CHAPTER IV

CHANGES IN CROPPING PATTERN

Cropping pattern is the central element of agricultural land use. In the Bist Doab it experienced considerable transformation during the study period. Some crops of the region gained area and improved their relative position in the crop complex while others came down sharply. Wheat and rice proved the largest gainers. Area under wheat increased from 27.3 per cent of the cropland in 1951 to 29.3 per cent in 1966 and to 44.2 per cent in 1980. During the same period proportion of rice increased from 3.1 to 7.0 per cent and to 18.7 per cent. Expansion of irrigation; introduction of high yielding varieties of seeds; use of chemical fertilizers, bio-chemical inputs and machines; creation of assured market for them through state trading and support prices; and development of infrastructural facilities in the form of link roads and market centres largely contributed to their upward trend.

The region is quite similar to Punjab as far as the changes in both the crops during 1951-80 are concerned (Table 4.1). Wheat-gram was the largest loser. Area under this crop decreased from 15.8 per cent in 1951 to 11.6 and 2.0 per cent respectively in 1966 and 1980. In the changed situation of irrigation farming and improved as well as mechanized methods of cultivation, farmers diverted most of their wheat-gram fields to wheat. Fodder crops too suffered areal loss. Their proportion decreased from 23.6 per cent in 1951 to 17.6 per cent in 1966 and to 12.0 per cent in 1980. Increase in the yield of fodder crops with improvement in farm practices, increase in competition from food-
### Table 4.1

**Bist Doab: Percentage area under various crops**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Percentage to total cropped area</th>
<th>Change in percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>27.3</td>
<td>29.3</td>
</tr>
<tr>
<td></td>
<td>(17.3)</td>
<td>(25.3)</td>
</tr>
<tr>
<td>Wheat-gram</td>
<td>15.8</td>
<td>11.6</td>
</tr>
<tr>
<td></td>
<td>(12.9)</td>
<td>(8.0)</td>
</tr>
<tr>
<td>Gram</td>
<td>2.7</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>(8.0)</td>
<td>(7.8)</td>
</tr>
<tr>
<td>Barley</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>(1.4)</td>
<td>(1.2)</td>
</tr>
<tr>
<td>Rice</td>
<td>3.1</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td>(3.5)</td>
<td>(5.9)</td>
</tr>
<tr>
<td>Maize</td>
<td>12.4</td>
<td>15.9</td>
</tr>
<tr>
<td></td>
<td>(5.5)</td>
<td>(8.2)</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>5.2</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>(2.2)</td>
<td>(3.0)</td>
</tr>
<tr>
<td>Groundnut</td>
<td>0.6</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td>(1.3)</td>
<td>(3.7)</td>
</tr>
<tr>
<td>Cotton</td>
<td>2.1</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>(6.0)</td>
<td>(8.8)</td>
</tr>
<tr>
<td>Bajra</td>
<td>2.5</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>(4.7)</td>
<td>(3.5)</td>
</tr>
<tr>
<td>Fodder</td>
<td>23.6</td>
<td>17.6</td>
</tr>
<tr>
<td></td>
<td>(16.6)</td>
<td>(16.2)</td>
</tr>
<tr>
<td>Vegetables</td>
<td>0.8</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>(0.6)</td>
<td>(1.1)</td>
</tr>
<tr>
<td>Pulses</td>
<td>2.8</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>( 2.5)</td>
<td>( 1.0)</td>
</tr>
<tr>
<td>Oilseeds</td>
<td>0.7</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>(2.9)</td>
<td>(2.2)</td>
</tr>
</tbody>
</table>

**Note:** Figures in brackets are for Punjab as a whole.
grains and growing use of machine power largely account for its decrease. A large part of its area was captured by wheat and rice. Gram and barley came down in favour of wheat. Most of the area of jowar, bajra, pulses, sugarcane and cotton was diverted to rice. Maize, however, maintained status quo during the study period. It is evident that cropping pattern in the region experienced rationalization on commercial lines. The traditional combinations of crops, which were normally complex, got simplified. Total cropped area in the region increased from 630,475 to 993,992 hectares thereby raising the intensity of cropping from 119 to 140 per cent during the study period.

Due to its sub-tropical location, the Bist Doab, similar to northern India, has two main crop seasons (i) winter or the rabi season and (ii) summer or the kharif season. Crops which require mild temperatures at the time of sowing (October-November) and higher temperatures at the time of their harvest (March-April) are raised during winter season. Wheat, barley, gram, clover, linseed, rape seed etc. are the major crops of this season. Kharif cropping season is associated with summer months. It starts with the advent of monsoons in June-July and ends with the onset of winters in October-November. Rice, maize, jowar, bajra, groundnut, cotton, sugarcane and sesamum are the chief crops of this season. Besides, there are two short intervening periods. These are called zaid-rabi (which follows the rabi season) and zaid-kharif (which follows the kharif season). Some fodder crops, vegetables and fresh fruits such as melons and water-melons are raised during these periods. The crops grown during these seasons cover an insignificant proportion of the total cropped area and thus have been clubbed with similar crops of the
main seasons. Sugarcane, however, is an annual crop. It stands in the fields throughout the year. But it has been treated as *kharif* crop because its maximum growth takes place during summers.

