insurance crops" requiring little care and weeding.

The pulses are grown in kharif and rabi seasons. The major share of acreage is contributed by the kharif pulses after excluding gram. The main kharif pulses are Urd (Phaseolus mungo - black gram), Moong (Phaseolus aureus - green gram) and Moth (Phaseolus aconitifolius - brown gram) in Hissar. The rabi pulse is Masur (Ervem lens - lentil), which is least important having a minimum coverage. Though gram is also a rabi food pulse it is treated separately because of its importance as a first ranking crop.

In the ensuing section, the kharif pulses are treated together in order to avoid the difficulty of mapping and losing the significance of pulses' proportion in farming. Interplanting is frequent in pulses, where these are sown with a main crop. In such cases, the share of the plot held by a pulse is missed altogether. Therefore not much reliance can be placed on their agricultural returns for absolute analysis. However, by treating the numerical values relatively, the sense of distributional pattern can be conveyed without losing much significance.

The main characteristics of the pulses are that they do well with low moisture on light soils, as a result the concentration is maximum in the south. Too sandy and excessively moist soils do not give good yields. These do not compete for space with the superior food cereals or food pulse except bajra.

In Hissar the bulk of the pulses acreage is matured without irrigation (Fig. 144). It can be observed that in the south-west over 90 percent of the pulses are matured without watering. In Fatehabad nearly 19 percent of the crop is irrigated and 25 to 40 percent is dependent on irrigation in the Nehri circle of Hissar and the Rohi circle of Sirsa tahsils. In Hansi nearly half of the crop is irrigated. As the cultivation in the majority of kharif pulses is done without irrigation, the sowing takes place after the first showers of monsoon. Urd is irrigated in the dry areas. It needs one or two irrigations after flowering, to increase its yield.

The soil and moisture requirements vary from pulse to pulse: light sandy soils for moth and clay loams for urd; maximum moisture for urd and minimum for moth, are the favourable physical environments.

The requirements of moong lie in between urd and moth. Irrigation is practised for urd being a superior pulse. Therefore, moth and moong are important catch crops of the rainfed areas in the south and south-west; urd of irrigated areas in the north-west, north and north-east. Urd is relished by human beings as a special dish, moong is recommended in the diet of the sick and moth is used as a green fodder for livestock.

Masur (lentil) is the only rabi pulse having a comparatively insignificant acreage. It requires fertile soil and considerable moisture. These requirements are met only in the flood plain by rice fields, which are re-cropped to a limited extent for domestic needs. It is less paying than gram. It is preferred to have gram in rotation with rice rather than masur, a crop levying more duty on soil moisture. On the whole the minimum acreage under masur is in the rice producing areas of Hissar. It is below 0·25 percent of the harvested area.

Distribution of Kharif Pulses (Fig. 145): As might be expected according to the physical requirements of the pulses, the acreage distribution primarily shows an appreciable correlation to soil, undulations and moisture supplies and secondarily to the competition of cash crops. A fairly marked tendency of concentration in the drier and sandy areas of the south can be observed. The average share of pulses for Hissar is nearly 3 percent of the harvested area. The significant regional variation is apparent: under 1 to over 7 percent, the former is in the north, north-west and north-east and the latter is in the south. Three areas of varying intensity can be recognised:-

(i) Areas of Intensive Cultivation (over 7 percent): The suitability of the south of Bhiwani tahsil is undeniable for moong and moth. The chances of raising any superior cash crop in these dry areas without moisture supply cannot be envisaged. The vast stretches where canal water is not able to reach particularly on sand-dunes, are devoted to moong and moth cultivation. These areas receive a rainfall of less than 15 inches in the summer, even then 100 percent of the crop is matured without irrigation, indicating the adaptability of the pulses to dry conditions and the light sands having excessive seepage.

(ii) Areas of Below Average Significance (1 to 3 percent): These comprise the flood plain, the old irrigated areas of Fatehabad and the Bagar circles of the south-west Hissar. In the former the availability of moisture makes a strong case for cash crops and sets aside the acreage of pulses. Urd is the primary pulse in the irrigated areas for human consumption and moth in barani conditions for livestock. In the latter, the importance of pulses is overshadowed by the suitability of the area for rabi crops. It is preferred to leave the land fallow for gram to have good yields and cash returns.

(iii) Areas of Least Importance (under 1 percent): These include the old irrigated areas of Hansi, Hissar and Bhiwani tahsils having higher intensity of irrigation and medium loams. The cash crops are preferred over pulses under such agronomic situations. The cultivation of urd predominates. Whatever little acreage is sown, is irrigated to a maximum extent (see Fig. 144). The second region is the Rohi circle, where the rabi crops give a set back to the pulses acreages.

Henceforth, it may be concluded that the distribution of pulses reflects their liking to environments and adjustment to the competition of cash crops and the preferences of the cultivators.

Wheat-Gram

On an average wheat-gram mixture occupies under 3 percent of the harvested area. The regional variation in distributional pattern is conspicuous and varies from under 1 to over 8 percent. Among the inter-mixture crops in Hissar, it is the most significant combination of all and ranks at the top. Such a great preponderance of this mixture has threefold advantages. Firstly, it helps in maintaining the soil fertility because of the opposing reaction of the crops on the soil. Secondly, it is economical to utilize the soil moisture of rice and cotton fields for raising an additional crop with least irrigation. Thirdly, the risks of complete failure of crops caused by the fluctuation of canal discharges after September are minimised. The last two facts are of great importance, leading to the significant contribution of the acreage under wheat-gram. A good amount of gram mixed with wheat is grown in soils which are too light for wheat. The combination is reaped and grounded together. The resulting flour is an excellent food.

Distribution: (Fig. 146). The great dominance of this combination can be observed in the flood plain and the Rohi circle of Sirsa (over 5 percent). In the former the rice beds and in the latter the light soils are devoted to wheat-gram. Furthermore, where uncertain water supply prevails the inter-planting of wheat with gram is preferred to increase crop maturity.

Second in importance are the old irrigated areas of Hansi and Hissar tahsils (3 to 5 percent). The cotton and green-fodder plots are re-cropped in rabi either with wheat-gram or pure gram depending on the availability of land at the appropriate time of sowing. These fields have plenty of residual moisture which can be economically re-utilized for the less demanding crops. Moreover, with assured water supply, the fertile soils are sown with pure wheat which can receive three to four waterings during the winter months. Eventually, the wheat-gram combination to some degree loses its importance.

The area of least importance (under 2 percent) is in the south and south-west covering the light sandy soils with low moisture content. The agronomic conditions are not in favour of this mixture. In the south-west gram dominates and in the south bajra replaces it.

Barley (Hordeum vulgare)

Barley is likewise an unimportant minor cash crop in Hissar accounting for only 1·42 percent of the total harvested area exhibiting regional variations ranging from under 1 to over 5 percent. The reasons for the small acreage may be two-fold: firstly, the suitability of conditions for superior rabi grains thus leaving little room for barley cultivation; secondly, the soils are too light sandy and moisture is too low and unreliable in winter for the survival of barley. The regional variations are primarily because of the above enumerated facts and secondarily due to the inadequate water supplies in winter for wheat cultivation even on medium soils which are ultimately devoted to barley adapted to adverse agro-climatic conditions.

Barley is the most dependable crop for feeding cattle. Very little is used as a human food because of its inferiority to wheat and the difficulty of making bread (loaf) unless it is mixed with wheat or gram. As a cattle feed it has an equivalent nutritional value to gram, provided it is used green. Barley "bhusa" is used as a feed for cattle after winnowing grain. It is much inferior to wheat "bhusa".

Barley can be grown successfully in dry and humid areas or under irrigated and unirrigated conditions. It is very rarely irrigated, except when sown intermixed with wheat. It is irrigated only when wheat needs water either due to rain failure or injudicious inter-cropping or improper conservation of moisture. It matures in a shorter period than any other food cereal crop which has won it the reputation of being drought-resistant. This is not exactly the case; the crop is drought-escaping rather than drought-resistant (Klages, 1942). During its short period of growth it demands a fair amount of moisture.

Barley is a shallow root and quick growing crop. It is pre-eminently the crop of well drained rather light soils. The highest yields are procured from the fertile loams. However, a good crop can be raised on all kinds of soils except those that are waterlogged and very light. It is a surface feeder, the roots are weak and do not penetrate deep into the soil. Thus, it exhausts the upper soil layer without leaving any crop residue. It is believed that barley exhausts the soil sooner than wheat. Therefore the wheat-gram mixture is preferable to the wheat-barley. Heavy and medium lands are usually avoided, thus barley is raised from light soils which are not useful for wheat husbandry.

In comparison to wheat crop, barley very gladly accepts the late sown conditions. The fields vacated by late maturing kharif crops can be re-cropped with barley intermixed with methy (fenugreek), a legume crop to utilise the left over soil moisture. Being a hardy grain, it does not require as much ploughing as wheat and is rarely manured. Barley does not compete for space with the rabi crops. It is a catch crop and utilises those spaces which are not suitable for wheat and gram husbandry.

Moreover, the Punjab barley is reputed for its good malting and brewing qualities mainly because of its well developed mealy grain and plump kernel. The samples of the Punjab varieties were supplied to the Research Institute of Brewing, London, for valuation (1930-31), the valuation committee of the Institute passed specially eulogistic remarks on the barley varieties of Haryana (Rewari Variety)(Ramdhan, 1931): "Would always find a market at price above the average. Well worth growing on commercial basis". From the yield point of view the varieties grown in the semi-arid climate of the Punjab are of premier types.

Distribution (Fig. 147): Two distinct areas of variable concentration can be discerned:

Firstly the Rohi circle (over 5 percent) has some significance of barley in cropping and produces a bulk of Hissar's crop. The importance of this area for barley cultivation is because of the availability of sandy and shallow soil, low rainfall and low intensity of irrigation in winter. However, barley can mature with the winter fall or one to two irrigations if needed in fields not suited to wheat.

Secondly, the vast area falls in the category of under 2 percent of the harvested acreage and even under 1 percent. Leaving aside the light sandy soils of the south and south-west with low moisture content, unsuitable for barley, the rest of this zone has fertile loams with adequate accessibility to canal water, thus suited to wheat. Furthermore, the status of barley is degraded by gram crop which is a more profitable and nutritious crop. The former increases the soil exhaustion and the latter induces soil fecundity.

Barley-gram mixture is sown from a safety point of view, just as wheat-gram. The former mixture is solely meant for cattle in a green form and little is used by human beings. Barley takes the place of wheat with gram where the soils are light, rainfall is meagre and irrigational facilities are inadequate. The area under this combination is of least importance as it is under 1 percent of the harvested area. The absence of this combination in the light sandy soils of the south and south-west is usual.

Rice or Paddy (Oryza sativa)

Rice as a food cereal is not important. On an average it occupies under 1 percent of the harvested area in Hissar. It is not a staple food of the farmers but is used at special occasions. In view of the extensiveness of the flood plain and waterlogged areas in Hissar, it may appear strange that rice is still a crop of minor importance, which is due to the insufficiency of moisture, low cash return and the attitude of the farmers. A good acreage of the rice crop is in the flood plain, where a considerable acreage of the flooded area is not fit for kharif cropping other than rice. Thus its cultivation is a virtue of necessity. The flood plain is a dead level land with poor drainage having clayey soil in which rice may be successfully grown. For rice poor drainage adds to the fecundity of the soil.

Rice needs a high temperature and excessive moisture, but in Hissar the latter is deficient. Rice is an acquatic plant, flourishes well in clayey soils where water can be kept standing to keep the plant's feet wet. Sandy soils are not suited due to the absence of clay pan leading to excessive seepage. It is mainly sown by the transplanted method. Intelligent farmers believe in early sowing as it gives better yields and makes the land available for the early sowing of rabi legumes (personal experience).

Three regions of variable importance are apparent (Fig. 148):

(i) Areas of Subsidiary Importance (over 5 percent): The excessive and cheap availability of moisture and clayey soil in depressions have given a fillip to rice cultivation in the flood plain. The rice husbandry is more important in the lower flood plain in Sirsa tahsil, because the stream is shallow and flooding is common. In the upper section the crop slides down in importance (3-5 percent) because of the deep stream bed limiting the overspilling. In the flood plain irrigation is available from various sources for rice, for instance, wells, canals, poor mans lifts and floods.

(ii) Areas of Minor Importance (1 to 2 percent): These include the Nehri circle of Hansi and the Rangoi circle of Fatehabad tahsils. In the former the waterlogged areas are devoted to rice and in the latter the clayey fields of the Rangoi Channel are transplanted with rice seedlings. The irrigation facilities from wells and canals are available when the need arises.

(iii) Areas of Least Importance (under 1 percent): The soft loams are not devoted to rice due to their unsuitability for rice and on the other hand their maximum utility for rabi food cereals.

The complete absence of paddy crop in the light sandy soils is not a strange occurrence.

The distribution of rice reflects its close relation to soil and water supply. Beside the flood plain and the waterlogged areas, elsewhere rice cultivation in Hissar, can be only at the cost of a tremendous water supply. The precious water cannot be used lavishly for a few acres of rice at the expense of other food cereals which are less demanding and more cash returning. The low acreage under rice on heavy clayey loams clearly discloses the adjustment of the farmers to environments and to the profitable use of canal water for other cash returning crops.

Maize (Zea mays)

Maize occupies about 0·50 percent of the harvested area on an average in Hissar. The crop has the lowest status among the food cereals. Unlike the western countries, maize is essentially a cereal used as human food and only a small proportion of the total crop is used as a green fodder supplied to the urban areas for cash returns. Near the towns it is rather an easy quick growing competitive cash-catch crop with the vegetables.

The limited acreages in Hissar are because of the agro-climatic abnormalities, the competition of other food cereals and the shortage of labour. Maize is a demanding food cereal. A heavy and leafy plant requires very fertile, easily workable and well drained deep loam and plenty of well regulated and assured moisture because a slight deficiency or excess even for a few days is enough to damage the crop. It demands weekly or more frequent irrigations due to heavy transpiration from its leafy surface. It requires 5 to 6 irrigations depending upon rain and 1 to 2 hoeings to give a good yield. Maize is an exhausting crop, so much so that even the fertile soils request a considerable manure to give a good harvest. It is not a surface feeder like barley, maize roots penetrate deep into the soil. Maize plants are set apart by thinning to meet their food requirements. The intervening gaps are essential to increase the yield but these make the plant vulnerable to the strong winds and the soil to rain erosion. The light soils are not suitable for maize because they cannot give anchorage to the heavy plant against strong winds and heavy thunder-showers. Maize is a calling crop as at silking it calls for more water and high temperature and at ripening for warm, bright and dry days. Watching is the most important item for the successful production of maize crop as it is susceptible to bird attacks. The ringing and musical sounds of the watchers in the early September mornings are a usual feature of the countryside. Its cultivation requires a lot of attention and care through weeding, thinning and manuring. The art of maize cultivation is known to Kamboj and Mali farmers.

In Hissar maize cultivation achieves some status in the flood plain because of soil, moisture and the concentration of the farmers expert in maize farming. Fig. 149 reveals the limited importance of the crop in Hissar and the distributional pattern can be analysed under three zones:

(i) Areas of Complete Absence, have light sandy soils, unreliable low monsoon rainfall and minimum extent of irrigation or complete absence of canals. These cover the whole of the south and south-west of Hissar.

(ii) Areas of Least Importance (under 1 percent), coincide with the soft loams suitable for other superior and cash returning crops. It is not advisable to use the canal water for maize as it is a low yielding crop with a small marketable value.

(iii) Areas of Minor Importance (1 to 2 percent), comprise the flood plain. The prevalent importance provides a lead to some of the factors which operated to increase maize acreage, summarized as:

(a) Heavy clayey soils.

(b) Sufficient water, available from wells, canals and overflow of the stream.

(c) Skill of Kamboj and Mali farmers in maize fields cannot be overlooked in their small holdings supported by the labour force from family members.

CHAPTER 16

THE DISTRIBUTION OF CROPS (Continued)

Oilseeds, Fibre and Fodder Crops

Hissar is not fortunate enough to devote a considerable area to fibre crops and oilseeds which greatly strengthen the economy of the farmers. On an average 8·87 percent of the harvested area is devoted to non-food crops. These include oilseeds, cotton and sugar-cane in the present text. Here in factors of physical environment are not only ones to be considered, however, the human factors are quite as significant for their cultivation. Oilseeds and sugar-cane have long been planted for local consumption, the former supply the edible oil as a fat and the latter as a raw material for raw sugar (gur) in the poor man's diet. The cotton supplies fibre for clothing and seed for livestock.

Oilseeds

The importance of oilseeds in the subsistence agricultural economy is next to food grains. Not only do oilseeds supply an essential requirement in the nutrition of farm economy, but they are also an important source of plant food, that is, the effect of oil-cake as a fertilizer lasts longer and oilseed plants leave a residue in soil improving fertility.

Oilseed's demand is increasing more rapidly than their supply, the primary problem is to increase production. It should be remembered that no expansion of oilseeds acreage can possibly be appreciated at the expense of the food cereals acreage in India because of the increasing population. The present problems pertinent to oilseeds production are: how to increase the acreage under oilseeds without encroaching on the food grain fields, and how to increase the yields and check the diseases and pests.