**Rabi Crops**

**Wheat (Triticum sativum)**

Wheat is the most prominent staple and cash crop of the people of Bist Doab. It requires cool, semi-dry to sub-humid climate. Temperature ranging from 15 to 20° C during its growing period (December to February), of about 27° C at the time of its harvest (April), and rainfall of 50 to 75 centimetres coming mostly during winter season are needed for its success. The requisite temperatures are adequately met within the Bist Doab. But rainfall is inadequate and uncertain. Its deficiency, however, has been overcome with considerable development of irrigation. Well drained fertile alluvial soils of the Bist Doab are excellent for this crop. As a result of favourable physical environments, wheat continued to be the principal crop of the region during 1951-80. Covering 27.3 per cent (172,166 hectares) of the total cropped area in 1951, it was the major crop of the Bist Doab. Its proportion increased to 29.3 per cent (235,812 hectares) in 1966 and to 44.2 per cent (437,131 hectares) in 1980 (Maps 4.1 to 4.3). Evidently, the pace of increase in area under wheat was much faster during post-1966 period. Its areal expansion before 1966 was slow and was due to the increase in its demand and development of irrigation. Faster increase after 1966, however, is associated with the implementation of Green Revolution technology. Introduction of high yielding varieties
in this crop; use of chemical inputs and machines like thrashers, combine harvesters, drills etc. which were especially designed for wheat; creation of market by way of state trading and support prices which made it much more rewarding than the competing crops; faster development of irrigation; extension of a large number of roads and link roads which facilitated its marketing; establishment of seasonal markets to mop up the surplus particularly after 1966 largely accounted for higher increase in wheat cultivation during post-Green Revolution period. The increase in percentage area under this crop, however, varies areally ranging from 0.8 per cent in Kandi assessment circle of Balachaur tahsil to 26.8 per cent in Dona assessment circle of Nakodar tahsil (Map 4.4).

Depending upon the type and magnitude of change, the Bist Doab may be divided into the following four types of areas:

1. Areas of high increase (over 20 per cent);
2. Areas of moderate increase (between 10 and 20 per cent);
3. Areas of low increase (below 10 per cent); and
4. Areas of decrease.

1. The Dona tract of Kapurthala, Sultanpur and Nakodar tahsils in the west; Sirowal circle of Dasuya and Sirowal and Rakkar circles of Hoshiarpur tahsil forming a contiguous patch in the northeast and Retli circle of Nawanshahr tahsil in the southeast are the areas where proportion of wheat increased by more than 20 per cent. These are the parts which recorded considerable extension or irrigation during 1951-80. Secondly, these parts of the region had relatively low proportion
of their area under wheat in 1951 over which the scope for further expansion of this crop was fairly high.

2. Central Bist Doab, covering whole of Jalandhar tahsil except its City Circle, Manjki circle of Nakodar tahsil, the whole of Phillaur tahsil Dhak and Dhaha Bet circles of Nawanshahr tahsil, Manjki and Sirowal circles of Phagwara tahsil, and Rakkar and Sirowal circles of Garhshankar tahsil recorded an increase ranging between 10 and 20 per cent in area under wheat. Maira assessment circle of Dasuya tahsil, forming an isolated patch in the north, too falls in the same category. Moderate gain in percentage area under wheat in these parts is attributed to their relatively high base of wheat cultivation in 1951 (Map 4.1). These were better irrigated parts of the region even in 1951. Further intensification of irrigation resulted in expansion of wheat cultivation. But due to already higher proportions of their area under this crop, the increase could be of moderate degree.

3. Low increase (below 10 per cent) in area under wheat is a feature of the flood plains of the two rivers and the hilly zone. Low increase in the flood plains is ascribed to the heavy cultivation of wheat since early fifties. The soil moisture conditions of these areas have always been more suitable for wheat culture but detrimental for the cultivation of other rabi crops such as gram, mixed crop of wheat-gram, barley and pulses. These areas had a very high proportion of their land under wheat in 1951. Thus, the scope for its further expansion was limited. Similarly, Dhak circle of Phagwara tahsil also recorded low increase. The case of hilly zone, however,
is different. In this tract, wheat occupied low proportion of the cropland in 1951 and continued to be so with small increase mostly because irrigation here could not extend to wider areas. A large part of its soil is sandy and less fertile over which wheat does not flourish well. City Circle of Jalandhar is another area of its own type where too wheat recorded low increase, due mainly to stronger competition from vegetables.

4. Rakkar assessment circle of Dasuya tahsil is the only exception where area under wheat declined by 6 per cent (from 44.0 to 38.0 per cent) during 1951-80. It has poor soils. Base of irrigation was poor in 1951 and extended to a limited extent by 1980. Thus, it offered conditions which were more conducive to the cultivation of gram or wheat-gram. These two crops captured area from wheat, thereby resulting into a decline in its cultivation.

Due to a substantial positive change in its area during the last thirty years, wheat at present (1980) covers 44.2 per cent (439,131 hectares) of the total cropland and 80 per cent of the rabi cropland of the Bist Doab. During winter season one sees wheat fields up to the distance the eyesight reaches. Other crops of this season appear like islands in the vast ocean of wheat. This crop ranks first in 26 out of a total of 35 assessment circles of the region. Percentage area under wheat, however, varies from 10.8 per cent in Kandi assessment circle of Balachaur tahsil to 53.7 per cent in Bet assessment circle of Nawanshahr tahsil (Map. 4.3).

The flood plain of the Satluj and of the Beas covering Bet assessment circles of the Nawanshahr, Nakodar, Dasuya, Kapurthala and Sultanpur
tahsils and the Sirowal assessment circle of Dasuya tahsil have the highest concentration of wheat. More than half (50.0 to 53.7 per cent) of the total cropland of these areas is devoted to this crop. These areas witnessed considerable expansion of wheat hectarage since 1951. The unchallenged position of wheat in flood plains is related to the fertile alluvial soils which retain enough of moisture, partly due to their better structure and partly due to closer sub-soil water. Such soil moisture conditions are detrimental to the cultivation of other crops of the season such as gram, pulses, oilseeds etc. Thus, the ultimate choice of the farmers falls on wheat. Sirowal circle of Dasuya tahsil is bestowed with fertile alluvial soils and considerable development of irrigation. Both these factors encouraged wheat cultivation on major part of its area during 1951-80 and hence put it in the highest category.

The entire upland plain and northern half of the foothill plain form the largest tract where wheat occupies 40 to 50 per cent of the cropped area. These areas come next to the flood plains in the concentration of wheat. Deep alluvial soils and fairly developed irrigation system furnish excellent conditions for raising wheat in these parts.

Hills and most of the dissected foothill plain have the lowest (less than 40 per cent) proportion of their cropland under wheat. Limited irrigation and exposed soils in many of their parts restrict large scale cultivation of wheat. Irrigated fields of these tracts are devoted to this crop while most of the rainfed fields are put to the mixed cultivation of wheat and gram. City Circle of Jalandhar and Dhak circle of Phagwara where vegetables
and fodder occupy larger share of the cropland due to urban influence, too have low proportions (30.7 and 39.2 per cent respectively) of their cropped area under wheat.

In sum, wheat was the most important crop of the Bist Doab in 1951. It consolidated its position further both in terms of absolute hectarage and relative position among various crops of the region during 1951-80. The expansion of its area was the highest in most parts of the upland plain where irrigation recorded significant development and Green Revolution technology exercised its impact without difficulty. Most of the foothill plain too witnessed substantial increase. On the other hand, the flood plains recorded limited increase in wheat hectarage, because they already had a very high proportion of their area under this crop in 1951, over which the scope for further increase was low. Although, these riverine tracts recorded lower increase in area under wheat than the upland plain, yet they are ahead of the latter in its cultivation due mainly to their already strong position. Nevertheless, both these areas have high proportion of their cropland under this crop. By comparison, the hills and parts of the foothill plain where irrigation could not make much headway and soils are lighter, had low proportion of their cropland under this crop and continued to lag behind other areas in matters of wheat cultivation.

Wheat-gram

Wheat-gram is a mixed crop. The seeds of wheat and gram are mixed together and broadcasted in the fields. Sometimes, these are sown
in rows. The most important feature of this practice is that two crops having different moisture requirements are raised simultaneously on the same piece of land. And it is expected that at least one of them will do well under uncertain conditions of rainfall. The basic objective in this cropping is to minimize the risks of crop failure in an uncertain environmental situation. Also, it gives a variety of products from the same field and the yield of these together is more than any of them grown alone. Besides, the practice helps in the management of the soil in a better way. Wheat is exhaustive of soil nutrients, such as nitrogen, whereas gram, being a leguminous crop, adds the same into it, in a natural process.

Wheat-gram covered 15.8 per cent (99,650 hectares) of the total cropped area of the Bist Doab in 1951 (Map 4.5). It was next only to wheat in this regard. Lighter and unirrigated soils were generally devoted to this crop. However, its cultivation came down to 11.6 per cent (93,325 hectares) in 1966 and to 2.0 per cent (20,747 hectares) in 1980 (Map 4.6 and 4.7). As compared to the 1951-66 period, the decrease was more pronounced during 1966-80. This was largely due to faster increase in irrigation which reduced the dependence on rainfall. It minimized risk in crop cultivation. Introduction of high yielding variety seeds of wheat, creation of assured market for this crop and increase in use of machines which are specially designed for wheat culture are some of the other factors which explain the decrease in interculture of wheat and gram. This apart, the consumption of wheat-gram as a cereal has gone out of habit. Its place has been taken by wheat which is preferred for bread-making. Also, the separation of these two grains from each other
after thrashing, is a clumsy and highly time consuming job. Due to these facts, most of the wheat-gram area was diverted to wheat. Barring few assessment circles, the whole of the Bist Doab experienced decline in wheat-gram cultivation during 1951-80. The decrease in its proportion, however, varies areally ranging from 0.7 per cent in Kandi assessment circle of Hoshiarpur tahsil to 25.9 per cent in Sirowal assessment circle of the same tahsil (Map 4.8).

Nine assessment circles (Dona assessment circles of Nakodar and Sultanpur tahsils; Retli assessment circle of Nawanshahr tahsil; Sirowal assessment circle of Dasuya tahsil; Rakkar and Sirowal assessment circles of Hoshiarpur tahsil; Rakkar assessment circles of both the Garhshankar and Balachaur tahsils) out of a total of 35, recorded decrease ranging between 18.0 and 25.9 per cent in area under wheat-gram. All these units have relatively light soils. Irrigation in them was less developed in 1951. As a result, a larger share of their cropland was devoted to this mixed crop at that time. However, considerable development of irrigation in most of these areas during 1951-80 reduced this practice sharply. Because these areas had very high proportion of their cropland under wheat-gram in 1951, the magnitude of decline in them was expected to be higher.