Oilseeds are an important item in the rural economy of Hissar and constitute a valuable group of cash crops. The acreage under the principal rabi oilseeds Sarsoon (Brassica napus - Rape), Toria (Brassica rapus - Indian rape) and Taramira (Brassica nigra - Rocket) is 3·95 percent of the harvested area on an average. Furthermore, Alsi (Linum usitatis-simum - Linseed) is of minor importance and is sown for livestock use. The rest are raised as a marketable surplus. Til (Sesamum indicum) is a kharif oilseed of minimum importance in Hissar. Rabi oilseeds combined together constitute the significant product of Hissar and is considered an important district of the Punjab for oilseeds cultivation and production.

Too much moisture is injurious to the rabi oilseeds and the loamy sand to clayey loams are suited to their growth, but alluviums are preferred. Weather plays a decisive role in the pollination of oilseed plants inflorescence affecting yields. It is definite that very few insects come out to visit flowers on cloudy days and even if some insects do visit at all, they remain lethargic. The comparison of the number of visits by insects to an individual inflorescence on a cloudy and clear day, i.e., 3 and 153 respectively (Oil Seed Botanist, Punjab, 1931) reveals the wide gap in the number of visits. It therefore follows that the intervention, during the blossoming period of the rabi oilseeds, of long spells of cloudy, humid and rainy elements particularly in November would decrease the percentage of setting (personal experience). Consequently, the yield is considerably reduced. The weather in the period following setting, that is in the month of December, is of importance in so far as the development of pods is concerned. Demand for food materials required for filling up the pods is the greatest. The deficiency of soil moisture and drought are sure to reduce the yield by cutting down food supplies and by increasing the liability of the crop to suffer from early frost. On the whole, a limited acreage of oilseeds is irrigated (Fig. 150). In the Nehri circle of Hansi a maximum acreage of oilseeds is irrigated because of the higher intensity of irrigation to the corresponding low acreage under oilseeds matured on a priority basis. In Hissar the limiting factors to improve the oilseed production are the deficient moisture supply and the similar soil requirements of wheat. Oilseeds are not able to face the space competition with wheat the staple food of the majority of the farmers.

The high concentration of the rabi oilseeds acreage in the flood plain and exceptionally low importance in the south and south-west are apparent and expected. Moisture, soil, population density and the competition from other crops play a role in the zonation of oilseeds distribution. These factors are responsible for a considerable regional variation, that is, under 1 percent to over 7 percent of the harvested area. Four zones can be recognised (Fig. 151):

(i) Areas of very low importance (under 1 percent): The south and south-west of Hissar carry the minimum oilseeds acreage, due to the very light soil, low and unreliable winter fall and exceptionally low intensity of irrigation. In addition to the above belt, it covers the Rohi circle, more suitable for wheat and wheat-gram.

(ii) Areas of Low Importance (1 to 3 percent): The Nehri circle of Hansi, the Haryana West and East circles of Bhiwani, and the Barani circle of Hissar tahsils are included in this zone. The minimum acreage under oilseeds is due to the high density of population, high intensity of irrigation and loams suitable for rabi cereals.

(iii) Areas of Average Importance (4 to 7 percent): The Nehri circles of Hissar and Fatehabad and the Barani circle of Hansi tahsils carry the average acreage of oilseeds due to the moderate density of population, low water allowances in canals and sandy loams making land accessible for oilseed cultivation.

(iv) Areas of Significant Importance (over 7 percent): The maximum acreage under oilseeds in the flood plain produces a considerable amount of Hissar's production. The soil is clayey loam having sufficient moisture and population density is low. The smaller labour requirements for the operation of oilseeds cultivation with favourable physical conditions, admit the importance of oilseeds acreage. The soil moisture is sufficient to mature the bulk of the crop without irrigation.

Cotton (Gossypium species)

Among the fibre crops cotton is the only important one. Sann-hemp (Crotalaria juncea) is grown on a very small scale as a kharif crop for domestic purposes or for green manuring in the irrigated areas. On an average, the area under cotton is 3·53 per-cent of the harvested area. Cotton is the foremost industrial crop of the farmers particularly in areas where it can be successfully grown. Appreciable achievement both in area and production has been made in Hissar in the field of cotton husbandry within the 'fifties. The gain in crop, however, is due entirely to the canal irrigation which has removed the mask of deficient rainfall, a long standing impediment to cotton cultivation. Further-more, the ambitious Package Programmes have been implemented in order to increase the acreage and production with the aid of special incentives in the form of subsidies on the purchase of Plant Protection Equipments and pesticides to control the various diseases. Hissar has great potential to increase cotton acreage and production provided the irrigational facilities are intensified. The land holdings are comparatively bigger in size in the new canal colonies, farmers can devote a considerable proportion of land to cotton. So much so, that a senior officer has been appointed in view of the great scope for development of the north and north-west Hissar into a very important cotton growing area, with headquarters at Sirsa. His main duties are to impart training, supervise and guide the local staff for the transmission of plant protection measures and techniques of increasing the cotton yield. The shortage of water supply prevents Hissar from being one of the largest producers at present. There is every possibility of a further increased percentage of the crop as is exhibited by the returns of the 'fifties.

As for the yield per acre, the Hissar farmer stands head and shoulders above the other farmers of India. The average production of cotton in Hissar is about 240 lbs. (lint) per acre, the nearest competitor being Rajasthan with 156 lbs. per acre. In comparison to the Indian average of 95 lbs., Hissar is much ahead in production but lags far behind when compared with the standards of U.S.A., Russia and Egypt. There is a great need for increasing the yield per unit area in Hissar by mobilizing the available facilities and resources.

Requirements: Cotton being a tropical plant, grows quite happily in the sub-tropical areas provided there is absence of frost and sufficiency of moisture. Without irrigation, 25 to 35 inches of well distributed fall is considered adequate for cotton. In the early periods of its growth it requires good moisture. At the time of picking, sunshine and absence of rain are preferable as the bolls may burst with sufficient warmth, or they may be spoiled by rain. Heavy showers are injurious and the quality tends to be better in drier conditions. Thus the cotton of Hissar is the best in the Punjab.

During the 'fifties the extension of irrigation made an appreciable success and is overcoming the limitation of moisture for the expansion of cotton cultivation in Hissar. The importance of irrigation for cotton cultivation in Hissar cannot be overlooked (Fig. 152). The considerable bulk of acreage is completely dependent on canal water. The vast potentials of soil and temperature cannot be exploited for cotton husbandry without developing an efficient, intensive and perennial network of canals. Cotton is a maximum water-wanting kharif plant after sugar-cane. It is considered as a perennial plant as it stands 7 to 8 months in the field.

Cotton does well on loams having good drainage. Water-logged and sandy soils are not to its liking. Moreover, it cannot be sown where the water table is within 5 feet. The soils of Hissar are equally suited to cotton except the south and south-western margins and the waterlogged stretches. The temperature remains above $70^{\circ}F$ and frost is unusual in Hissar during the period of cotton growth. Eventually, the deciding factor for the intensity of cotton cultivation in Hissar is the distribution and the amount of moisture. Despite the recent introduction of canals in the major part of Hissar the indigenous variety still predominates that the water allowances in canals fluctuate and are limited.

Cotton requires a fine and porous seed bed. At least five to six ploughings are given before sowing. The pre-sowing dose of irrigation is heavy so that the soil may saturate thoroughly up to a considerable depth. The sowing period extends from mid-April to mid-July, depending upon the availability of canal water. Early sown crops are damaged by the late September rains. On the other hand, the late sown crops could be damaged by the frost and the decreasing temperature of November which hampers the bursting of the bolls. The suitable sowing period is May to mid-June. The first irrigation is applied about one month after sowing, partially due to the sufficient soil moisture and partially to allow the roots to penetrate deep to utilize the thick layer of soil for food, to tape the underground moisture so as to be less dependent on irrigation and to form a stronger anchorage for the heavy plant. The subsequent waterings are given after every two to three weeks, depending upon the monsoon rains and the canal flows. The crop is allowed to undergo a water stress at the time of flowering, otherwise a lot of shedding of buds, flowers and bolls will take place resulting in depressed yields. The judicious irrigation is one of the foremost requirements for cotton farming.

The thinning of the cotton plots is essential for getting a proper stand of crop. It is usually done when plants are one month old. The distance from plant to plant is kept at one foot and the off type plants are removed. The crop is sown with drills at $2\frac{1}{2}$ feet apart. These wide gaps lead to soil erosion. The mixed cropping is worth practising to overcome this limitation. The kharif pulses are recommended for interplanting, further to reduce the soil evaporation and to step up the soil fertility. Inter-row cultivation to keep down the weeds counts for more yield. The Punjabi proverb "JITNI GODI UTNI DODI" meaning: as you hoe so will the number of cotton bolls grow is very valid.

Under the Punjab conditions, the application of nitrogenous fertilizers has been found to result in marked increase in yield of cotton. In Hissar it can be provided in three ways, that is, by artificial manuring, by green manuring and by crop rotation such as the cropping of the gram and egyptian clover fields with cotton. The last two means can be safely recommended for Hissar as these do not burden the pockets of the poor farmers. It is an exhausting crop and thus needs proper soil management. On the whole it is a demanding crop: needs well distributed moisture, even distribution of temperature and sunshine, fertile and well drained loams, and labour for thinning, hoeing and picking.

Distribution: The importance of cotton varies within Hissar from 0 to over 6 percent of the harvested area (Fig. 153). The governing factors are the intensity of irrigation, nature of soil, density of population and the location of textile mills. The analysis of distribution is based on five empirical divisions:

(i) Areas of Complete Absence, lie in the south having very light sands and exceedingly limited moisture supply. It is a permanent negative zone for cotton cultivation.

(ii) Areas of Very Low Proportion (under 1 percent): The cotton is merely cultivated for domestic needs in the Bagars of south-west. The light sandy soil and limited irrigational facilities restricted the cotton culture.

(iii) Areas of Low Proportion (1 to 2 percent): These are the future potential cotton growing areas of Hissar. There is hope for increased acreage and production with the aid of intensive Package Programmes. The Rohi circle and the flood plain are covered by this category. In the former the soil is well drained loam best suited to cotton. The limiting factors are the moisture deficiency and the shortage of labour. These have been improved during the 1950's. It is hoped that these areas will emerge as a prosperous cotton growing belt in the near future. The new markets and ginning mills are coming up at Sirsa and Tohana.

(iv) Areas of Moderate Proportion (3 to 6 percent): These include the Barani circle of Hansi tahsil. It is a small stretch of land adjoining the old area of importance. Although the soil is loamy, the limiting factor is the inadequate water allowance. There is a great possibility of increase in cotton acreage in the future on account of the increasing irrigation facilities and location near to the cotton mills.

(v) Areas of High Proportion (over 6 percent): The old irrigated areas of Hansi, Hissar and Fatehabad tahsils, having well drained loams, high intensity of irrigation and high density of population, have achieved importance in cotton cultivation but not to the extent (22 percent) recommended by the experts. The localization of textile mills at Hissar and Bhiwani with marketing facilities at Hansi, provide an impetus to the farmers to grow cotton.

The cotton cultivation has bright prospects in Hissar, provided the irrigation facilities are made adequate and reliable and that the yields are raised to justify them. Thus, much of the land which at present is devoted to inferior kharif food cereals, can be converted to cotton by maintaining the food cereal production from the existing acreage of rabi and the small acreage of kharif with increased yields. The difficulties of transporting the raw cotton to markets have been greatly modified with the increasing metalled road mileage.

Sugar-cane (Saccharum officinarum)

Sugar-cane ranks next to cotton as a perennial crop in Hissar, having a limited acreage of very low significance. It is meant for domestic needs. On an average, it occupies under 0·50 percent of the harvested area. The regional variation in acreage can be observed, ranging from 0 to under 3 percent. It is a demanding perennial crop: calling for heavy loams, heavy moisture requirement, absence of frost and heavy demand of labour. Sugar-cane leaves the soil in a poor tilth so that the preparation for the next crop is laborious. Its annual water needs amount to 50 to 60 inches and the greater the number of irrigations, the higher the yield. Sugar-cane is a heavy crop and so requires careful cultivation and a higher standard of crop husbandry. Its cultivation entails intensive efforts on the part of the cultivator combined with an abundant supply of moisture and fertile loams (personal experience). Thus, the agro-climatic and socio-economic conditions are not in favour of sugar-cane cultivation in Hissar. Furthermore, it cannot stand in competition with less demanding and more paying rabi food cereals and oilseeds. Yield per acre on the average is 10 tons of cane which is pitifully low compared with 15 tons of the Punjab and the exceptionally high standards of Java and Hawaii. It is due to the fact that Hissar lies in the zone of unfavourable physical environments for cane and also because of inefficient agronomic practices.

The distribution of sugar-cane acreage can be summarized as (Fig. 154): In the Nehri circle of Hansi tahsil (2 to 3 percent), it has some status in the cropping pattern, but of minor importance. The availability of moisture, the high density of population and the compact loam contribute for this acreage. In the Nehri circle of Fatehabad and the Haryana-East of Bhiwani tahsils (1 to 2 percent), the sugar-cane status is of minimum significance. In the south, the cultivation of sugar-cane is absent. Elsewhere, the importance of sugar-cane is insignificant (under 1 percent).

<u>Fodder Crops</u>

Fodder crops are of particular importance to Hissar. Cattle breeding tracts may do without commercial crops but cannot exist without good nourishment for the cattle. Animal husbandry is so intimately identified with the economic life of the people of Hissar, that, in judging the utility of the existing agricultural economics, or suggesting improvements, the needs of livestock cannot be ignored, and the cultivation of economic crops at the cost of fodder cannot be defended.

The food of animals may be broadly grouped into
(a) Concentrates, that is grain, oilcake, cotton seed etc., and
(b) Roughages (fodder). A working definition of fodder would be "the food derived by livestock from crops exclusive of the ripe grain". Thus the ripe grain of wheat, gram, barley, pulses and millets are not fodder, but the leaves, stalks and broken pods left as residue after threshing are the dry fodder. Fodders are, however, more important than concentrates as the digestive organs of cattle require food in bulk: an animal can live and thrive on selected fodders but cannot survive on concentrates only although these are more nutritious. During normal years of rain Hissar produces plenty of dry fodder, even available for export in large quantity to the adjacent districts and the nearest urban towns without the district limits.

The optimum food value is obtained when the crop is harvested at the commencement of the formation of grains. The system in vogue in Hissar, even throughout the Punjab, is that crops which yield both grain and fodder, are allowed to stay on the land until the grain matures. Thereafter, these are harvested, threshed and the residue of the dry plants is fed to animals. Unfortunately, at places there is a habit of cutting off the heads of bajra and jowar and leaving the stalks standing in the field to be cut when needed for fodder, instead of harvesting and stacking to prevent deterioration. The poverty of farmers does not allow them to waste grain as a cattle feed.

The grazing grounds are the other source of fodder supply. The grazings are a poor source on account of overgrazing and are progressively dwindling in size due to being brought under farming in Hissar. Therefore, the cultivated crops remain the major source of dry and green fodder supply. Any improvement effected in the latter, with a view to getting higher forage tonnage will have a far reaching effect on the agricultural economy by improving live-stock feeding. The importance of good quality green fodder for maintaining the proper health, up-keep and efficiency of both milch and draught cattle are the basic necessities. The milk production, which is very low and the deficiency of which adversely hits the developing nation, can be substantially increased if adequate green fodder supplies are available. The ordinary village cow can easily produce 50 percent more milk provided she is well fed on a balanced ration.

With the increase of irrigation facilities more and more land is being put under food grains due to the increasing population and thereafter come the economic crops. The area under fodder crops under such circumstances cannot be increased. The need is, to improve and grow such varieties and to follow such cultural practices by which farmers may get more fodder per unit area spread over a longer period. It can be implemented in the irrigated areas. Bajri (pearl millet having small grain) and Barseem (egyptian clover) offer an excellent example in this regard.

The fodder question in Hissar is largely one of economics. The majority of the farmers are peasant proprietors, each cultivating an area of a few acres, a minimum part of which is set aside for the cultivation of fodder crops. On an average, in Hissar, farmers till 8 to 10 acres, and devote nearly 10 per-cent of their holdings in kharif and 1 percent in rabi crop seasons to green fodder. An ordinary farmer keeps 5 to 6 head (two bullocks for ploughing the land, one buffalo for milk and the rest young stock to replace the working and milching stock). The average requirement of one head is 20 seers (41 lbs.) of green fodder per day. Thus the owner requires about 1004 maunds of green fodder per annum for his whole stock. This quantity of fodder, he can get by putting about 2 acres of land under fodder crops. It is only possible, if he cultivates the fodder crops with the equal care that he puts to other food and economic crops. The present proportion of the fodder acreage is half of the average requirement, thus the cattle in Hissar are undernourished. Any improvement in livestock can be followed by the improvement in fodder supply, as in the realm of animal husbandry better feeding is just as important a factor as better breeding.

The area under economic crops is increasing which is regrettable especially in a cattle breeding area of great fame in India, like Hissar. It would appear that canal water rates in Hissar and similar localities need a fantastic revision to discourage the cultivation of those commercial crops which yield no fodder on the irrigated lands adjacent to the rainfed areas to avoid fodder famine and in the cattle breeding tracts to improve the present lot.