On the other hand, flood plains and parts of the hilly zone form two different types of areas where cultivation of wheat-gram registered low (below 9 per cent) decline. In the flood plains, low decrease is attributed to the low proportion (below 7 per cent) of their area allocated to wheat-gram in 1951. Over the moisture retentive silt-loam soils, the cultivation
of wheat alone, rather than the mixture of wheat and gram was more common even in 1951. Thus, the scope for curtailing this practice was small. In contrast to the flood plains, the hilly zone had very high proportion (between 20 and 35 per cent) of its area under wheat-gram in 1951. Due to lighter soils and inadequate irrigation, this tract was especially suitable for the cultivation of this crop. The situation in this regard did not change much mainly due to slower and limited increase in irrigation. Thus, it recorded a small decrease. Other areas, which are mostly associated with the upland plain recorded a decline between 9 and 18 per cent in the cultivation of wheat-gram. The crop occupied almost the same proportions of their cropland in 1951. Increase in irrigation and competition from wheat, largely brought the decline in mixed cultivation of wheat-gram in these parts.

Contrary to the general trend, cultivation of wheat-gram increased by 3.7 and 0.7 per cent respectively in Rakkar circle of Dasuya tahsil and Kandi circle of Hoshiarpur tahsil during 1951-80. Poor quality, lighter soils and continued dependence on rainfall explain this trend.

As a result of various agricultural developments which took place during the study period, mixed culture of wheat and gram shrank to only 2.0 per cent (20,747 hectares) of the total cropland of the Bist Doab in 1980. The percentage area under this crop, however, varies markedly from one part of the region to another (Map. 4.7).

The hilly and foothill parts of the Bist Doab have the highest concentration of wheat-gram. The crop covers 6.1 to 34.1 per cent of the
total cropped area of various assessment circles falling in these tracts. Continued dependence on rains due to less developed irrigation and associated risk of crop failures force the people to resort to this crop. Less fertile, lighter soils of these areas, too encourage the cultivation of the mixed crop.

On the other hand, flood plains and upland plain have lowest proportion of their cropped area under wheat-gram. It covers less than 0.6 per cent of the cropland in half of the assessment circles covering these areas. In the remaining half, cultivation of wheat-gram is totally absent. Highly developed irrigation and fertile alluvial soils furnish excellent conditions for the cultivation of wheat rather than a mixture of wheat and gram.

The remaining areas of the Bist Doab falling mostly over the foothill plain are transitional to the two types of areas discussed above, in the cultivation of wheat-gram. The crop covers 1.0 to 4.0 per cent of their cropland. As compared to the upland plain, they have lighter soils and are less irrigated. Therefore, proportion of wheat-gram in these parts is higher than the upland plain. But they follow the hilly zone in the cultivation of this crop, where a more dissected topography, lighter soils and an under-developed irrigation system encourage its cultivation.

In brief, the practice of sowing wheat and gram together in a mixed form drastically decreased in the Bist Doab during 1951-80. Among other factors, considerable expansion of irrigation is instrumental in bringing
its area down. The magnitude of decrease in wheat-gram cultivation is directly related with increase in irrigation and with its strength in 1951. The decline was considerable in the upland plain and adjacent parts of foothill plain where irrigation developed significantly and this crop occupied fairly high share of the cropland in 1951. It now occupies a small proportion of the cropland of these areas. The flood plains had low percentage of their area under wheat-gram which decreased further. However, the hilly tract and few parts of the foothill plain where physical conditions remained favourable for its cultivation and irrigation could not make much headway, had high proportion of their cropped area under this crop in 1951, and continued to grow it on a substantial part of their cropland till 1980. The decrease in its cultivation in these tracts had been smaller.

Gram (*Cicer arietinum*)

Gram ranks third among rabi crops of the region. It is mainly consumed as a pulse. A significant part of this crop is used as animal feed. Gram thrives well on light loamy or sandy loamy soils. Heavier clay loams and silt loams do not suit its cultivation. It is drought resistant. Being leguminous, it fixes nitrogen into the soil and hence enhances soil fertility in a natural process. Excessive cloud cover, heavy rainfall, high humidity and lightening during its flowering period are harmful for gram. That is why, its cultivation is risky in the environmental set up of the Bist Doab.

Gram covered only 2.7 per cent (17,277 hectares) of the total cropped area of the Bist Doab in 1951 (Map 4.9). Its proportion came down to 0.9 per cent (9,160 hectares) in 1980, due mainly to the expansion of assured irrigati
BIST DOAB GRAM
(Data by Assessment Circles)

1951

As percentage of total cropped area

1966

As percentage of total cropped area

1980

As percentage of total cropped area

Change 1951-80

As percentage of total cropped area

MAP 4-9

MAP 4-10

MAP 4-11

MAP 4-12

Source: Unpublished Revenue Records (Lal Khaint)

Significant values

Highest: 13.5%
Lowest: 0.2%
Mean: 2.7%

Significant values

Highest: 5.0%
Lowest: 0.1%
Mean: 1.6%

Significant values

Highest: 13.0%
Lowest: 0.1%
Mean: 1.9%

Change in percentage

Decrease

Increase
Most of its area was diverted to more profitable crop of wheat which fits better into the environmental set up of the region. The decrease in gram cultivation, however, varies spatially. It ranges from 0.1 per cent in Bet assessment circle of Dasuya tahsil to 4.4 per cent in Kandi assessment circle of Garhshankar tahsil (Map 4.12). To a large extent, the decline in gram cultivation in various parts of the region is directly related with its percentage, areal coverage in 1951. The scope for the reduction was higher only in those areas where it occupied greater share of the cropland in 1951 and vice versa.