It is suggested that the canal water rates should be much higher on economic crops and lower on fodder crops. It may help in increasing the area under green fodder.

Kharif fodder crops which are grown in the semi-arid tract of Hissar possess certain hardy characteristics, such as a small moisture requirement; a long sowing period, so as to take advantage of early or late rains; early maturity of the crops take advantage of the short monsoon period and produce ample fodder and grain in normal years and yield some fodder even when rains are scarce.

Guar (cluster bean) is the major green fodder in Hissar having 9·36 percent of the harvested area followed by chari and bajri (great millet and small pearl millet) covering 3·79 percent of the harvested area. The total share of the kharif green fodder is 13·15 percent and the rabi constitutes 0·99 percent. The rabi green fodder crops are: barseem (Egyptian clover), methy (Fenugreek), lusan (Alfalfa) and senji (Indian clover). The rabi green fodders require excessive moisture, but have threefold advantages: being legumes fix up the soil fertility, are more nutritive than the cereal green fodders, and give higher yields because of their three to four cuttings. The minimum ratio of the rabi fodders is due to the scarcity of moisture and the competition of food cereals for space. The guar is drought-resistant and is the only kharif legume green fodder. It has rich food value for livestock and is used for green manuring. The kharif fodder is used to feed livestock during summer and the rest is stacked for use during the following winters. It is chaffed and mixed with rabi green fodder for feeding the stock. The dry roughages of rabi cereals are used as a mixture with kharif/rabi green fodder up to the following harvest of the rabi food cereals. In the kharif period, the scarcity of green fodder is often experienced from May to June. However, with the adoption of new crops, improved varieties, and the technique of making silage, it is possible to bridge this gap. Non-leguminous crops like bajra, jowar, chari and bajri can be made into a good silage being less watery and having more sugar content.

Guar (Cyamposis psoralioides - Cluster bean)

Guar is an important fodder crop in the semi-arid districts of the Punjab. In the south and south-west areas of Hissar it is raised as a seed crop. Its seed and forage are highly nutritious cattle feed. Its seed is a cheap substitute for gram and is fed in winter as a valuable concentrate to livestock except horses. The seed also contains gum which is extracted commercially and is used in certain foods and in the paper and textile industries (Cobley, 1962). A guar factory is established at Bhiwani as a subsidiary to the cotton mills. The green pods are used for culinary purposes in the rainfed areas in human diet.

Being drought-resistant, guar can succeed where other crops fail. A mixture of guar and jowar is the most popular fodder crop both in the irrigated and rainfed areas to provide a highly balanced feed for cattle. Guar is used as green manure under irrigated conditions to restore the fecundity of the poor and depleted soil. It forms a better mulch of vegetative accumulation on the soil for holding back water that is of much value for the following crops.

Guar is adapted to hot and dry climate with limited moisture. It does not grow well under heavy rainfall. It is a highly reliable crop because of its adaptability to make good growth even under the worst climatic conditions. Guar grows well in all kinds of soils but well drained soils are necessary. It cannot stand waterlogging. No special preparation of land is required, except one or two ploughings. The crop needs very little care and is ready for forage within 2 to 3 months after sowing. The importance of guar in Hissar is considerable. The work on improving the crop is under way to evolve some high yielding varieties at the Fodder Research Station, Sirsa. Through breeding and improvement, varieties have been evolved having big leaves and bold seeds.

In the rainfed areas it is matured without irrigation (Fig. 156). In the old irrigated areas a high proportion of crop is irrigated to make a luxuriant vegetative growth for forage or green manuring. The areas of intensive irrigation having commercial stabilised-diversified farming can afford to irrigate guar as a green manure for economic crops and forage for stock. Seed crop is not irrigated.

Distribution (Fig. 155): The distribution of guar acreage can be analysed under four groups:

(i) Group of Higher Importance (over 15 percent): In the rain-fed areas of the south having light soil and meagre monsoon rainfall, guar becomes a catch seed crop. Bhiwani is a famous market in India for guar seed. The high proportion is because of suitable agro-climatic conditions and the lacking competition of rabi cereals.

(ii) Group of Above Average Importance (10 to 15 percent): This comprises the south-western sandy areas of Hissar. That of inadequate irrigation available for guar, it is recognised as a seed crop.

(iii) Group of Below Average Importance (5 to 9 percent): The major part of Hissar is covered by this category exclusive of the Nehri circle of Hansi tahsil. The intensity of irrigation is considerable and the soils are suitable for food cereals, thus guar is replaced by the economic and food crops. It is mostly grown for forage and green manuring.

(iv) Group of Low Importance (under 5 percent): In the Nehri circle of Hansi, the exceptionally high intensity of irrigation, the maximum importance of the food cereals, the economic and the green fodder crops, all combined, pull down the guar acreage. The greater proportion of guar is irrigated with the aim of luxuriant vegetative growth.

Other Fodders

Fig. 157 exhibits the combined acreage of kharif and rabi green fodders other than guar. It apparently reveals the exceptionally low importance of green fodders in the south and south-west due to the agro-climatic disadvantages. In Hansi tahsil these achieve some status (over 3 percent) because of the higher intensity of irrigation, importance of livestock in intensive, stabilised and diversified farming, and the rest of Hissar, falls in the range of minor significance. In the near future there is great scope for the improvement of acreage under green fodder in the newly colonized areas on account of the improved irrigational facilities, the large size of holdings and the influx of progressive farmers.

On the whole, the distribution of green fodder acreage is not in a balanced form over area and time in Hissar. The maximum acreage is in summer and it is below the requirement. Therefore, for maintaining the importance of Hissar as a breeding tract, practical actions are required to increase the area under fodder crops, to increase the yields, to introduce the high yielding varieties, to make good silage and to improve the stacking techniques for reducing wastage. No doubt the straw of the pulses generally contains more albuminoids than that of cereals, and it is on this account that it is more valuable as fodder. Little is known to the illiterate farmers about the relative nutritive values of different fodders in India. It is apparent from general observations that little has been remedied so far amongst the farmers to enlighten them about the utility of the different kinds of fodder. Before starting with the other practical actions, it is essential to improve the knowledge of the farmers about the nutritive values of the green and dry fodders within their reach.

CHAPTER 17

THE CROPPING PATTERN, THE RANKING OF CROPS AND THE CHANGES IN THE CROPPING PATTERN

By considering the important crops of Hissar, seven cropping pattern zones emerge (Fig. 158):

(1) A Gram-Wheat-Bajra-Jowar-Cotton zone covers the Nehri assessment circle of Hansi;

(2) A Gram-Bajra-Wheat-Cotton-Oilseeds zone embraces the Nehri assessment circles of Hissar and Fatehabad tahsils;

(3) A Gram-Bajra-Wheat-Oilseeds zone includes the flood plain;

(4) A Gram-Wheat-Bajra-Barley zone coincides with the Rohi assessment circle of Sirsa tahsil;

(5) A Gram-Bajra-Jowar-Wheat zone comprises the Barani assessment circle of Hansi, and the Haryana Sharqi and Garbi assessment circles of Bhiwani tahsils;

(6) A Bajra-Gram-Cluster Bean-Pulses zone covers the Bagar assessment circles of Bhiwani tahsil;

(7) A Gram-Bajra zone coincides with the Bagar assessment circles of the south-west.

In Hissar comparatively low value crops, like gram and bajra, account for 64 percent of the harvested area as against 32 percent of the Punjab as a whole. This cropping pattern is basically inferior and shows the limitations of moisture and soils. The comparable percentages of wheat and rice are nearly 10 percent and under 1 percent respectively of the harvested area in Hissar as against 22 and 3 percent for the Punjab as a whole. Oilseeds, cotton and sugar-cane cover the lower percentages of the harvested area, that is, 3·95, 3·50 and under 0·50 percent as against the overall Punjab figures of 6·3, 5·8 and 2·3 percent respectively. The regional variations in cropping are apparent because of variable agronomic and socio-economic conditions (Table 17.i):

Table 17.i

Cropping of the Various Crop-Belts of Hissar, 1951-61

(Percentage of area under different crops to the harvested area)

Crop Belts	Soil	Intensity of Irrigation	Gram and Bajra	Wheat and Rice	Cotton, Oilseeds and sugar-cane
1. Old Irrigated, East	Compact Loam	Above 60%	44·05	15·83	15·84
2. Old Irrigated, North-East	Loam	30 to 60%	53·35	5·83	15·12
3. Flood Plain	Clayey-Loam	30 to 45%	59·25	10·93	8·74
4. Rohi, North-West	Soft-Loam	15 to 30%	60·52	8·67	4·25
5. Old Irrigated, South-East	Loam	15 - 30%	58·82	6·58	2·98
6. Bagar Circles, South-West	Loamy Sand	Below 15%	85·38	1·31	0·74
7. Bagar Circles, South	Light Sandy	Nil	68·09	-	0·50
District Level			64	11	7·95
State Level			32%	25%	14·4%
Recommended Crop Pattern (Uppal, 1961)	Soft-Loam to Compact-Loam	62% (Perennial)	10·60	35·00	28·40

Several observations can be based on this table. The variability in cropping is basically due to variability in the intensity of irrigation. The higher the intensity of irrigation the lesser the area under gram-bajra and the greater that under superior food cereals and economic crops. Soil-texture is of foremost importance. In the light sandy soils inferior food grains predominate, and in the loams superior food cereals and economic crops gain status. On the whole, the cropping pattern of the various crop belts reveals its inferiority. Even in the areas where the required intensity of irrigation (62%) prevails, there is a wide gap between the existing cropping pattern and the recommended crop pattern. It is economically undesirable to waste the precious canal water, hence practical actions are needed to adjust the cropping pattern towards the recommendations.

With the development of irrigation new problems in the sphere of agriculture arise in Hissar. One of these is the changes in the cropping that are bound to come. In the ordinary course of events the changes would come about through hit and miss methods in the illiterate farm community. This takes a long time and results in a considerable wastage of valuable resources. It is therefore desirable to cut short this period of adjustment. It has importance both for the individual farm and the nation as a whole. Farm profits must be increased and the most efficient utilization of the nation's resources achieved. Extension services already have in the recommendations goals to work towards.

Cropping is also intimately related to the animal husbandry, which is a neglected part of the rural economy. At present the residue of the low value crops is used and it is thought good but it is neither enough nor nutritious enough. Hissar is in a stage of change. Thus there is an opportunity to increase the area under green fodders in the kharif and rabi crop seasons respectively from the existing 10 and 1 percent to the recommended level of 14 and 10 percent of the harvested area. The present rigidity in the cropping pattern can only be changed through drive and initiative in the countryside. There is a great leeway for upgrading the present cropping pattern in the areas where the intensity of irrigation is increasing and the volume of change in other variables like tenancy, land-use, population etc., is high.

Ranking of Crops

The distributional pattern of various crops has been analysed showing the areal status of individual crops and comparisons with others. The general areas where different crops dominate and the crop-acreage rank order can now be discussed. The relative status of various crops is made by ranking them for each assessment circle according to the percentage of the harvested area occupied by each crop. These percentages have been arrayed in a descending order for the individual areal component, thus obtaining crops from first to sixth ranks for studying together. The first to sixth ranking crops for each unit of Hissar, have been mapped in Figs. 159 to 164, bringing out the regional dominance of various crops in areal distribution. The distributional pattern becomes more fragmented when one proceeds to a portrayal of the third ranking crop in percentage strength in Hissar.

The First Ranking Crops

There are two crops in thefirst rank, gram and bajra (Fig.159).

Gram as a first ranking crop covers the sandy loams to clayey loams and bajra dominates in the sandy areas. Gram covers a greater area than bajra, the percentage strength varying from 28·19 to 60·49 percent. That of bajra varies from 34·89 to 46·03 percent. Bajra is a first ranking crop in the south because of the restrictive agro-climatic conditions for other crop production. The agro-climatic conditions are suitable for other crops and the only restrictive element is the deficiency of water supply.

The Second Ranking Crops

The simplicity still prevails in the map of second ranking crops, with a total of three crops involved (Fig. 160). The additional crop joining gram and bajra is wheat. Bajra covers a greater area. The percentage strength of bajra varies from 12·19 to 31·28 percent, gram from 20·95 to 30·18 percent and wheat from 8·67 to 14·54 percent. Numerically the position of gram as a second ranking crop is still superior to that of bajra. Wheat has become the second ranking crop in the Nehri circle of Hansi due to the higher intensity of irrigation and fertile loam; in the Rohi circle due to the well drained soft loam and the progressive farmers, and in the Nali circle of Hissar owing to the favourable growth conditions. Lastly the dietary habit of the cultivators has a strong hold in bringing wheat into the second rank.

The Third Ranking Crops

The number of crops has risen to six. The four additional crops besides bajra and wheat appearing on this map (Fig. 161) are: wheat-gram, guar, jowar and oilseeds. The areal coverage of guar is considerable and next in order of importance comes wheat. Still the importance of crops requiring less water is considerable. In the east bajra and jowar dominate in third position because of the dietary habit of the Hindu Jat farmers who relish these food cereals mixed with gram and wheat. Guar becomes a third ranking crop in the south and south-west, being a drought-resistant seed crop. In the north-west and north wheat and wheat-gram achieve a third rank status due to the favourable agronomic conditions, and the liking of the cultivators for wheat.

The Fourth Ranking Crops

The distributional pattern of fourth ranking crops is more fragmentary (Fig. 162). However, some interesting facts can be observed. Note firstly, the status of pulses in the south and south-west on account of sandy soil and moisture limitations. Secondly, wheat-gram mixture is prominent in the lower flood plain because of the availability of rice fields. Thirdly, wheat and cotton rank in the old irrigated areas due to the accessibility to moisture and fertile soil. Finally, guar ranks in the north-west owing to the limited moisture for other crops.

The Fifth and Sixth Ranking Crops

The number of crops in fifth and sixth ranking order is 7 and 8 respectively, with the addition of barley in the former and rice and fodder in the latter (Figs. 163 and 164). The distributional pattern is fragmentary and the crops are of minor importance.

The preceding discussion helps in arriving at some conclusions:

(i) Crops included up to the fourth rank are of great significance because of their share of above 5 percent of the annual harvest. Furthermore, the dominance of two to three crops - gram, bajra and wheat - is apparent up to second crop-rank order, exhibiting the areal specialization. Thereafter the fragmentary crop-rank acreage distribution reveals diversity rather than speciality.

(ii) The agro-climatic and cultural factors have the primary control in determining the status of the crops in Hissar, the others such as economic, technical and organizational influences are weak in their operation.

(iii) The rabi food cereals and food pulse dominate at the higher ranks over great areas.

(iv) In the kharif crop season bajra predominates and the other food cereal jowar enters the scene at third rank and the pulses at fourth rank. Cotton comes to fourth rank, that too with a limited areal and numerical dominance. The kharif food cereals are more important than the kharif economic crops. Sugar-cane is out of the picture.

(v) Green fodder enters at sixth rank. It shows the little attention paid to the livestock feed and the neglect of animal husbandry.

(vi) The persistence of millets can be observed in many parts due to the need to minimise the risk of crop failures against the bad seasons in dry areas.

On the whole, food cereals and food pulses have a considerable areal and percentage dominance over fibre and oilseed crops because of the low demanding nature of the former and the increasing pressure of people.

Changes in the Cropping Pattern

In Hissar the cropping pattern within the last decade has been changed, which is to be expected. The factors that influence the cropping pattern of any particular region are legion but the farmers in Hissar have made adjustments to twin developments, the intensification of irrigation and the marketing facilities.

During the post-irrigation period, agricultural potentials of the new canal colonies of Hissar have been tested afresh with new techniques and enterprising inmigrating farmers. Demands for a wide range of produce, supported by subsidies and prices, have encouraged the diverse and flexible farm economy and the adoption of successful new practices. Some of the greater fluctuations discernible over considerable areas of the district, may be related to the periods of adverse weather that are liable to disrupt normal cropping in the more exceptional years.

Hunger and new ideas are the two advocates of change which plead best in each other's company. Hunger makes men willing to act and the new ideas give them matter for enactment, relevant to the problem created by increasing population and less rapidly increasing supplies of available food. In Hissar the main shift is from the inferior food cereals to superior food cereals. The friable nature of soil and moisture limitations of Hissar are admirably suited to a shift from grain to grain. The majority of Hissar cultivators especially Bagri and Hindu Jats are well known for their indolent habits. A statement which can be justified by the fact that their main rabi crop is gram and their main kharif crop is bajra. Gram and bajra are the crops which require the least amount of care on the part of the cultivators, whereas wheat or other economic crops need a considerable attention. They have therefore carefully avoided the shift to cash crops requiring constant hard labour and care, like cotton, wheat, maize, rice and sugar-cane in the old irrigated areas where the agro-physical and the socio-economic variants permit these to be grown.

The considerations influencing the cropping pattern at the Macro-Level can be taken to be related to soil, climatic variations, development of markets and transport, and demand and supply situations. At Micro-Level the important considerations are those like farm size, tenancy, irrigation, net-return of crops and certain other considerations like food habits. Lastly, it is claimed that the food and fodder requirements of the farmers introduce a rigidity in the cropping pattern by fixing a limit to the area that can be spared for economic crops. These have a considerable hold on the cropping pattern in Hissar because of the small size of holdings over the greater part.