Southern Bist Doab and parts of the submontane zone in the east, which devoted comparatively high proportion of their area to this crop in 1951, recorded higher decline (between 1.0 and 4.4 per cent) in gram. This crop occupied small percentage of cropland in most of the flood plain and upland plain in 1951 and, therefore, recorded a low (below 1.0 per cent) decrease. The Kandi assessment circle of Hoshiarpur tahsil too recorded low decline, in spite of the fact that gram occupied higher proportion of its cropped area in 1951. Suitability of soils and limited extension of irrigation did not permit great reduction in the cultivation of gram in this area.

Contrary to the general trend, eight out of thirty-five assessment circles of the Bist Doab registered increase in area under gram. In four of these, the increase is marginal (between 0.2 and 0.7 per cent) while in the remaining four, it ranged between 1.8 and 6.5 per cent. Most of the units where gram cultivation gained impetus are located in the hilly zone.
and the foothill plain. Existence of large sandy tracts and low development of irrigation encouraged further increase in cultivation of gram.

Currently, gram occupies only 0.9 per cent (9,160 hectares) of the total cropped area of the Bist Doab. Less favourable environmental set up of the region for gram and low net profits from this crop as compared to the parallel crop of wheat largely explain its inferior position in the crop complex of the region. Under the prevailing physico-economic conditions, farmers prefer growing wheat to gram. However, some parts of the region do devote a fairly good proportion of their area to this crop. It is an important crop of most of the hilly zone and parts of the foothill plain (Map 4.10). Gram occupies 2.6 to 18.0 per cent of the cropped area of various assessment circles located in these tracts. Large areas of lighter soils in the hills and along the seasonal streams in the foothill plain, which have scanty irrigation and greater dependence on rains, are largely devoted to gram. In rest of the Bist Doab, this crop covers less than 1.0 per cent of the total cropped area.

**Barley (Hordeum vulgare L)**

Barley is a coarse grain. It grows well even on lighter soils. It is relatively less water demanding than wheat. The duration of barley is also shorter than that of wheat. That is why, it is grown many a time in the fields over which sowing of wheat is delayed due to one reason or the other. Being an inferior grain, most of it is raised as a feed and fodder for cattle. Some of it is consumed by distilleries.
Barley covered only 0.4 per cent (2,367 hectares) of the total cropped area of the Bist Doab in 1951 which decreased further to 0.2 per cent (1,628 hectares) in 1980. With increase in irrigation, most of its area was diverted to more remunerative crop of wheat. The decrease in its proportion has been below 1.0 per cent in all the assessment circles of the region. However, in Rakkar and Sirowal assessment circles of Garhshankar tahsil and Bet circle of Balachaur tahsil, barley gained some area during 1951-80. Therefore, these are the only parts where barley at present displays relatively high proportion of the total cropped area. It covers an insignificant proportion of the cropland in other parts of the Bist Doab.

**Kharif Crops**

**Rice (Oryza sativa L.)**

Rice comes next to wheat in the total crop complex of the Bist Doab. However, it ranks first among kharif crops. The people of Punjab traditionally are wheat eaters. The consumption of rice is only occasional. That is why nearly 90 per cent of the rice produced in the region is marketed whereas only 50 per cent of the wheat production is sold for cash. Rice emerged as an important commercial crop of the region. It can be raised in a wide range of temperature conditions, provided enough of water is available. But hot and wet climate especially suits its cultivation. Temperature varying between 20° and 37.5°C is required for its growth. It needs large quantity of water. Flooding of fields particularly during first few weeks of its growth, is one
of its basic requirements. Heavy clay and clay loams, which do not permit easy percolation of water, are excellent for this crop. The monsoon season, extending from July to September provides requisite climatic conditions for its cultivation in the Bist Doab. Monsoon rains, however, are uncertain and inadequate. This limitation has been overcome through the development of irrigation. At present almost whole of the rice raised in the region is irrigated. Changes in the cultivation of this crop are much more spectacular and interesting than those of wheat. As compared to wheat, which increased by two times, rice experienced six-fold increase during the study period.

Rice occupied only 3.1 per cent (19480 hectares) of the total cropped area of the Bist Doab in 1951 (Map 4.13). Its percentage rose to 7.0 (56,206 hectares) in 1966 and to 18.7 (186,330 hectares) in 1980 (Map 4.14 and 4.15). Increase in rice cultivation during 1951-66 was gradual and was mostly due to the development of irrigation through canals, wells, pumping sets and tube-wells. However, faster expansion of its area during post-1966 period was due to the introduction of Green Revolution technology, accelerated increase in irrigation and creation of assured market for this commodity through state trading and support price. People diverted most of the area from less paying crops of kharif season to rice. Many new lands too were devoted to rice cultivation. As a result, its position among various crops in the Bist Doab changed from sixth in 1951 to second in 1980. No other crop of the region experienced faster and larger increase than rice. The region is quite similar to Punjab in the expansion of area under this crop where
BIST DOAB
RICE
(Data by Assessment Circles)

1951

As percentage of total cropped area

Significant Values

Highest: 21.9%
Lowest: 0.1%
Mean: 3.1%

MAP 4-13

1966

As percentage of total cropped area

Significant Values

Highest: 29.3%
Lowest: 0.2%
Mean: 7.0%

MAP 4-14

1980

As percentage of total cropped area

Significant Values

Highest: 30.2%
Lowest: 0.0%
Mean: 18.7%

MAP 4-15

Change 1951-80

Significant Values

Highest: 33.5%
Lowest: 0.1%
Mean: 15.6%

MAP 4-16

Source: Unpublished Revenue Records (Lai Kitabs)
too it witnessed increase from 3.5 to 5.9 per cent and to 17.1 per cent during the same period. Increase in rice cultivation in the region, however, shows striking spatial variations ranging from 0.1 per cent in Kandi assessment circle of Balachaur tahsil to 33.5 per cent in Dhak assessment circle of Phagwara tahsil (Map 4.16). On the basis of the magnitude of change in this crop, the Bist Doab may be divided into three types of areas:

1. Areas of high increase (above 20 per cent);
2. Areas of medium increase (10 to 20 per cent); and
3. Areas of low increase (below 10 per cent).

1. High increase (above 20 per cent) in rice cultivation is a feature of parts of the flood plains comprising Bet assessment circles of Kapurthala and Sultanpur tahsils and Bet circle of Nakodar tahsil. Flood plains, of course, furnish excellent soil moisture conditions for this crop. The control on floods and extension of irrigation through minor irrigation schemes to these areas went a long way in extending rice cultivation. The whole of Phagwara tahsil and Manjki circle of Nakodar tahsil too experienced high increase in rice. Both these areas have heavier clay loam soils which especially suit rice culture. At the same time these areas recorded considerable expansion of irrigation. No doubt, the greater net profits from this crop provided necessary incentive for this change.

2. As many as 14 assessment circles out of a total of 35 in the region, experienced moderate (10 to 20 per cent) increase in proportion of
area under rice. Dona belt falling in Jalandhar, Nakodar and Kapurthala tahsils constitutes one such region. Relatively light soils of this tract did not permit extension of rice to wider areas, despite considerable increase in irrigation. Over such soils, groundnut offered stronger competition to rice. Sirowal circles of Dasuya and Jalandhar tahsils; Dhak and Dhaha Bet circles of Nawanshahr tahsil; and the whole of Phillaur tahsil are other areas which recorded moderate increase in rice cultivation. Maize continued to give a fairly strong resistance to rice over the well drained loamy soils of these areas. Similarly, City Circle of Jalandhar tahsil, where vegetables and fodder remained more commercial and remunerative, too falls in the same category. Flood plain of the Beas in Dasuya tahsil and that of the Satluj in Balachaur and Nawanshahr tahsils are the other parts where also rice cultivation recorded moderate increase. These areas were already under intensive rice cultivation where the scope for further expansion of this crop was not that high.

3. Hilly and foothill zone of the region is characterized by low (below 10 per cent) increase in area under rice. Even within this zone, the increase in its percentage varies. More irrigated parts, such as Sirowal assessment circles of Garhshankar and Balachaur tahsils and Maira assessment circle of Dasuya tahsil experienced comparatively high (between 6.7 and 8.3 per cent) increase in rice cultivation. Elsewhere, the increase is low (less than 3.0 per cent). Lighter and porous soils which do not suit rice culture and paucity of irrigation in this tract account for this.
Retli circle of Nawanshahr tahsil, forming an isolated patch in the south, where soils are lighter, also falls in the same category.

Currently, rice occupies 18.7 per cent (186,330 hectares) of the total cropland of the Bist Doab. But different parts of the region display marked variations in rice cultivation. Percentage area under this crop ranges from a maximum of 35.2 per cent in Dhak assessment circle of Phagwara tahsil to a minimum of 0.1 per cent in Kandi assessment circle of Balachaur tahsil (Map 4.15).

High concentration (above 20 per cent) of rice in the region is found in the flood plain of the Beas and that of the Satluj in Nakodar tahsil. As discussed earlier, these tracts are environmentally ideal for the cultivation of rice. Maira circle of Dasuya tahsil, Manjki circle of Nakodar tahsil and an isolated patch comprising Phagwara tahsil also fall in the same category. Proportion of rice in all these areas ranges between 21.4 and 35.2 per cent. Their heavier clay loam soils and fairly developed irrigation favour rice cultivation.

Moderate concentration (ranging between 10 and 20 per cent) of rice is a feature of 13 assessment circles. Most of these fall in the upland plain. As compared to the flood plains, rice in this highly irrigated tract of the Bist Doab faces greater competition from groundnut in the Dona area, from vegetables and fodder in highly urbanized central parts and from maize in gently sloping and traditional maize producing southeastern parts.

The submontane zone is least known for rice cultivation. The
crop occupies normally below 10 per cent of the cropped area in this zone. Lighter sandy soils and limited development of irrigation largely explain this fact. Rice shows spatial variations within this tract too. These are largely associated with the clay content in the soil and development of irrigation. Area under rice hardly reaches 2 per cent in 9 out of 13 units falling in this category. And in two out of the remaining four, it is well below 4 per cent. Sirowal assessment circle of Garhshankar tahsil is the only one where area under this crop is 9.3 per cent. Retli circle of Nawanshahr tahsil is another unit where rice occupies higher share of the cropland due largely to more developed irrigation.