Volume of change (1951-56 to 1956-61) is calculated for individual crops in percentage for every component areal unit. These figures having positive and negative tendencies arrayed separately in a descending order for each unit. Having thus marked the crops of leading increase and leading decrease, these are mapped in each component unit (Figs. 165 and 166), providing a comparative view of the direction of swing. There have been a notable shift from inferior to superior food cereals and food pulse or from less remunerative to more remunerative crops. The crops of leading increase (Fig. 165) in order of importance are gram, wheat, oil-seeds and pulses. These are crops of superior quality and are more remunerative and nutritive than the kharif food cereals. The modern farmer, wants a cash income in his hand to buy improved implements and articles of convenience. The basic consideration before a farmer when he decides to grow a crop from a group of crops requiring the same geographical and economic conditions, is the economic gain. The food habits of the inmigrants are also responsible for this significant departure from the traditional pattern.

The crops suffering the largest relative decrease are bajra, barley and oilseeds (Fig. 166). In the south the increase of gram over bajra is partly due to the success of dry farming and economic gain and partly because of the normal conditions of the second quinquennium over the abnormalities of the first half of the 'fifties. Figs. 165 and 166 do exhibit the beginning of a tendency towards the reallocation of resources for the better utilization of soil and the canal waters. The change is not in a diversified form, that is, during the 1950's only three crops can be identified, viz., gram, wheat and pulses, having the largest percentage point increase; two crops, viz., bajra and barley suffering the largest relative decrease. The adaption and adjustment are gradual in relation to the changed conditions and are in the right direction.

The bajra crop suffered a relative decrease all over Hissar (Fig. 167). The decrease is considerable in the flood plain, the Nehri circle of Fatehabad and the dry sandy areas of the south. The decrease is small in the Rohi circle and the Nehri circle of Hissar tahsil where it was already an insignificant crop. The pattern of decrease directly corresponds to the pattern of the extension of irrigation, the growth of population and the variable rainfall conditions of 1951-56 to 1956-61.

The nature of change in gram (Fig. 168) is in a positive direction everywhere and the increase in gram acreage corresponds to a decrease in bajra. Thus the shift is from the kharif food cereal to the rabi food pulse, which is beneficial for a semi-arid area from an agronomic and economic viewpoint.

The positive and negative tendencies in the volume of change of wheat percentages may be observed (Fig. 169). In the south wheat acreage has undergone a change with a negative tendency because of the light soil and the limitation of moisture. The second area is the Rohi circle, where the acreage under wheat increased but the proportion to harvested area of 1956-61 declined compared to 1951-56. The interesting fact is that of the increase of irrigation at a comparatively slower pace than the increase in cultivated area, thus the maximum diversion was to gram. Elsewhere, wheat acreage increased with a positive trend but the percentage increase is small except on the lower flood plain where it is at a maximum due to the conversion of the seasonal canals into perennials, to the extension of new canals and to the inmigration of farmers having drive in their farming ways and wheat as their staple food.

The percentage of that harvested area which was involved in change among the first eight crops of Hissar for each component areal unit is compiled and mapped in Fig. 170. This map provides an overall comparative picture of the areas where the cropping pattern swing has been relatively dynamic, and where by contrast it has been relatively stable. After examining the map, it is noted that conditions of relative stability prevailed in the old irrigated areas and the south-west sandy areas, these being the areas of maximum and minimum agricultural potential respectively. The leading area of total crop emphasis shift is the lower flood plain, an outstanding area of change with an exceptionally high dynamic swing. The other areal units are in a state of semi-dynamism and the prominent areal units straddle the flood plain which are considered to be the potential agricultural areas of Hissar.

It is appropriate to give the final picture of the crop changes by a combinational pattern of increase and decrease (Fig.171). The summations of the volume of change of first six food cereal and food pulse crops, and the first two fibre and oilseed crops are utilized. Six convenient categories are selected showing all increase crops as a numerator and all decrease crops as a denominator in a simple fraction of identifying symbols: G stands for gram, W for wheat, P for pulses, J for jowar, Ba for barley, B for bajra, C for cotton and O for oilseeds. In numerator and denominator the symbols are arranged in order of considerable to minimum percentage volume of increase or decrease. The units having the increase and decrease crops of the same pattern are then laid off in a combinational behaviour of the similar shifts in crop associations. The symbols with a sign (+ or -) are inserted in blocks, they mean that in these areas the representative crops have displayed a relative increase (+) or decrease (-) in strength with deviation from the overall pattern.

The overall shift picture is from inferior cropping to superior cropping, but is also from grain to grain. In the flood plain, the old irrigated areas of Fatehabad and the Rohi circle, the shift is impressive, as the cotton and oilseeds are gaining importance. The position of cotton in the Nehri circle of Hansi has been weakened due to the increasing danger of waterlogging. In the Barani circle of Hansi on the other hand, the cotton has achieved strength due to the improvement in irrigation, marketing facilities, and the nearness to textile mills. In the Bagars of the south-west, pulses showed an increase owing to their remunerative value.

In summary, the change in cropping pattern has been motivated by the extention of irrigation, the increase in population, the improvement in dry farming techniques and the aptitude of farmers to earn cash. Though the change is on a right path, it still requires proper guidance from the experts to propagate and to expedite changes on planned lines.

CHAPTER 18

THE CROP COMBINATIONS

So far the individual crop geography has been studied. However, rarely does a crop assume a position approximating an absolute isolation. Crops in Hissar never occur in monoculture, but competition for space is observed in field crops. Moreover crops are grown in rotations which are necessary to keep the land in good health and tilth, to utilize the land resources and labour force more efficiently, and to use the precious canal water more economically. The exact crop combination indices will provide grounds for speculation about the contemporary rotational practices and the combinations practised by the farmers.

Crop combination regions are here delineated on the basis of the methods laid down by Weaver (1954b), Thomas (1964) and Coppock (1964). It has been observed that Weaver's technique fails to operate in the areal units where the share of several crops is quite close to each other. The use of other methods has been adopted whenever the need arose. The crop combination indices calculated in relation to standard combination values are appropriate because the accepted indices show least deviation from combination proportions.

Crop-Combination Regions, 1951-56 and 1956-61

The crop-combination indices of each areal unit, having been thus derived, the appropriate designations have been plotted on maps for the two quinquennia of the 'fifties. The grouping gives consideration to the status of crops as far as possible. The status of crops after two to three is not considered in a few instances, for example, the units with the crop combination indices of "B-G-P-C.B" or "B-G-C.B-P" are consolidated in the same crop-association region. Then it becomes feasible to attempt basic interpretative analysis regarding the sequence of changes that can be observed in the crop-combination maps especially in the changing status up to second and third-ranking crops. Otherwise, in most cases the ranking order is maintained.

In certain cases the minor crops assume a sufficient strength to be included in the crop-combination index. These occasional occurrences are to be accepted as a principle, but to avoid diversity of combinations leading to confusion, the primary and secondary crops are taken into account in displaying the basic regional distribution structure. The presence of minor crops has been shown by a separate symbol in the respective areal unit. The crop-combinations are marked from the first ten field crops, viz., gram, bajra, wheat, cluster-bean, jowar, oilseeds, cotton, pulses, barley and wheat-gram.

Figs. 172 to 175 are attempts to show the number of crops and the crop-associations in Hissar for 1951-56 and 1956-61. The features of these maps are not unexpected from the preceding analysis of individual crop distribution and changes. The rabi food cereals and food pulse predominate in the crop combinations. The discussion on the maps is, briefly, as follows:-

Fig. 172: Four regions have been derived. Two crops combination covers the Bagars of the south-west and the Barani circle in the north of Hissar. Three to four crops association includes the Bagars of the south in Bhiwani tahsil. The crops on the whole are drought-resistant so far, namely, bajra, gram, pulses

and guar. The above associations correspond to the light soils and the moisture-deficient areas. In the rest of the district, the number in combinations ranges from 5 to 7. These areas are identified with the canal irrigated and fertile loams. The former are the areas of speciality and the latter of diversity in farming.

Fig. 174: This shows the number of crops in crop-combinations of 1956-61. Two and three crops still dominate in the south and south-west. In the old irrigated areas of Hansi and the lower flood plain the number goes up to nine crops, and in the remaining parts it is ranging from 5 to 7. Farming is in a stage of stagnation in the south and south-west and in the remaining part of Hissar it is in a varying state of diversification.

Another pair of maps, Figs. 173 and 175, shows the crop-combination regions for 1951-56 and 1956-61 with 8 and 7 appropriate regions respectively. It is not surprising that in an area having diversity the technique should produce more than 7 different crop combinations. The assessment circles having the same crop-associations are grouped together under one region and mapped. B represents bajra, G gram, W wheat, Ba barley, J jowar, C cotton, C.B cluster bean, P pulses, O oilseeds, R rice, S sugar-cane and W/G wheat-gram mixture. The areas occupied by the different combinations are shown with a distinctive shading and each shade denotes a combination of symbols. The symbols of various crops in each crop-combination region are arranged in descending rank order as far as possible.

Fig. 173: A bajra-gram association is found in the south-west and the rainfed areas in the north. It is a region of crop

specialization. A bajra-gram-cluster bean-pulses combination occupies the areas dependent on rain in the south. It is a region specialising in drought-resistant crops. A bajra-gram-jowar-cluster bean grouping covers the Haryana West and East circles of Bhiwani and the Barani circle of Hansi. Wheat enters the combination in the Haryana East and Barani circles but is a crop of minor importance. The above-enumerated crop-combinations are the ideal examples of subsistence crop economy, with a high degree of specialization in the inferior drought-resistant crops.

A gram-bajra-wheat-cotton-jowar combination extends over the old irrigated areas of Hansi. This combination is noteworthy, having the dominance of superior food pulse and food cereal and a fibre crop. It is the outcome of recognisable variants, the considerable intensity of irrigation, the compact loam, the high density of population and the marketing facilities. Jowar enters the combination because of the dietary habit of the farmers. A gram-bajra-wheat-oilseeds-cluster bean association is outstanding in the upper flood plain. Superior food pulse and food cereal have the upper hand in the combination and oilseeds have achieved the fourth rank in order. The rabi crops are of great significance as they occupy three positions out of the first four positions in the combination due to the suitable agro-climatic variables.

The gram-bajra-cotton-oilseeds-wheat-cluster bean combination covers the Nehri circles of Hissar and Fatehabad tahsils, in the latter jowar is an additional crop because of the dietary habit of the Bishnoi farmers. A gram-bajra-wheat/gram-rice-wheat-oilseeds-cluster bean association covers the lower flood plain. Dominance of the rabi food and cash crops is due to the suitability for diversified farming based on favourable agronomic, economic and social variables. A gram-wheat-wheat/gram-barley-bajra-cluster bean-jowar combination is found in the Rohi circle. These last five regions have a considerable diversification in farming and the commercial crop economy prevails to a variable degree.

Fig. 175 does not require much explanation as it speaks for itself, when compared with Fig. 173. Although in the 1956-61 mapping, 7 crop combinations can be recognised having crops and numbers identical to 1951-56, certain changes can be observed in the status of crops which provide a clue to the impact of changing irrigation and socio-economic variables on the agrarian activities of Hissar during the 'fifties. Gram has become the first-ranking crop in the south and south-west of the district replacing bajra. Wheat has achieved the second status in the old irrigated areas of Hissar, Hansi and Fatehabad tahsils and the lower flood plain by replacing bajra. In the upper flood plain oilseeds attained second rank in place of bajra. In the south the area under pulses has been captured by gram and the latter succeeded in pulling out the pulses from the combination. The cotton has entered the combination and oilseeds have been pushed to a higher rank in the lower flood plain. In the Rohi circle barley has been pushed down in status and cotton has entered the crop association.

A comparison of Figs. 173 and 175 makes clear the vital matter: that the regional combinations of cropping are not static but are dynamic and are subject to recognizable changes, many of the reasons for which have already been given. Changes in crop combinations may be of help in predicting the future potentials of an area in respect to cropping and crop diversification. The simplest combinations are to be found in the south-west and south and the most complex in the areas having adequate moisture and productive soil.

In Figs. 176 and 177, an attempt has been made to ascertain the magnitude of variability of the crop-combination of the individual units from the mean. The regional pattern of crop-combination deviation from a theoretical base has achieved compactness in 1956-61.

Conclusion

Diversity and flexibility are especially advantageous under a system of planned agricultural economy, and they facilitate the maintenance of economic stability in the agrarian structure. The intensive, arable, irrigated farming areas with their assured markets and reliable returns have shown a tendency to greater diversity reinforced by new incentive. The crop diversification is in the sense that it obtains the maximum crops from the soil. The differential multiplicity of cropping in the areal units is partly the result of the interactions of the variable agro-climatic phenomena and partly the differential effect of economic and cultural forces. The considerable amount of crop diversity reveals the suitability of the area for a variety of crops and the extent of agricultural efficiency. In the areas of ideal conditions the efficiency is greatest and in the areas of handicaps, the efficiency of farm economy falls correspondingly.

The cultivation of crops occupies a dominant position in agriculture on account of the general absence of livestock enterprise. Further, the twelve months growing period permits the cultivation of a variety of crops adaptable to the different crop seasons.

The investigation of the crop combinations opens up a future line of analysis for the agricultural and irrigational planners, that is, to focus attention on the weaker parts. In these areas the crop diversity and agricultural efficiency could be considerably increased with the provision of adequate and assured water supply, improved varieties of seed, fertilizers, and with due attention to better tillage practices, to a balanced rotation of crops and to the practising of dry farming. Furthermore, the crop diversity will maintain the soil health and tilth and would enable the farmer to utilise his labour force economically. If the agricultural efficiency of the weaker parts of Hissar is brought to par with that of its strongholds, the food production of the region will be substantially augmented.

PART VI

LIVESTOCK AND ITS PLACE IN THE AGRICULTURAL ECONOMY

Introduction

Outside the farmers' family, there is nothing that fills so large a share of their thought as their holding and livestock. The importance of livestock in Indian agriculture is of great significance, as the land is of little use to the cultivator without the poor creatures that draw the plough. Therefore, in addition to crops, draught and milch cattle are raised and maintained by an individual farmer. They are his constant companions in the field by day, and live beside his house, or even under his roof, at night. But his treatment is not humane towards his livestock. The maintenance of the supply of livestock and their proper care and treatment closely affect the prosperity of the Indian cultivator.

Mixed farming is more valuable in an agrarian economy and it makes the farmer more progressive in his outlook on agriculture. He has to devote a sizeable part of his holding to fodder cultivation. He is supposed to set out a plan for getting a maximum yield from his fields and to select proper strains of better-yielding fodder. He gets an additional source of income with dairying. He can provide employment for other members of his family who are not fruitfully employed. The free labour of his family, his fallow land, the residue of crops and the village grazing land, go a long way towards reducing his expenditure during the lean period. He gets the draught force required for agricultural operations. He maintains a balanced diet for his family. He utilizes his farm-yard manure which increases soil fertility without any cash expenditure.

The decreasing acreage of grazing land is directly linked with the intensitifation of irrigation and the growing population pressure. Obviously, the pressure of livestock population on cropped land is increasing. Now it is an acute problem for the farmers to find acreage where their herds can graze freely, especially in the canal irrigated areas with their intensive farming. It is during the monsoon period that grasses grow in the fallow farmland left for the rabi crops. On such land the stock can graze only for a month or so because afterwards the ploughing cycle of dry farming begins. Therefore, for the major part of the year the stock is stall-fed on dry crop residues. The inadequacy of grazing resulted in demands on the land for cultivated fodder. The increasing pressure of human population on the holdings does not allow much spare land for green fodder, as has been already observed. Thus, the livestock not only in Hissar, but every where in India are undernourished - a present day problem taxing the planners and breeders.

The importance of animal husbandry in Hissar is evident from the fact that most of the crops are semi-fodder types which supply grain for man and fodder for beasts. Hissar is an important part of the "Haryana Breeding" tract of India. The physical features of Haryana constitute an ideal breeding ground. In the past its recognition as a breeding ground was due to the abundant grazing after rains, the dry climate, generally healthy, and the presence of lime in soil essential to bone formation of the young stock. Hissar as a breeding region is losing its significance because of canal irrigation, partly linked with the reclamation of the grazing lands and partly of its affect on climate. When canal irrigation begins the increase of moisture renders the climate less healthy, breeding becomes less and less successful and effective (Stow, 1910). Evidence contained in the reports shows that canal irrigation ruined the Montgomery breed or Sahiwal breed (now in Pakistan). In Hissar district, where the irrigated and unirrigated areas exist side by side, it may be found that cattle-breeding has shifted to the unirrigated areas except for the breeding of she-buffaloes. With the spread of cultivation and irrigation, therefore, cattle-breeding may become localised in the rainfed areas.

The livestock industry of Hissar is facing problems such as those accruing from the frequent fodder famines, the breaking up of the culturable wastelands for cultivation with the extension of irrigation, the promiscuous breeding and the religious prejudices make the elimination of useless oxen a sacrilege, and the eating of beef meat a sin.