In short, rice cultivation in the Bist Doab recorded nearly ten-fold increase in its hectarage and six-fold increase in its percentage during the study period. No other crop of the region witnessed such a spectacular positive change. Introduction of high yielding varieties and consequent increase in its yield along with state trading and support prices, similar to wheat, made this crop much more remunerative in comparison to the competing crops. The development of irrigation further facilitated its expansion. But for lighter soils and dearth of irrigation in some areas, this crop would have reigned supreme all over the region. The flood plains, which furnished highly suitable soil moisture conditions and to which irrigation was also extended particularly after the checking of floods, recorded highest increase in area under rice. As a result, these tracts at present display maximum concentration of this crop. In most of the upland plain, rice gained moderately despite
intensive irrigation, due mainly to the resistance offered to it by companion crops, such as groundnut, maize, fodder and vegetables. Few parts of the flood plains, where its cultivation was fairly high in 1951, also experienced moderate increase. As a result, the upland plain comes next to the flood plains in the concentration of rice. This crop registered low increase in submontane zone where soils are lighter and irrigation could not make much progress. These areas are environmentally least suitable for rice cultivation and thus lag far behind the other two regions in the cultivation of this crop.

Maize (Zea mays, L.)

Maize follows rice in areal coverage and thus ranks second among kharif crops of the region. Major proportion of this crop is consumed as a cereal. People relish it during winter months. A part of maize production is used as poultry feed. Some of it also finds its way to the distilleries. Maize requires hot and humid climate from germination to flowering. It flourishes well if the temperature varies between 20° and 27° C. A well distributed rainfall ranging from 50 to 100 centimetres during its growing season is needed for its proper growth. Maize can bear heavy rains, provided water does not stand in its roots for longer duration particularly at its young stage. It can be successfully raised with irrigation, if the rains are insufficient. The crop grows on a variety of soils. However, well drained fertile loams are excellent for this crop. Such soils are abundantly available in the Bist Doab. The requisite climate too prevails in the region during the monsoon season.
Maize covered 12.4 per cent (77,861 hectares) of the total cropland of the Bist Doab in 1951 (Map 4.17). Its proportion increased to 15.9 per cent (127,760 hectares) in 1966 and afterward came down to 12.4 per cent (123,518 hectares) in 1980 (Map 4.18 and 4.19). Introduction of improved varieties of seeds, expansion of irrigation and growing demand for this commodity for food and poultry feed accounted for its areal and percentage increase during 1951-66. But after 1966, it experienced decline mostly because of increased competition from more remunerative crop of rice. Although percentage area under this crop is the same as in 1951, yet its absolute hectarage increased from 77,861 to 123,518 during the study period. Greater increase in total cropped area vis-a-vis the increase in area under maize explains this fact.

Like the Bist Doab, maize cultivation in Punjab increased from 5.5 to 8.2 per cent during 1951-66 and decreased to 6.0 per cent in 1980. It is evident that the study region remained far ahead the state in the cultivation of this crop during the entire period under review. Better position of maize in the Bist Doab vis-a-vis Punjab is attributed to more conducive environmental conditions with regard to soils and climate in the region than that in the state. Different parts of the Bist Doab, however, recorded differential change in percentage area under maize. In order to discuss spatial variations in this crop, the region may be divided into two halves (Map 4.20):

1. The eastern half, where maize recorded increase; and
2. The western half, where it experienced decrease.

1. Increase in cultivation of maize over eastern half of the region varies from a minimum of 0.4 per cent in Bet circles of Balachaur and Nawanshahr.
BIST DOAB
MAIZE
(Data by Assessment Circles)

1951
1966
1980
Change 1951-80

As percentage of total cropped area

Significant Values
Highest 37.0%
Lowest 5.0%
Mean 10.4%

As percentage of total cropped area

Significant Values
Highest 42.6%
Lowest 3.4%
Mean 15.9%

As percentage of total cropped area

Significant Values
Increase 12%
Decrease 6%

As percentage of total cropped area

Change in percentage

Significant Values
Increase 14%
Decrease 0%
Mean 0.0%

Source: Unpublished Revenue Records (U.S. Kinda)
tahsils to a maximum of 19.6 per cent in Sirowal circle of Balachaur tahsil. Greater increase (above 6.0 per cent) in maize cultivation over the eastern half is associated with two types of areas. First, the hilly and choe infested foothill plain which offered favourable environments for maize in the form of well drained loamy soils and relatively high rainfall. This is the least irrigated part of the Bist Doab. Under such conditions, neither rice nor cotton offered significant competition to maize. Thus, maize gained considerable area. South-eastern parts of the upland plain, comprising Nawanshahr and Phillaur tahsils too recorded higher increase. These are the traditional maize producing areas where its cultivation increased further. Other assessment circles of the eastern half where maize already covered sufficiently high percentage of their cropland and where rice gave stronger competition due to enhancement in irrigation, recorded relatively low increase (below 6.0 per cent) in maize cultivation.

2. Western half of the Bist Doab experienced decrease ranging between 2.2 and 6.6 per cent in cultivation of maize. This is especially true of the flood plains where rice gained prominence and of the Dona tract where groundnut offered stronger competition. City Circle of Jalandhar and Sirowal circle of Phagwara also witnessed low decline in maize cultivation. In these units it came down in favour of vegetables and fodder crops, the demand for which increased due to increase in urban influence.