Cattle breeding is not restricted to any particular section of the cultivators. Most of the farmers of the rainfed areas have adopted cattle breeding as their subsidiary occupation, carried on under traditional conditions. During field work, the general impression gathered is that Gujjars look after their cattle well and cattle trading is mainly conducted by them. Hindu Jats are renowned for raising excellent oxen stock.

The livestock figures for the years before 1930 should only be read generally as depicting tendencies. For the period before 1930 the livestock enumerations are very unreliable, for ordinarily, they are not synchronous, only being prepared for 25 percent of the villages of the district in any one year. 1930 saw the first all-India Livestock census carried out systematically by the revenue department. Since then they are conducted every five years, with a complete age, sex and category breakdown. Thus, the changes which are taking place after 1930 can be statistically measured and graphically represented for correlation with the controlling variables.

CHAPTER 19

LIVESTOCK: CHANGES, DISTRIBUTION, INTERESTS AND COMBINATIONS

The quinquennial changes of the cattle population bring out succinctly the effect of fodder famines. In the past famines were quite common in Hissar, owing to the erratic fluctuations of rainfall and their succession makes a sad picture in the livestock history of Hissar. Fig. 178 reveals two prominent features, viz:-

(i) The wide fluctuations in cattle population from census to census can be observed. These changes reflect the semi-arid nature of the area with its rainfed cultivation and adaptability of cattle breeding to such conditions. In good years, when rainfall is above average and well distributed, fodder and grass are abundant, the tendency is to keep more stock. On the other hand, these animals were sold in large numbers in years of scarcity at a very low price and a considerable number were moved to the nearby irrigated areas and the flood plains of the perennial rivers to tide over the hard times. A severe food grain famine was always accompanied by a very severe fodder famine, as the scarcity of the former involved still greater scarcity of the latter; if human beings suffered, cattle were bound to suffer. Thus, the unfortunate drought of 1935 to 1941 was disastrous in point of loss of cattle. By mortality, or sales or transfers, the cattle of the people were so reduced in numbers that the census of 1940 enumerated the fewest survivors during the present century - practically half of what they were five years earlier in 1935. Prior to the rapid extension and expansion of irrigation, the maximum number was in 1928, a year preceded by a number of good harvests. Since 1940 the cattle population increased significantly, in the beginning due to the transfer of the outmigrated stock linked with the absence of severe drought, and during the 1950's because of the improved availability of fodder.

(ii) Sheep and goat populations experienced least fluctuation. During the drought of 1935 to 1941, the number of sheep and goats recorded an increase. The hardy nature of these animals and the suitability of the rainfed areas for sheep and goat breeding, even during the years of fodder famine, is the reason. Declining sheep and goat population in later years is due to the decreasing grazing lands, the restrictions imposed on grazing by the forest department, and the increasing pressure of human population. Oxen, sheep and goats do not prefer stall-feeding, but like to roam about. On the other hand buffaloes prefer stall-feeding, and thus demand land set aside for fodder. The area under fodder crops can be set aside if there is a possibility of intensive cultivation, which in turn is linked with irrigation and low population pressure.

The Affect of Irrigation

Before the 1950's large herds of cattle were kept by landowners in the countryside and the flocks of sheep and goats were maintained by the menials. The grazing stretches were abundant, the question of real fodder famine only grew acute when rains failed for two to three years in succession. In the case of a severe famine, after fodder reserves had been exhausted, it was customary to move many herds and flocks to the areas where grazing lands were available. Of those that remained behind, many thousands died. Although every famine causes hardship and privation, the worst are those which occur in succession, such as the drought of 1927 to 1929 followed by the drought of 1936-41. With the spread of irrigation, the increase in the means of communication and the state famine relief measures, such disastrous results from food grain and fodder famines are never likely to recur. Thus, the period of 1951 to 53 was a drought duration, but did not hit the cattle population adversely. One would have imagined that with the increase of irrigation and arable farming, the livestock industry can achieve security and stability. Unfortunately this is not the case in Hissar. In the irrigated areas more importance is given to the superior cereals and the economic crops and little attention to the cattle breeding with a superior feeding. Cattle rearing is common in the rainfed areas where fodder famine is still of first rate importance and the scarcity can hit the people hard and the cattle harder, but not to the acute degree it did in the past.

The extension of irrigation is changing the cattle composition in many ways in Hissar (Table 19.i):

*Table 19.i

Year	Percentile Increase	Oxen				Buffaloes			
		Bulls	Bullocks	Cows	Calves	Males	Females	Calves	Total
1951		0·23	13·52	25·98	28·21	0·48	15·58	16·00	100·00%
1956	6·85	0·20	17·38	22·67	25·57	0·57	16·65	16·94	100·00%
1961	17·82	0·21	18·44	19·97	19·96	0·57	20·64	20·21	100·00%

The increase in total cattle population from 1951 to 1961 corresponds with the maximum extension of irrigation facilities in Hissar. The cropped area and the human population increased

* The source of all the tables in this section is the Revenue Department.

tremendously creating a considerable demand for the draught and milch stock, whilst irrigation blunted the edge of stock famine. The percentage of bullocks increased from 13·52 in 1951 to 18·44 in 1961 because of the increased intensity of cropping. The proportion of cows and calves declined due to the increasing importance of bullocks and the decreasing acreage of the grazing lands. The proportion of buffaloes changed positively because of the availability of fodder for stall-feeding and the increased demand for milk by the increasing rural and urban population. To some degree the influx of the enterprising farmers has initiated the increase of the high milk yielders. She-buffalo yields 1867 lbs. of milk as an average per annum, considerably higher than the corresponding figure 1026 lbs. per cow in the Punjab.

Not only can the changes in the cattle composition be observed but the cows to she-buffaloes ratio also alters (Table 19.ii):

Table 19.ii

The Number of She-Buffaloes per 100 cows, Hissar

Year	1920	1923	1928	1930	1935	1940	1951	1956	1961
She-buffaloes per 100 cows	61	64	68	71	75	71	60	74	103
Percentile Change		4·92	6·25	4·41	5·63	-5·33	-15·49	23·33	39·19

Since 1951 the number of she-buffaloes per 100 cows showed a rapid rise, due to the extension of irrigation and the breaking up of the wastelands. She-buffalo not only stand stall-feeding much better than the cow but also thrive on all kinds of coarse roughages, whereas the cow needs a certain amount of grazing and daily exercise.

In 1961 she-buffaloes outnumbered the cows, but the latter will continue to be in demand by the rural class because the male buffalo has not proved as useful a working animal as the bullock, as is evident from the sex-ratio of oxen and buffaloes for Hissar as a whole (Table 19.iii):

Table 19.iii

	1951	1961	Percentile Change
Oxen (cows per 1000 males)	1667	1168	-29·93
Buffaloes (females per 1000 males)	5102	5662	+10·98

The higher number of she-buffaloes per 1000 males is owing to the lower utility of males. Males are sold at an early age for slaughtering and there is excessive mortality amongst males compared to females because the latter are looked after well. The importance of a bull calf can be judged from a local proverb: When fortune favours a she-buffalo drops a heifer and a cow a bull calf. It does not end here but the housewife takes a greater care of she-buffalo as the producer of milk and fat which are her daily requirements; a cow is looked after well by the cultivator because she is the mother of a bullock. The females were kept within the breeding tract and the males were mostly sold to the adjacent prosperous agricultural areas of the Punjab. But in 1961 the number of cows decreased due to the reclamation of the wasteland and the greater need of bullocks for cultivation, bringing a decline in the male trade to the surrounding districts of the Punjab and an increased female trade to the urban centres of India like Delhi, Calcutta and Bombay.

Affect of Human Population

The farmer of Hissar is almost universally illiterate, therefore custom and tradition play an important part in his practices of animal husbandry. So far as cattle breeding is concerned he prefers to go on in the same way as his forefathers did, irrespective of the changes which are valuable from an economic point of view. All Hindus object to the slaughter of oxen, even when they become unfit. Oxen breeding is suffering from this religious taboo which is a hinderance in the weeding-out of undesirable stock. With a smaller and poorer acreage left for fodder, the problem of the standard of feeding and breeding are taxing the breeders.

Live-Stock Structure and Distribution

Table 19.iv

Live-Stock Classification, Hissar (percentage of total stock)

Year	Oxen	Buffaloes	Horses, etc.	Camels	Sheep and Goats
1951	42·81	20·19	2·16	5·84	28·45
1961	40·65	28·75	1·87	6·58	21·48
Percentile Change	8·52	62·71	-21·92	28·74	-27·19

The increase of oxen as a whole is small. The change in buffaloes is exceptionally rapid and is nearly eight times that of oxen. The increase is in she-buffaloes, being the high yielders of milk. The proportion of horses, etc. decreased due to the development of the mechanical means of transport. The number of camels increased significantly. These are used as draught animals for ploughing the sandy undulating stretches. During field work, at the time of the sowing of kharif crops, the maximum use of camels was observed in the rainfed areas. Sheep and goats observed a significant numerical decline owing to the restrictions imposed on grazing and lopping of the trees and the declining acreage under pastures.

In summary, it is evident that the livestock composition changed on expected lines in Hissar with the extension of irrigation and the growth of population. The changes are prominent in she-buffaloes for milching and oxen and camel as draught force for tilling. The peasants can add to their income markedly by organizing agriculture on a mixed farming basis. This would give additional food and employment throughout the year to the rural population.

Draught Force

Im Hissar draught force is essential for every agricultural operation on account of unmechanized farming. It is mainly confined to bullocks and camels. Their differential regional importance is linked with the soil and the intensity of irrigation. It is surprising to note that the male-buffalo is not used as a draught force. Although it has enough strength, its slow activity does not encourage its use in a semi-arid and hot climate, where it is essential to conserve the limited moisture from rain immediately. The bullock force provides efficient power in the irrigated areas whilst none can challenge the supremacy of camels in the light sands and soft loams of the rainfed areas.

Table 19.v

Draught Force, 1951 and 1961 (Percentage of total livestock units)

Tahsils	1951	1961	Camel Draught Force as percentage of total draught force 1951	1961
Sirsa	21·49	25·51	65·28	56·87
Fatehabad	22·54	27·97	40·85	33·10
Hissar	22·14	27·71	18·69	12·34
Hansi	23·74	27·76	1·11	1·14
Bhiwani	15·50	19·90	67·02	56·90

The percentage of draught force increased all over the district with the increasing demand on account of the increased cropped area. In Bhiwani tahsil draught force is comparatively low because of the absence of intensive farming and the prevalence of rainfed cultivation. The proportion of camel force is highest in Bhiwani and Sirsa tahsils owing to the extent of soft loams and sands. In Fatehabad camels have appreciable importance due to the rainfed cultivation in the south on the sandy soils. Elsewhere, camels are unimportant. There the farms can be effectively tilled with the bullocks because of their briskness and manoeuverability. On the whole, the proportion of camel force decreased because of the extension of irrigation, the closure of the forests and the reclamation of the grazing lands restricting the grazing limits. In irrigated farming none can compete with the performance of bullocks in ploughing.

In Hissar, there are 5 draught force head for every 100 acres of the cropped area. For the Punjab and India as a whole the figures are 14 and 22 respectively. The large area of ploughing under a yoke of draught force in Hissar is due to six things. Firstly, the bullocks are of superior quality with a considerable tilling strength; secondly, the soil is soft and easily workable over the greater part; thirdly, the force needed is less owing to the absence of intensive farming in the rainfed areas; fourthly, a single camel can do the job of two bullocks in the sandy tracts; fifthly, in the absence of well irrigation over a vast area there is no need of additional force to lift water, and finally, in the newly colonised areas the farmers having a suitable size of farm started mechanized farming, thereby reducing the burden on draught force.

Fig. 179 shows the density of draught force in Hissar per 100 acres of the cropped area and three blocks of varying density can be recognised:

(i) Areas of Low Density include the tahsil of Bhiwani. The low density is due to sandy soil, absence of well irrigation and irrigated farming, use of camel and the low land-use efficiency.

(ii) Areas of Average Density embrace the tahsil of Sirsa. The situation is improved with the increasing intensity of irrigation, the growth of population, the impact of the progressive inmigrants and the increasing efficiency of land-use.

(iii) Areas of High Density cover the tahsils of Fatehabad, Hissar and Hansi. In the flood plain the water is lifted from wells by the draught force, as also in Hansi. The soil is loam to clay loam, which requires more force to till and to conserve the moisture immediately. The holdings are small, and the water supply from canals is adequate, thus intensive cultivation is practised to sustain the dense population base.

Milch Cattle

A limited number of farms in Hissar specialise in dairying, but the majority of the cultivators keep one to two milch cattle according to their means, the size of holding and the nature of farming. It is combined with crop production as a necessity. The milch cattle in Hissar are cows and she-buffaloes.

The cow is not only the giver of milk but is the mother of a bullock too. She furnishes the necessary power for the tillage of the soil. Agriculture and raising of the food are so dependent on the efficiency of the cow that it is sometimes truely said that "No Cow, No Food". Indians have realized the usefulness of this animal from times immemorial. Thus, the cow has been playing, and will continue to play, a very important role in the agricultural economics of India. No wonder, therefore, that the protection and service of the cow is an article of faith and a part of religion with the Hindus. It was indeed considered to be the symbol of the nation's economic prosperity in the farm economy. With the ancients, the sentiment for the cow was an intimate aspect of their conception of life and religion. But as those old days have gone, so the attitude to the cow has been modified. What remains is only a symbol without spirit. It is an unfortunate change for the breeding tract of Hissar. It is harmful for an area where farming is dependent on bullock force.

Table 19.vi

Milch Cattle, Hissar: 1951 and 1961
(Percentage of the total Livestock)

Tahsils	1951	1961	She-buffaloes as percentage of the total milch cattle 1951	1961
Sirsa	12·78	14·67	36·67	48·86
Fatehabad	14·23	18·01	42·33	50·71
Hissar	16·62	19·72	40·30	52·05
Hansi	17·69	17·27	43·60	58·08
Bhiwani	18·85	19·85	21·06	32·48

The proportion of milch stock increased in the newly-irrigated areas, the percentage is static in the old irrigated areas and increased less significantly in the rainfed areas. Furthermore, the trends correspond with the decennial change of human population. The percentage of the she-buffaloes increased all over the district over the decade. The she-buffalo is the most splendid and highly-prized milch animal in the Punjab. It is an animal of tough nature and is easily adaptable to stall-feeding. The quality of milch cattle in Hissar is much superior to the national level: average annual yield of milk per buffalo in Hissar is 1867 lbs. (India, 1117 lbs.); a cow's average is 1026 lbs. (India 382 lbs.) but the production is unsatisfactory when compared with the standard of European countries (6000 to 7000 lbs.). It is difficult for the landless class or the farmers of rainfed areas to keep she-buffaloes on account of their considerable requirement of fodder and concentrates for a good milk yield.

Cows are decreasing in numbers because of the drastic changes in the land-use and the conversion of pasture lands to the arable fields. The primary aim in keeping a cow is to procure and replace draught force when the need arises. Its position as a milch cattle is secondary. Although the cow is being replaced by the she-buffalo for milk in the canal irrigated farms, in Bhiwani the cow still dominates owing to the rainfed cultivation.

The density of milch cattle in Hissar varies from 5 to 8 per 100 acres of the harvested area (Fig. 180). The density is high in Bhiwani tahsil.

Milk Production

Numerically, Hissar possesses the largest number of milch cattle. Thus the district may be thought to have a good quantity of milk; but this is not so. The number of milch cattle per 1000 persons is given below for Hissar, Punjab and India (1961) (Table 19.vii):

Table 19.vii

Milch Stock	Sirsa	Fate-habad	Hissar	Hansi	Bhiwani	District Average.	Punjab	India
Cows	59	65	63	50	81	64	54	51
She-Buffaloes	56	69	69	74	39	61	66	30

Hissar has a favourable position in the per capita daily milk production when compared with India as a whole, but when put with the foreign countries, only a sixth or an eighth as high. The per capita daily output on an average for Hissar comes to 8 ounces, as against the national level of 4 ounces. The area has a superior quality of milch breed, the maximum yielders in India and in most of the part she-buffaloes exceed cows, thus there is an overall higher production of milk. There is a significant gap in per capita milk output within Hissar as between 1951 and 1961 (Table 19.viii):

Table 19.viii

Per Capita Daily Production of Milk in Hissar (ounces)

Year	Sirsa	Fatehabad	Hissar	Hansi	Bhiwani	District Average
1951	8	10·7	14·4	9·3	8	10
1961	7·2	8·8	8·8	7·7	6·9	8
Percentile Decrease	10·0	17·76	38·89	17·20	13·75	20·00

It is evident that the position of milch stock is unsatisfactory. It has not kept pace with the increasing population and the changing activities of farming in Hissar. According to the present day dietary standards the quantity of milk required for satisfactory maintenance of health should be at least 16 ounces per head per day (Indian Council of Medical Research, New Delhi). The output of milk in Hissar would, therefore, need to be doubled to meet even the minimum recommended requirements. Therefore, the implementation of changes in the animal husbandry of Hissar is to be sought. Thought is needed to save a cattle breeding area from future deterioration and to make some practical improvements to raise the existing milk production. The excessive export of milch stock is primarily responsible for the present deterioration of the situation. The younger calves which leave the area with milch stock are not replaced within the zone and do not come back. An important feature of the cattle rearing is the confinement of breeds to their home tracts. This is necessary to improve the quality of production with intensive multiplication of breed characteristics and intensification of performance capacity. A breed of the semi-arid zone may not thrive in an altogether different environment to which it is sent at present, like Calcutta, Bombay and Delhi. Any shifting of the nucleus stock from its original home may prove a permanent loss and is a short sighted policy on the part of the traders and the state officials. Cattle marketing is, therefore, a delicate task, as any large scale injudicious trading may do more harm on the production side than the benefit derived at the destination end. Thus priority might well be given to implement legislation restricting the movement of the Haryana breed to unfavourable environments. Only then can the other improvements bear fruit to maintain the initial momentum of cattle breeding in Hissar.

Goats and Sheep

Goats and sheep population is said to have been least affected by fodder famine and seems even to have made steady progress in the years of distress. From the food-consuming point of view the goat is the most economic of all milk producing animals. It is very prolific and very cheaply reared (Stewart, 1926). Kidding twice in fourteen months is common, as is also the birth of twins and triplets. The high fertility guarantees an assured income to the rearer (Randhawa, 1958). Goats eat the class of fodder which the cow and sheep will not touch and thrive where the latter starve to death. The breeders do not incur any expense on feeding goats and sheep as they have free access to common lands, village fallows and harvested areas. These stock are largely maintained on the reckless chopping of the trees. The closure of the forests and the breaking up of the commonlands resulted in a decline in sheep and goats population during the 'fifties (Table 19.ix):

Table 19.ix

Sheep and Goats as a Percentage of Total Livestock, 1951 and 1961

Tahsils	Sheep		Goats	
	1951	1961	1951	1961
Sirsa	19·84	14·26	20·50	13·30
Fatehabad	20·02	10·84	15·80	8·78
Hissar	14·50	11·26	12·88	7·80
Hansi	10·37	6·35	10·91	5·32
Bhiwani	9·29	11·88	10·53	12·80

The rainfed areas of Bhiwani had a slight increase because of the availability of the grazing lands and the least extension of irrigation. Elsewhere the ratio declined in varying degrees depending on the decreasing acreage of the pasturelands related to the extending irrigation facilities.

It can be inferred that sheep and goat rearing as practised today has no place in the dynamic agricultural economy of Hissar. The only way left is to rear the stock under stall-fed conditions. The goat as a milch animal is essential because it is a cow of the poor landless class and makes milk within his access at low cost. The cultivators rear a few for meat. It is desirable to evolve breeds which can adjust to stall-feeding. In a semi-arid region goat breeding is profitable as compared to other breeds of animals on account of the low cost of maintenance, hardy nature and a variety of products obtained from them which can be testified with a local saying:

Camel breeders are ever bankrupt;
Buffalo breeders half so;
Cow breeders just get by;
So keep goats and prosper.

Density of Livestock

The raising of livestock in Hissar ranges from small animals like goats to big animals like camels. Obviously, the forage requirements of these differ. Furthermore, the keeping of livestock is most important in association with crops in an agricultural economy because of the necessity of draught and milch stock. Total livestock pressure cannot be measured with the help of absolute numbers, as these are not standard units. The various categories of livestock are not enumerated in a standard unit having the same food requirement. Thus to analyse the pressure of livestock in a specific way the animal feed unit is used as a base (evolved by the U.S. Department of Agricultural Economics, and used by Weaver, 1956). With this as a base various classifications of livestock have been converted into one standard unit of livestock referred as a "livestock unit". Due weight is given to matured and young stock for their differential forage requirements (Fig. 181).

Within the mapped region the density varies from under 20 to over 25 according to the variable carrying capacity of land which is attributed to, the availability of grazing lands and fodder, the size of holdings, the density of population, the requirements and traits of the farmers and the suitability of the area. On an average there are 23 livestock units per 100 harvested acres. Livestock units numbered 795,826 in 1961 compared to 630,530 in 1951. The increase is primarily because of the increase in the number of buffaloes and bullocks. The increase is 26·22 percent, which is comparatively low compared with the increase in harvested area (67·68 percent) and population (47·84 percent) for the same period. A detailed interpretation of the Fig. 181 is made under three categories of variable pressure, viz:-

(i) Areas of High Concentration: These include Hissar and Hansi tahsils, with a pressure of over 25 units. The concentration is high due to the availability of fodder, the small size of holdings, the high density of population, the adequate irrigational facilities and intensive farming. A large draught force is required to plough the compact loams and to carry out intensive farming; milch stock are demanded to provide the milk and fat requirements of the dense population; lastly, momentum is there because it is a part of the long-established, important breeding area of India.

(ii) Areas of Moderate Concentration: These cover the tahsils of Sirsa and Fatehabad. The pressure varies from 20 to 25 units and corresponds to the district average. This region has potentials for the development of the animal husbandry on account of the expanding irrigation and the ingression of the enterprising farmers.

(iii) Area of Low Concentration: This comprises Bhiwani tahsil. A major part of the area is rainfed, soil is sandy, the cropping pattern is inferior and population density is low. Further, the large percentage of goats and sheep pulls down the weighting by livestock units.

Changes in Livestock Pressure

Fig. 182 shows the overall decrease in livestock units in 1961 as per 1951. The range of decrease varies from 1 to 20 units per 100 harvested acres. The negative tendency is primarily due to the rapid increase in the harvested area and the decrease in the acreage of grazing lands. Secondarily, the increasing population pressure at a faster rate did not encourage the farmers to spare land for fodder crops. Although the livestock units increased yet the increase in number did not correspond to the increasing land-carrying capacity. Further, it is kept down everywhere because of the declining importance of cows, sheep and goats. Three categories of differential absolute decrease are recognisable:-

(i) Very low decrease is observed in Hansi tahsil.

(ii) Moderate decrease is noticed in Fatehabad and Sirsa tahsils.

(iii) Considerable decrease in livestock units has been seen in the tahsils of Hissar and Bhiwani.

Interests: Concentration on Livestock Types

The individual concentration of livestock types can be viewed within the total livestock units relating to farming. The three major livestock categories which are the chief source of draught and milch stock are mapped in Figs. 183, 184 and 185, showing the proportions of their units to the total livestock units in 1961. These maps summarize many points already made.

The concentration of horses is more conspicuous in Hansi (4·40 percent) due to the availability of green fodder and the cavalry traits of the Rajputs. In the rest of the area, the proportion varies from 1 to 2 percent.

Changes in the Density of Livestock Units

The volume of change in the concentration of livestock units, in Hissar from 1951 to 1961 is as (Table 19.x):

Table 19.x

(Figures as percentages)

Tahsils	Oxen	Buffaloes	Camels	Sheep	Goats
Sirsa	-3·58	6·20	1·44	-1·75	-2·59
Fatehabad	-0·05	7·46	0·05	-2·53	-1·95
Hissar	-3·49	7·21	-1·57	-0·96	-1·29
Hansi	-7·09	6·71	-0·27	-0·76	-1·25
Bhiwani	-3·11	10·14	2·79	-0·79	0·74

The pressure of oxen decreased over the whole of the district with the extension of irrigation and the restriction of grazing lands. The pressure of buffaloes increased with the increase of irrigation, the availability of roughage for stall-feeding, the influence of in-migrated farmers and the growth of population. The pressure of camel units has not changed so prominently. The pressure of sheep and goats is declining.

Livestock Combinations

The farmers keep several types of livestock for their various purposes. It is a common practice to keep many types rather than a single type. Thus the concentration on a single class of livestock is not common (cf. Figs. 183, 184 and 185). To establish the significance of livestock categories in concentration, the livestock combinations are ascertained. These are mapped in Fig. 186 where O means oxen, B buffalo and C camel. The livestock combination is thus exhibited, without changing the ranking, identity and the number of livestock classification in each areal unit. Three empirical regions can be identified:-

(i) Oxen-Buffalo livestock combination is found in Hansi and Hissar tahsils. These are the old irrigated areas where the draught force and milch cattle are of great significance because of the intensive farming, the small size of holdings, the high density of population and the maximum degree of urbanization. The draught force is derived from the oxen and the milch stock primarily from she-buffaloes and secondarily from cows. It is one of the representative parts of the famous breeding tract of India known as "Haryana".

(ii) Oxen-Buffalo-Camel livestock association includes Fatehabad tahsil. The camel is an additional animal at third rank due to its splendid utility as a draught force in the sandy areas. The importance of oxen and buffaloes is recognizable in the irrigated areas.

(iii) Oxen-Camel-Buffalo livestock grouping covers the tahsils of Sirsa and Bhiwani. The camel is a second ranking stock owing to the expanses of the sandy, undulating fields, which can be managed efficiently and economically with a camel plough. Furthermore, it can graze well on the delicate offshoots of the wild trees standing in the farm.

One interesting feature of all the combinations is the first rank strength of oxen everywhere on account of the scarcity of the fodder for stall-fed stock and the utility of bullocks in ploughing the small-sized holdings. The cow is going to lose ground but not the bullocks, which are sure to gain importance with the intensification of irrigation and farming. Thus, the oxen are going to maintain their first rank status.

The comparability of livestock combinations of 1951 and 1961 revealed no change in combinations. Understandably, the combination pattern is simple. The notable feature is the negative percentile change in the standard deviation from the mean in 1961 as per 1951:

Percentile Decrease in Standard Deviation, 1951 to 1961

	Sirsa	Fatehabad	Hissar	Hansi	Bhiwani
Percentile Decrease	10·59	7·34	31·08	40·13	12·18

The overall decrease in standard deviation signifies that the first ranking stock is losing its strength and the second ranking and the third ranking are coming up. The decrease is more prominent in Hansi and Hissar which are included in the Oxen-Buffalo combination. In these areas milch buffaloes are gaining importance because of the stimulant environments created by irrigation, cropping and the market of local towns and the great market of Delhi. In the rest of the areas the decrease is less conspicuous, but in the near future the change may be hoped for in Sirsa and Fatehabad.

Conclusion

From the foregoing analysis of the livestock it becomes evident that the changes are directly associated with the changes in land-use, irrigation and population. The distributions of various livestock categories are related to farming, soil, cropping, size of the holding and traits of the farmers.

In Hissar moderate human population pressure in the canal irrigated areas necessitates the development of an intensive system of mixed farming combined with dairying. This is, however, impossible to achieve until and unless the peasantry revise their present attitude towards the maintenance of superfluous, and uneconomical stock. The incentive is lacking; proper guidance and restrictions on indiscriminate export from the home tract are needed. There are opportunities to make big improvements, as is evident from the changing livestock structure in 1951 and 1961.

PART VII

CONCLUSION

CHAPTER 20

THE AGRICULTURAL REGIONS AND THEIR FUTURE

The determination of areas of homogeneity inevitably must come late in an investigation. Only after an ample and sound body of data has been gathered, and the significant relations between various categories of data have been ascertained, can the important or essential homogeneities of areas be determined. And only after such homogeneities have been established can boundaries of areas of homogeneities be drawn with any approach to precision (Wellington, 1934). The account so far of the agricultural geography of Hissar has been based on the survey of the revenue assessment units. Physical and human controls, irrigation, land-use, land ownership and tenure, size of holdings, harvested land occupancy, ranking of crops, crop associations and finally livestock have all been treated in their various aspects. It now remains to integrate these facts for formulating agricultural regions having variable agronomic, economic and demographic problems and differential farming features and potentials. Because of the uniformly heavy reliance upon agriculture, the delineation of agricultural regions of Hissar is needed for future planning and orientation of farming on the right lines with the changing farm controls. The comprehensive analysis of each would help the planners to plan the rural economic progress systematically based on past experiences and to marry the potentials with performances effectively bearing good results.

The agriculture of Hissar exhibits the complete list of commercial and subsistence farm products, from the wheat-oilseeds-cotton in the irrigated areas and the bajra in the rainfed areas, through the extensive cultivation of gram in the south-west and the changing cropping pattern of the newly colonised areas to the stabilised diversified cropping pattern of the old irrigated areas. In Hissar lie the interesting examples of modern and traditional land-use. Hissar in contrast to the old irrigated districts of the Punjab, represents in its entirety an area in which agriculture is in a state of change. In only a limited area agriculture has attained the permanency of that in more densely populated and intensively irrigated areas of the east. Furthermore, the susceptibility of the rainfed areas to the dry-farming techniques is worth mentioning initiating a swing in the cropping on a small scale. In the south farming is of subsistence nature because of the dependence on rain. In the Bhakra canal irrigated areas, the extension of irrigation, the growth of population and the ingression of the progressive farmers have brought about a strong influence in the establishment of new crops, methods of farming and the structure of livestock. Still the low frequency of double cropping and the high percentage of fallow land cannot fail to impress any one acquainted with agriculture in India which itself is a sign of the low level of farming. The only way to raise the level of farming in the first instance is to increase and assure a regular water supply to ensure the maturity of the cropped area, to decrease the intensity of fallowing and to increase the intensity of cropping in accordance with the problems and potentials of the agricultural regions.

Although in general Hissar has extraordinary uniformity in relief and climatic conditions as to favour the production of the same major crops and kinds of livestock throughout the area, yet striking diversity in farming within the boundaries of Hissar can be observed. Accordingly it is difficult to put Hissar as a whole under one agricultural region, but agriculturally it is heterogeneous in itself. The variable growth of population pressing upon the land for food supply, the variable soil capabilities, the intensity of irrigation, the habits and traits of the farmers and the wealth of first hand statistical information make it possible to have more definite delineation of agricultural regions on a uniform statistical basis. The fundamentals for demarcating the integrated and more comprehensive agricultural regions are the identical zones having a similar degree of suitability for irrigated farming, soils, intensity of irrigation, economic density, growth of population, number of crops and crop combinations. Obviously the basis of classification sought is objective and quantitative based on the regional types of farming derived through statistical values, taking into account the various agricultural determinants. The demarcation of the agricultural regions of Hissar as shown in Fig. 187 is based on six grade criteria (Table 20.i, p.310a):

Table 20.i

Classification of Hissar in Agricultural Regions

Sr.No.	Region and Area	Suitability for Irrigated Farming	Soil	Intensity of Irrigation in Percentage (Average, 1956-61)	Economic Density per standard sq. mile of net area sown for 1961	Growth of Rural Population 1951-1961 percent	Crop combinations and Number of Crops in each group 1956-1961
		Criteria used for the delineation of the Regions					
1.	Region of Summer Cropping (Rainfed Area of South)	Low	Sandy	Negligible (0)	Exceptionally High (1105)	Very low (29·48)	G,B,C.B (3)
2.	Region of double-cropping of Gram and Bajra (Rain-fed area of south-west)	Moderate	Loamy Sand	Exceptionally Low (10·04)	Very High (794)	Low (37·73)	G,B (2)
3.	Region of Winter Cropping (Rohi)	High to Exceptionally High	Sandy loam	Very low (20·24)	Very low (515)	High (56·35)	G,W,C.B,B,W/G,C (6)
4.	Region of Change (Upper Flood Plain)	High	Silty Clayey Loam	Low (28·85)	High (668)	Exceptionally High (113·86)	G,O,B,W,C.B (5)
5.	Region of Change (Lower Flood Plain)	Moderate to High	Silty Clayey Loam	Moderate (39·06)	Exceptionally Low (462)	Very High (73·84)	G,W,O,B,C.B,R,W/G,J,C (9)
6.	Region of Diversified Farming (Old Irrigated areas of east)	Moderate to High	Sandy loam and loam	High (48·48	Moderate (620)	Average (47·23)	G,W,B,J,C,C.B,O (7)
7.	Region of Stabilized and Diversified Commercial Farming (Old Irrigated areas of Hansi)	Exceptionally High	Compact loam	Very High (65·50)	Low (582)	Very Low (31·01)	G,W,B,J,C,C.B,S,W/G (8)

G stands for gram, B for bajra, W for wheat, C for cotton, J for jowar, C.B. for cluster bean, R for rice, O for oilseed, S for sugar-cane and W/G for wheat/gram mixture

A sample of 88 villages (Fig. 187) based on a systematic grid pattern of 7 x 7 miles, has been drawn representing the seven agricultural regions. The land-population proportion and the intercensal growth of population of sample villages in relation to regional growth establishes the validity of sampling (Table 20.ii):

Table 20.ii

Regions	Sample area as percentage of total area	Sample population as percentage of the total population	Percentage Increase of total population 1951 to 61	Percentage Increase of total population in the sample villages 1951 to 61
1. Region of Summer Cropping:	7·26	8·22	29·48	29·98
2. Region of double-cropping of Gram and Bajra:	17·56	18·80	37·73	37·04
3. Region of Winter Cropping:	8·80	9·14	56·35	49·21
4. Region of Change (upper flood plain):	7·83	7·52	113·86	113·10
5. Region of Change (lower flood plain):	7·93	8·96	73·84	78·21
6. Region of Diversified Farming:	9·27	9·55	47·23	42·37
7. Region of Stabilized and Diversified Commercial Farming:	11·36	11·34	31·01	29·76

The agricultural returns of the sample villages have been combined for the representative agricultural regions for graphical representation (Figs. 188 to 194). These diagrams portray the trends of seasonal rainfall (Fig. 188-A), land-use, seasonal irrigation, intensity of cropping, seasonal cropping, seasonal harvesting and cropping pattern extending over a period of 12 years, that is, 1950-51 to 1961-62. The interpretation of graphs will show that there is a fairly general agreement in the changes of land occupancy primarily with rainfall fluctuations and secondarily with the changes in irrigation, population and the techniques of farming. These graphs also exhibit the crop diversity or specialization and the changing cropping pattern from a considerable to negligible degree. The study is arrayed in an order running from region of minimum exploitation and potentials to a region of maximum exploitation and stability.

1. Region of Summer Cropping

The region of summer cropping embraces the Bagars of Bhiwani tahsil. The sowing of summer crops is done on an extensive scale. The physical features are the main handicaps for the extension of free flow irrigation or well irrigation. The physical and agro-climatic conditions are favourable for raising the inferior summer food cereals and pulses. The land-use is directly controlled by rainfall, the land accessibility, the soil capability, the techniques of dry farming and the human controls. The complete absence of irrigation is worth mentioning.

Land-Use: From Fig. 188-B an idea can be formed of the pattern of land-use since 1950-51. Cultivated area increased at a very low rate because of the limited acreage of culturable waste-land. Very high population pressure on cultivated land left little scope for the culturable land to be wasteland. The acreage of land not available for agriculture is static. It means there is no addition of permanent structures like canals, buildings and roads etc. Any extension in the acreage of non-agricultural land is an indicator of economic prosperity provided the land is not rendered waste by waterlogging or drifting sands. Current fallowing has steadiness in its percentage except the year 1951-52 when it was maximum coinciding with the drought year. The net-area sown has shown least fluctuation due to secured farming with the drought-resistant crops sown by using the dry farming cycle of ploughing except for 1951-52 which was a year of distress.

Cropping (Fig. 188-C): It will be interesting to survey the intensity of cropping and seasonal cropping. These will indicate if any progress has been made towards increasing the productivity and improving the economic efficiency of farming in the rainfed areas. In the beginning of the 'fifties the double-cropped acreage was very small. This is mainly due to the fact that the whole of the cultivation is dependent on untrustworthy low rainfall based on traditional methods of farming. In the later three quarters of the period it is moderate showing an improvement in the regional productivity owing to the normal rains and the adoption of new farming techniques. The percentage distribution of the cropped area under kharif and rabi crops exhibited great change, that is, the conversion of summer cropped area under inferior food cereals and pulses to the winter cropping of food pulse. Still the low percentage under rabi crops alternates with the high acreage under kharif because of the congenial conditions for bajra, pulses and guar husbandry.

Harvesting (Fig. 188-D): Much of the capital invested and labour input are wasted every year through crop failures. When the climatic conditions are favourable at the sowing time, seed is put in the soil, operating day and night covering large areas. However, it happens almost every year that the rainfed areas do not get favourable conditions during the growth period of the crops, particularly at the flowering and ripening stages resulting in outright failures. Thus these areas are the maximum sufferers. The whole of the cropped area never matures due to the highly unreliable rainfall. The fluctuations in seasonal harvesting correspond to the seasonal rainfall. On the whole the conditions of maturity are improved. The increased maturity of the winter cropping is more pronounced. The increase in the percentage maturity of crops as brought about by the dry farming facilities reflects a good deal on the economy of the holdings in bringing an economic security.

Cropping Pattern: Fig. 188-E reveals that an extensive acreage is under the kharif crops. The cultivated area is largely devoted to the drought-resistant crops such as bajra, pulses, guar and gram. Crops requiring copious water and fertile soil are markedly absent. The extensive cultivation of summer food cereals, food pulses and seed crop is practised on account of the limitations for winter crops. The consistency in the acreage of pulses and guar on the one hand and the transfer of bajra acreage to gram on the other are the conspicuous features. The commercial crop is gaining importance. The farmers are steering their cropping with the changing prices and the success of dry farming. Still there are great potentials in this region to implement changes in cropping with the help of planned dry farming methods and the drought-resistant strains of seeds.

2. Region of double-cropping of Gram and Bajra

In the south-west of Hissar lies the sandy undulating area in which two crop combination predominates, that is, bajra in kharif and gram in rabi. There prevails a biannual monoculture as in each crop season single crop specialisation is the main feature.

Land-Use (Fig. 189-A): Cultivated area increased at a minimum rate with the corresponding decline in the culturable wasteland. Some of the area has passed to the unculturable waste for constructional purposes. Maximum acreage of the cultivated area was left fallow during the drought year of 1951-52. Afterward, the intensity of current fallowing declined because of the extension of irrigation and favourable rainfall conditions with the corresponding increases in the net area sown.

Irrigation (Fig. 189-B): A synopsis of the extent to which the cropped acreage has been irrigated and at what rate it changed, reveals that irrigation made good progress during the late 'fifties. The irrigation is more in winter because of the low duty of the winter crops and the low rate of evaporation. Still there is considerable scope for the extension of irrigation.

Cropping (Fig. 189-C): The intensity of cropping increased due to improvements in the farm controls. The percentage of seasonal cropping is showing a change from subsistence to cash earning farm economy owing to the swing from bajra to gram acreage. The shift is prominent which is a sign of economic prosperity. It gives a clue for further improvement in this direction to take immediate advantage of the situation.

Harvesting (Fig. 189-D): The areal maturity of crops increased in both the seasons. It reflects a good deal on the economy of the holdings as it brings a secured return for the input of manual labour and the bullock force as well as seeds and manures used on the crops.

Cropping Pattern (Fig. 189-E): The two crop predominance has been observed, thus the use of the cropped land is a simple one. The area under gram is increasing with a corresponding decrease in bajra acreage. Some of the acreage is coming under wheat which is the direct influence of irrigation. Still there is significant scope for bringing a change in the cropping pattern with the help of increased water allowance. In the near future it may be hoped that the vast potentials of this region may help to increase the agricultural productivity through proper planning and orientation of irrigation into farming.

3. Region of Winter Cropping

In the soft loams of the north-west of Hissar, the sowing of rabi crops is practised on a conspicuous scale. There lie the wide "tals" of the abandoned beds of the old streams which provide silt stretches for farming. On the confines of deserted streams lie the undulating fields. The extension of irrigation provided an initiative to the hard working Jat sikh farmers to level their fields for irrigation.

Land-Use (Fig. 190-A): Land-use remained steady, showing minimum changes in cultivated area, non-agricultural land and the culturable wasteland. Current fallow percentage showed an immediate fall after 1952-53 portraying the impact of irrigation, normal rains and orientated techniques of farming. The 1952-53 was a period of maximum proportion of current fallow because of the complete failure of winter falls (cf. Figs. 188-A and 190-A).

Irrigation (Fig. 190-B): The canal irrigated area in the beginning of the 'fifties was low when compared with the corresponding picture during the early 'sixties. The canal irrigated proportion is steadily increasing with more water allowance in summer. The region has a future for cotton cultivation.

Cropping (Fig. 190-C): The intensity of cropping is low. The increase can be observed in the second half of the 'fifties and the early 'sixties due to the extension of canals. The maximum area of the cropped acreage is utilized during the rabi crop season owing to the suitability of the soil for rabi food cereals and food pulse and the limitation of the moisture supply for kharif cropping. Although the share of rabi and kharif acreage maintained steadiness, the occasional fluctuations are not uncommon on account of the seasonal deficiencies of rain and water allowances in canals.

Harvesting (Fig. 190-D): On the whole, the percentage maturity of kharif and rabi crops shows consistency but fluctuations are usually linked with rainfall vagaries (cf. Figs. 188-A and 190-D). During the late 'fifties irrigation tends to have a stabilizing effect on the maturity of crops creating more secured crop production.

Cropping Pattern (Fig. 190-E): The cropping changed conspicuously in the Rohi as compared to the rest of the regions of Hissar. In the beginning of the 'fifties a bulk of acreage was devoted to the drought-resistant mixture and crop, such as, wheat-gram and barley to secure the maturity of crops under adverse conditions. However, with the changing methods of farming and the extension of irrigation facilities the area under wheat, cotton and gram increased with a corresponding decline in the acreage of wheat-gram and barley. It reveals the substantial contribution of irrigation in changing the farming from subsistence to commercial economy. Still there are potentials for the orientation of prosperous farming in a region having fertile soil, low intensity of irrigation and enterprising farmers.

4 and 5. Regions of Change

The regions of changing farm economy embrace the upper flood plain and the lower flood plain. Both have the variable physical, cultural and economic conditions.

4. Upper Flood Plain

In the upper flood plain the Ghaggar stream flows through a narrow and deep channel. The flooding of the surrounding lands is limited and is less significant than in the lower flood plain. The region under investigation is inhabited by the hard working farmers who are expert in managing the small holdings intensively and efficiently. The well irrigation is common and is considerably higher than the in lower flood plain. The prevailing conditions facilitate the intensive farming.

Land-Use (Fig. 191-A): The cultivated area increased. It is a sign of prosperity and increasing agricultural productivity. The increase is directly linked with the reclamation of the wastelands by the inmigrated farmers. The current fallow shows a sharp decline because of the increasing water supply. The acreage of the non-agricultural category increased due to the utilization of land for permanent structures like roads, canals and the expansion of planned settlements.

Irrigation (Fig. 191-B): The irrigation is steadily increasing. The share of the cropped area irrigated is more in rabi crop season. There is still a large acreage awaiting irrigation facilities. There is room for the development of mechanical lift irrigation.

Cropping (Fig. 191-C): The intensity of cropping is low as compared to the intercensal growth of population. On account of the difficult workability of the clayey soil without an adequate amount of moisture or due to excessive flooding, the land is left unsown in the summer crop season or in the coming winter crop season. It is presumed that the intensity of cropping will increase owing to the small size of the holdings, the traits of the farmers and the extension of irrigation. The proportion of rabi cropping increased more conspicuously. It indicates the impulse of irrigation and migrated progressive farmers. They have started to grow superior cash-returning rabi crops under the improving farm conditions.

Harvesting (Fig. 191-D): The seasonal intensity of harvesting shows consistency in the acreage except the years of drought, 1951-52 and 1959-60 (cf. Figs. 188-A and 191-D). In the rest of the period the extent of maturity is favourable because of the adequate moisture supply.

Cropping Pattern (Fig. 191-E): The interchange in the acreages under the various crops has been observed. The farmers are shifting from inferior subsistence to superior commercial crops. The area under bajra is decreasing with the corresponding increase under gram, wheat and oilseeds acreage. It reveals that the rural, economic progress has been steered by the changing cropping pattern to cash crops.

5. Lower Flood Plain

The shallow bed and gentle sloping surroundings of the Ghaggar stream in the lower section give imperfect drainage helpful in the flooding of the adjoining lands. The flood plain widens. The proportion of "khaddar" increases at the expense of "bhangar". With excessive flooding the waters spread over the land in vast sheets, slowly seeping into the ground and afterwards being used by rabi crops like gram, wheat and oilseeds. The soil consists mostly of fertile alluviums suitable for a variety of crops with adequate and regular water supply. These physical features show in the rapidly changing farm economy. The holdings are comparatively large favouring extensive mechanized farming. The adventurous farmers, attracted by the economic opportunities of this area, purchased large-sized farms from the landlords. Obviously, mechanized farming can be observed in this region.

Land-Use (Fig. 192-A): The cultivated acreage increased tremendously because of the reclamation of the arable waste by the progressive farmers. The vast stretches of cheap fertile wastes acted as a magnet to the Jat sikh farmers of the densely populated districts in the north of Hissar. The area under non-agricultural waste increased on account of the extension of canals, roads and rural settlements with the growing population. Current fallow acreage showed a declining tendency owing to the stabilized irrigation facilities and the susceptibility of the farmers to adopt the improved techniques of farming.

Irrigation (Fig. 192-B): Irrigation is steadily increasing and the share of winter and summer irrigated acreage is nearly the same. Still a large acreage is left unirrigated. The winter change is comparatively more than summer due to the conversion of the seasonal Ghaggar canals to perennial flow.

Cropping (Fig. 192-C): The intensity of cropping is increasing and it fluctuates with rainfall and irrigation abnormalities. The shift of kharif cropped acreage to rabi acreage is an interesting feature and needs to be mentioned as it is a signal of rural economic progress. On the whole the winter cropping is of great significance.

Harvesting (Fig. 192-D): The extent and trend of seasonal harvests bear a similarity with the upper flood plain (cf. Figs. 191-D and 192-D).

Cropping Pattern (Fig. 192-E): In the first half of the 'fifties the cropping pattern fluctuated because of the rainfall vagaries and in the later half attained stability. The area under gram, wheat, oilseeds and cotton increased with a corresponding decline in the acreage of inferior crops. The cropping pattern has room for further change with the extension of irrigation as a large extent of cropped acreage is still rainfed.

On the whole the Regions of Change have potentials for bringing a considerable change in the existing agricultural pattern by improving the moisture supply. There are considerable opportunities for the development of lift irrigation other than flow irrigation. The development of the former would economise the canal water which can be used for the agricultural uplift of the areas lacking ground water. These regions may be the future granaries and the cotton producing areas of Hissar.

6. Region of Diversified Farming

The region of diversified farming embraces the vast level loams of the old irrigated areas inhabited by the Hindu Jats. The fluctuations in the agricultural land occupancy are recognizable in the beginning of the last decade, thereafter the stability in farming is apparent. The departure from normal can be observed in 1951-52, the year of drought.

Land-Use (Fig. 193-A): The steady increase in the cultivated area at a slower pace has been portrayed. The area under unculturable waste is greater because of the economic prosperity of the region. It increased during the last decade. These extensions are the indicators of prosperous farming. The acreage of the arable waste decreased, partly because of its shift to non-agricultural category for permanent structures, and partly because of its reclamation for cultivation. The percentage of current fallow was maximum in 1951-52 and afterwards it declined steadily due to the steady increase in the share of canal irrigation.

Irrigation (Fig. 193-B): The summer share of irrigation remained static, but the winter percentage changed steadily owing to the change of seasonal channels to perennial flow. This change may be held responsible for increasing the winter cropped area.

Cropping (Fig. 193-C): A synoptic view of the extent to which cropping has been done on the cultivated area shows that the impulse of irrigation has been reflected by the high intensity of cropping as compared to regional standards. The intensity of cultivation was very low in the earlier years because of the precipitation fluctuations and thereafter it maintained its steady, high percentage.

In 1959-60 the intensity of cropping remained high despite the low rainfall on account of the stabilized irrigation facilities and the improved techniques of farming.

Winter cropping is increasing with a corresponding decrease in summer cropping due to the improvement in winter irrigation. The winter cropped area is more than the summer cropping. The high intensity of cropping, the change of summer cropped area to winter and the maximum concentration of cropped area in winter are the indicators of progress in rural economy.

Harvesting (Fig. 193-D): In the beginning of the last decade much of the capital invested and labour input were wasted owing to the low intensity of harvesting. Afterwards the situation improved tremendously. This clearly shows that a steady increase in irrigation tends to have a stabilizing effect on the maturity of crops and creates more secure conditions for crop production. It is the primary fundamental of the peasant prosperity.

Cropping Pattern (Fig. 193-E): The facts which stand out prominently are that the farming is diversified; the cropping pattern is achieving stability; the area under cotton remained static on account of less improvement in summer water allowances; the acreage under bajra declined and the rise in the share of gram, wheat and oilseeds has been observed and the sorghum acreage remained nearly the same as it contributes to the dietary habit of the inhabitants.

7. Region of Stabilized and Diversified Commercial Farming

In the east lies a block of level, compact loams having maximum intensity of irrigation and very high density of population. In this region the irrigation has been in practice for centuries. The effects of intensive and injudicious irrigation and poor drainage are visible in the form of waterlogging. Therefore, the problems and solutions of this region are different from the rest. In other regions the need for bringing more water to the cultivated land is a primary need and the region under discussion is faced with the problem of how to drain out the water from the depleted cultivated land.

The Figs. 194-A to 194-E exhibit the various agricultural aspects. An overall glance immediately reveals the state of stability observing minimum fluctuations on account of the very high intensity of irrigation and the consistency in human controls.

Land-Use (Fig. 194-A): The fall in the cultivated area is the outcome of the infestation of waterlogging. The non-agricultural land-use is maximum because of the large size of the settlements and the huge network of canals. The arable waste is exploited to the maximum. The waste lies only in the form of either village common-land or waterlogged area. The cultivated area can be increased only by reclaiming the waterlogged acreage.

Irrigation (Fig. 194-B): The intensity of irrigation is very high and the percentages of the cropped area irrigated is more in winter due to the low duty of crops. The steadiness in irrigation is the key note. A maximum acreage of the commandable cropped area is irrigated. There is little room for the extension of irrigation.

Cropping (Fig. 194-C): The intensity of cropping is fairly high because of intensive irrigation. Nevertheless, the drought of 1951-52 showed its impulse on the intensity of cultivation, bringing it down considerably. On the whole steadiness can be observed. The share of kharif and rabi cropping interchanged slightly. Winter cropping gained importance owing to the increasing prices of the winter food crops and oilseeds and the improvement of canal discharges.

Harvesting (Fig. 194-D): The fluctuations in the matured cropped area run parallel to the seasonal fluctuations of rainfall (cf. Figs. 188-A and 194-D). The fluctuations are not so erratic because of the excellent irrigation system which has a stabilizing effect on the maturity of crops creating more secure, prosperous and diversified conditions for crop production. The after effects of the 1951-52 drought suggest that the moisture supply is the primary need of farming in Hissar.

Cropping Pattern (Fig. 194-E): There is no doubt that various forces such as climatic, agronomic, economic and human, act as instruments in deciding the cropping pattern but irrigation is one of the most important single factors in deciding and stabilizing the crop land occupancy of this region. The following observations have been derived from Fig. 194-E: the diversity in cropping is the key note; the consistency in acreage of individual crops can be observed; the acreage under bajra decreased slightly and that of wheat increased significantly and of gram and oilseeds moderately; and the cotton acreage decreased on account of the susceptibility of the crop to waterlogging. During field work empty patches of "Kallar" area were observed within the cotton fields. The sorghum acreage remained steady as it is deeply ingrained in the dietary habit of the farmers. On the whole, in this region the improvements suggested may be on the lines of improving the existing techniques of irrigated and dry-farming to increase the yields.

To sum up: the same types of crops continue to be grown as before the extension of irrigation, although greater emphasis has now been laid on the cultivation of gram, wheat, cotton and oilseeds. The incidence of current fallow, wasteland and crop failures has been reduced and that of non-agricultural land, harvested area, cropped area and crop production increased. The progress achieved in the agricultural sector so far is reflected everywhere in the rural landscape. It has brought considerable benefits to the formerly poor regions of Hissar. The standard of living has risen, as can be seen from the appearance of model villages, and the use of farm machinery, cycles and radio sets in the countryside. The coming years will show with even greater clarity the advantages of irrigated farming increasing the agricultural productivity. By relying on modern methods of farming, making use of up-tp-date farm technology and increasing productivity, Hissar agriculture will assure the farmers of a full and cultured life comparable to that of city-dwellers. To achieve this aim, the diversity in the distribution of agro- and socio-economic variables demands the applications of principles set for each region rather than the practice of specific policies laid down for the district as a whole for stepping-up production.

The long term effects of subsistence agriculture in the rain-fed areas on the fertility of soil are drastic. Under the present system of land-use, with a trend towards shorter fallows and increasing crop specialization or mere crop rotations for specialised food grain or food pulse production, the capabilities and potentialities of the soils are decreasing each year. Recognition of the fact that a prosperous and permanent agriculture depends on the conversion of the present, mainly exploitative systems of land-use to systems that conserve and augment the productivity of the farm, is fundamental to any policy for the development of the agricultural economy of Hissar as a whole and the rainfed areas in particular. The rainfed areas of Hissar possess environmental conditions favourable to the production of food grains and commercial crops, for which there is a vast market in other parts of India, and these resources should be utilized to the best advantage. The economic and agronomic measures should be undertaken by the respective departments to equalize opportunities between the privileged and the underprivileged agricultural regions. There is no reason why the progressivism cannot be extended to the underprivileged regions.

The systems of organization must be devised which will utilise economically the existing moisture supply, land capabilities and man force in Hissar. Unfortunately, in a peasant subsistence economy, the dissemination of the concept of the economic use of the farm resources is extremely difficult and there is little doubt that future generations will inherit farms whose productivity has been impaired, in some cases permanently, on account of waterlogging. The persistence of antiquated and traditional, deeply-ingrained agricultural techniques among the majority of the farmers because of poverty, illiteracy and ethnic traits influence the agricultural practices and soil management, pulling down the land-use efficiency, the irrigation efficiency and the farm productivity. Therefore, any initiative for planning and execution of large scale schemes of development must be a State Enterprise as the level of farmer income and illiteracy preclude the possibility of spectacular achievements by private enterprise. Any policy aiming at agricultural development will begin with the realization of fundamental areal problems and their solutions.

A geographer, by his discipline and cartographic skill, has a distinct advantage in the field of agricultural geography. In the first place, he is able to comprehend land-use and cropped land occupancy in areal extent by associating it with the basis of farm economy. In the second place, he is able to communicate knowledge and description of farming through the techniques of visual representation he normally employs. Maps, quantitative treatments, and descriptions are his tools for distributing the facts to the people who require them, and these people are not specialist in agricultural geography. In the majority of cases, they are people engaged on agriculture either as farmers or as agricultural advisers. Agriculture and Irrigation officers require facts of land-use and changes, and the agricultural geographer is well qualified to supply this kind of information. In newly developing areas, it has become the practice to employ teams of specialists in many related aspects of agriculture to collaborate in field work. Yet the synthesis of their individual reports and records must be done by one man: for this task, the agricultural geographer as a correlator is unsurpassed. The geographer can make a utilitarian contribution to the agricultural problems of India by delineating the agricultural regions for each district. A contribution based on his knowledge of facts supported by personal observations and the statistical analysis of the data will be recognised by the agronomists and the irrigation engineers for the development projects to be prepared for a homogeneous farm landscape. Finally, it is now left for the experts who direct the agricultural and irrigation development to propose plans for the future orientation of agricultural policies and the economic progress in Hissar from a parallel study of the agricultural regions. The future projects should be based on the agro and socio-economic conditions which prevail in each region. Other things being equal, moisture deficiency comes first. The deficiency and variability of rainfall and the considerable intensity of soil moisture deficit are enough for irrigation to be an asset. The more secure water supply from the Bhakra-Nangal scheme is a big help to agriculture. In the Hissar Plain, farming, based on modern perennial irrigation, achieves a higher material living standard than the neighbouring "bagar" lands. There is considerable scope for the extension of irrigation to the potentially productive "bhangar" and "khaddar" lands of the Rohi, Haryana and Nali areas of Hissar.

Appendix I

The Technique of calculating the "Standard Nutrition Unit for Ingestion, Standard Production Unit and Economic Density or Population Pressure" for the district of Hissar.

The dubiousness of the calculations has been avoided as far as possible by processing the whole of the figures and by giving the reasonable allowances. The procedure is laid down under five steps as follows:-

Step No.1

Weighted Average Nutrition Unit in Calories/person/day: The daily caloric requirements of an individual to keep him in full activity and health have been calculated for Hissar on the basis of the recommended dietary allowances of calories by the Indian Council of Medical Research, New Delhi (Aykroyd, 1963). These allowances are comparable with the recommendations of Sir Stanley Davidson *et al*. (1961). The requisite weight is given for the proportions of different age and sex groups in the calculations.

Daily Weighted Caloric Requirements for Hissar, 1961

Age Groups	Percentage of Total Rural Population			Recommended Caloric Intake	Total Caloric Intake
	Children	Male	Female		
0-4	18·19	-	-	1200	21828
5-9	15·68	-	-	1675	26264
10-15	-	6·20	-	2500	15500
10-15	-	-	6·35	2100	13335
16-19	-	4·20	-	3150	13230
16-19	-	-	3·97	2100	8337
Above 19	-	23·22	-	2600	60372
Above 19	-	-	22·19	2300	51037
				TOTAL:	209903

The weighted average caloric requirement/person/day for Hissar as a whole is almost precisely 2099 calories. Where the intake falls below 2000 calories per day there was an obvious evidence of malnutrition (Stamp, 1960), it reveals the fact that the figure taken for Hissar is above the malnutrition level.

Step No.2

Standard Nutrition Unit for Ingestion in whole wheat/person/year: In India 90 to 95 percent of calories are derived from food cereals and food pulses by the rural population. For poor peasant communities the first question should be the availability of calories and proteins. A community at the lowest level of agricultural productivity, living predominantly on cereals such as barley, maize, sorghum or millet, if they have enough calories, will also receive enough protein (Clark, 1964). In the present calculation wheat is substituted for all the food stuffs being a superior food grain containing the human requirements in suitable proportions. Furthermore, it is the staple food of the bulk of the rural population and can be raised successfully from the soils of Hissar under irrigated or dry farming.

It does not seem reasonable to assume that the subsistence cultivators would really waste food, but for strict scientific analysis of any nation's food, distinctions ought to be drawn between food disappearance, food consumption and food ingestion. After calculating the disappearance in the form of seed and losses, the consumption in kitchen preparation and grinding, the remainder may be referred to as ingestion, the food which goes to the mouths of the population. An amount of 346 calories per 100 grams of whole wheat are available. The food consumption of 5 calories per 100 grams in grinding and 10 percent in cooking have been taken into account. Finally, 307 calories per 100 grams of whole wheat are left for human consumption. The annual caloric consumption of 766660 calories as human fuel can be obtained from 249·73 kilograms of whole wheat or 6·75 maunds (1 maund = 37 kilograms or 82 lbs.) is the Standard Nutrition Unit for Ingestion in Hissar district.

Step No.3

Weighted Average Yield of wheat per acre of canal irrigated land, Hissar, 1958-59 to 1962-63

Year	Number of Fields	Average of Yield per acre in lbs.
58-59	46	1137
59-60	52	882
60-61	69	1346
61-62	46	1166
62-63	54	1045
	TOTAL:	5576

Source: Statistician Agriculture Department, Chandigarh

Weighted average yield centred to 1960-61 per acre comes to 1115 lbs. or 13·60 maunds. After giving an allowance of 10 percent of the yield for disappearance (Stamp, 1958), 12·24 maunds of wheat is left for human consumption and ingestion, available from one standard acre. One acre can support 1·81 persons or one square mile of canal irrigated land can carry 1158 persons. It may be considered the "Optimum Carrying Capacity" of one standard square mile of the arable land in Hissar, at the present rate of production.

Step No.4

To make a significant comparison of economic density and land-use, it is desirable to devise some technique which excludes the non-agricultural land and makes allowance for the land of low value or unusually high value in terms of production. To effect this comparison both soils and methods of irrigation are taken into account to convert the arable land of Hissar to a Standard Unit of Production. The net area sown has been converted to one standard unit of production with the help of a key evolved for the evaluation of different classes of land. The nominal value of one standard unit termed as a Standard Acre is equivalent to 16 annas or one Indian Rupee (Equivalent approximately to one shilling in foreign exchange value). This standard acre of land is one which can yield 13·60 maunds of wheat and is considered as one Standard Unit of Production.

The key for the conversion of the land into the standard acre for the Hissar district follows:

Key for the Evaluation of Land for Hissar district

Tahsil/ Assessment Circle (Fig. 2)	Canal-Irrigated (Perennial) Land (Nehri)	Well Irrigated Land (Chahi)	Seasonal or Inundation Canal Irrigated Land (Nehri)	Land Usually Flooded by river (Sailab)	Rainfed Land (Barani)
Sirsa					
1. Rohi	15	10	10	5	5
2. Nali	15	10	10	5	5
3. Bagar	15	-	-	-	4
Fatehabad					
4. Rangoi	15	10	10	6	5
5. Nehri	15	-	-	-	5
6. Barani	15	10	-	6	5
7. Nali	15	10	-	5	5
8. Bagar	15	-	-	-	4
Hissar					
9. Nehri	15	10	-	-	5
10. Barani	15	10	-	-	4
11. Nali	15	10	-	5	5
12. Bagar	15	-	-	-	5
Hansi					
13. Nehri	16	10	-	-	5
14. Barani	16	10	-	-	5
Bhiwani					
15. Haryana Sharqi	15	10	-	-	5
16. Haryana Garbi	10	10	-	-	5
17. Amrain Bagar	10	-	-	-	3
18. Behl-Siwani Bagar	-	-	-	-	3
19. Loharu Bagar	-	-	-	-	3

Source: Land Settlement Manual for Displaced persons in Punjab and Pepsu, 1952 (Tirlok Singh)

With the help of the above key the net area sown has been changed to the standard unit of production. The net area sown taken for conversion, is the average of 1959 to 62 and 1950 to 53, centred to 1960-61 and 1951-52 respectively. One case has been cited to illustrate the procedure of conversion:

Rohi assessment circle (No.1 in Fig. 2), 1959-62

	Nehri Perennial	Chahi	Nehri Seasonal	Sailab	Barani	
Net Area Sown (acres):	56,817	63	902	7	438,775	
Value (annas):	15	10	10	5	5	(according to key)
Total Value (annas):	852,255	630	9,020	35	2,193,875	
Division by	16	16	16	16	16	for conversion

to Standard Acres, Total: 53,265·94 + 39·38 + 563·75 + 2·19 + 137,117·19 = 190,988·45

Total Standard Square Miles = 190,988·45/640 = 298·42

Step No.5

Calculation of Economic Density or Population Pressure:

$$\text{Population Pressure} = \frac{\text{Rural Population}}{\text{Standard Square Miles of Net Area Sown}}$$

$$\text{Rohi assessment circle, Economic } \underset{(1961)}{\text{Density}} = \frac{153,757}{298\cdot42} = 515$$

Thereafter, the potential of supporting additional population can be determined as: 1158 (Optimum Carrying Capacity) - 515 (Economic Density) = 643 per Standard Square Mile of net area sown.

Additional Allowances Made

There is no doubt that the measurement of population pressure is an intricate problem. Maximum efforts have been made to maintain the degree of accuracy by making more allowances. These are as follows:

(a) Fallow land is not included.

(b) Double cropped area is excluded, as it must be remembered that land is needed for other non-food crops. Furthermore wheat is sown once a year.

(c) Intake of calories through milk is additional.

(d) The proportion of lactating mothers is considered by including the children below 1 year in the age group of 0-4.

Appendix II

For the quantitative measurement of the total volume of change in land-use during 1951-61 in Hissar, the index used is a modification of Weaver's Index (1954-a), applied by him in his study of ascertaining the volume of change in crop land use in the middle west (U.S.A.). The symbols for crops used by him are replaced by the symbols given to various land-use classes.

Index for determining the Volume of Change in Land-Use = $\frac{A}{B}$

where "A" is the differences of percentages of land-use categories of increase and "B" the differences of percentages of land-use categories of decrease for the periods 1951-56 and 1956-61.

The summation of numerator and denominator should be the same. This can only be achieved if agricultural returns are accurate and carefully computed.

The technique of calculation is as follows:

Land-Use of the Loharu Bagar assessment circle (No.19 in Fig.2)

Periods	Percentages of the total area					
	Forests	Land not available for cultivation	Culturable wasteland	Current fallow	Net area sown	Total Percent
1951-56	-	2·34	7·37	13·01	77·28	100·00
1956-61	-	2·39	7·11	4·79	85·71	100·00
Differences	-	+0·05	-0·26	-8·22	+8·43	±8·48

$$\text{Index of Volume of Change} = \frac{\text{NAS } 8{\cdot}43 + \text{NAC } 0{\cdot}05}{\text{CF } 8{\cdot}22 + \text{OF } 0{\cdot}26} = \frac{+8{\cdot}48}{-8{\cdot}48}$$

where NAS is the net area sown, NAC is the land not available for cultivation, CF is the current fallow and OF includes the other fallows or the culturable wasteland.

In the case of the sample assessment circle, 8·48 is an index figure. It is the percentage of land which is actually involved in the transfer of acreage from one category to the others. Having thus achieved a measure of the percentage of land-use involved in change for every assessment circle, this can be mapped, giving a comparative view of the areas where land-use patterns have been highly dynamic, and, by contrast, other areas where they have been highly stable. The higher the index the more radical are the changes in the land-use pattern and the lower the index the more stability prevails. Weaver in his study, referring to the volume of change in crop land occupancy, suggests the value of 20 percent and above as volume of change, as an indication of the higher dynamism and below 10 percent is a category of the higher stability.

Glossary

ANDHI	Dust storm
ASSESSMENT CIRCLE	A sub-division of a tahsil including the villages having the same land capability and productivity.
BAGAR	Sandy area (Area inhabited by the Bagri Jats)
BARANI	Land dependent on rain (Rainfed)
BATAI	Crop-sharing
BHANGAR	Old alluvium
BHUSA	Straw crushed and broken into short lengths by trampling with bullocks during the process of threshing
BISHNOI	A semi-religious sect of farmers
BISWADARI	Landlord tenure
CHAHI	Well-irrigated land
CHARSA	A primitive method of lift irrigation
DAKKAR	Stiff clay
DISTRICT	The most important administrative unit of a state
GARBI	West
GUJJAR	Dairying caste
HARYANA	Area inhabited by the Hindu Jats
JAT	One of the principal agricultural tribes of the Punjab
KALLAR	Saline deposits
KAMBOJ	Group communities of farmers who help each other "The crow and the Kamboj Sikh help their progeny, while the crocodile and the Jat Sikh destroy them." (local saying)
KHADDAR	New alluvium
KHARIF	Autumn harvest, monsoon or summer crop
LAL-KITAB	Inventory book for the revenue records
LOO	Hot-dry winds

MALI	Gardener, a class of petty cultivators
MANDI	Wholesale market
NALI	Channel of the Ghaggar river
NEHRI	Canal irrigated land
PURANA	Ancient
RABI	Spring harvest, or winter crops
RAJPUT	One of the principal agricultural tribes of the Punjab; coming originally from Rajasthan (Rajputana).
RANGOI	Colourful
ROHI	Soft loam
SAILAB	Land usually flooded by river in rainy season
SHARQI	East
SIKH	A member of a Hindu monotheistic, casteless and military, community of the Punjab
SOTAR	The generic name of the soil of the Ghaggar valley (hard red clay)
TAHSIL	Sub-division of a district with separate revenue staff
TAL	Level loam
TIBBA	Sandy, unlevel land
TILLA	Low, rocky hill

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