At present, the hilly as well as the foothill zone and southeastern parts of the upland plain grow more maize than any other part of the Bist Doab. The crop occupies 12.4 per cent to 49.4 per cent of the total cropped area of various assessment circles in these parts. As already stated, well drained loamy soils,
comparatively high rainfall and limited irrigation in these tracts favour maize but most of these conditions are detrimental to parallel crops such as rice, cotton and groundnut. Flood plains, where rice reigns supreme, Dona tract where groundnut does better, City Circle of Jalandhar where vegetables and fodder offer considerable competition and parts of Phagwara tahsil where irrigation is well developed and soils are heavier, have low proportions of their area under maize.

In short, maize registered increase in its cultivation over the eastern half of the Bist Doab. The areas of increase are traditional maize growers. In these parts, environmental conditions are conducive for maize but are detrimental for the parallel crops like rice, cotton and groundnut. At present these parts display the highest concentration of maize. On the other hand, cultivation of maize decreased in western half of the Bist Doab because of enhanced competition from other crops. Currently, this part devotes low proportion of its cropland to maize.

Sugarcane (Saccharum officinarum L.)

Sugarcane is an annual crop. It is sown in March - April and harvested during December - March. It is a ratoon crop and gives two to three cuttings from a single sowing. However, its yield decreases with successive ratoons. This crop requires hot and wet climate and well drained, fertile, loamy soils. Although the Bist Doab has loamy soils for growing sugarcane, but the hot and wet climate needed by this crop is confined only to the monsoon months. Hot and dry climate during its early stages (March-June)
and low temperature during later stages (November - February) retard its
growth. Occasional frost associated with very low temperature during winter
months is highly injurious for sugarcane. Nearly 80 per cent of its growth
takes place during summer months. That is why, it has been treated as a
kharif crop.

Sugarcane occupied 5.2 per cent (32,990 hectares) of the total
cropped area of the Bist Doab in 1951 (Map 4.21). The proportion came down
to 4.6 per cent (37,409 hectares) in 1966 and to 1.8 per cent (17,603 hectares)
in 1980 (Map 4.22 and 4.23). Although percentage area under sugarcane declined
during 1951-66, yet its absolute hectarage increased. However, after 1966,
the crop suffered sharp fall both in percentage area and absolute hectarage.
Increased competition from wheat and rice, which became much more paying,
especially after mid-sixties largely explains this fact. In a year, a crop of
wheat and rice could be raised successively from the same field as against
one in case of sugarcane. Decline in sugarcane cultivation in the Bist Doab,
however, varies from 0.3 per cent in Dhaha Bet circle of Nawanshahr tahsil
and Beat Manswal circle of Garhshankar tahsil to 5.3 per cent in Sirowal
circle of Dasuya tahsil (Map 4.24).

Sirowal circle of Dasuya and Hoshiarpur tahsils, Dona Charda
circle of Jalandhar tahsil, Dhak and Sirowal circles of Phagwara tahsil and
Dhak circle of Nawanshahr tahsil are the areas where sugarcane cultivation
came down by over 4.0 per cent during the study period. All these areas
devoted higher (between 6.0 and 8.0 per cent) proportion of their cropland
to sugarcane in 1951. In most of them, it recorded increase during first half
BIST DOAB
SUGARCANE
(Data by Assessment Circles)

1951

As percentage of total cropped area

1966

As percentage of total cropped area

1980

As percentage of total cropped area

Change 1951-80

Change in percentage

Source: Unpublished Revenue Records (Lal Widdas)
of the study period due to the establishment of sugar mills at Bhogpur (in 1957-58) and Nawanshahr (in 1962-63) and came down sharply afterwards. In rest of the Bist Doab, decrease in area under sugarcane is below 4.0 per cent. These are the areas where sugarcane cultivation was not that prominent in 1951 and, therefore, the scope for decline was low.

In contrast to the areas discussed above, Sirowal circle of Balachaur tahsil and Bet circle of Nawanshahr tahsil recorded an increase of 0.1 and 2.1 per cent respectively in cultivation of sugarcane. The increase in the case of former is marginal. Increase in the latter is significant and is in response to an incentive from the Nawanshahr sugar mill.

Due to a strong competition from wheat and rice, sugarcane could retain only 1.8 per cent (17,603 hectares) of the total cropped area of the Bist Doab by the end of the study period in 1980. Its cultivation, however, varies areally from a minimum of 0.2 per cent in Rakkar assessment circle of Dasuya tahsil to a maximum of 6.3 per cent in Sirowal assessment circle of Balachaur tahsil (Map 4.23). Maximum concentration of sugarcane in the Bist Doab at present is associated with the sugar mills located at Nawanshahr, Phagwara and Bhogpur because of incentives of market. Around these mills, sugarcane covers more than 2.5 per cent of the total cropland. In other parts of the region it is raised mostly for preparing brown sugar (shakar and gur) for domestic consumption. Its percentage in these areas is below 2.5. Spatial variations in sugarcane cultivation within these areas are associated with...
In brief, sugarcane cultivation in the Bist Doab registered decline during 1951-80. The magnitude of decrease, however, has been higher where the area under sugarcane during the base year was fairly high. Parts of the foothill plain and upland plain, which had relatively high proportions of their cropland under this crop in 1951, experienced greater decrease. The decrease in the remaining parts was low. At present, sugarcane concentrates mainly around the three sugar processing centres in the Bist Doab. In areas located away from these mills, its cultivation is less remunerative and therefore, occupies smaller proportion of the cropland.

**Groundnut (Arachis hypogaea)**

Groundnut is the most important oilseed raised (as cash crop) in the region. Nearly 70 per cent of the total oilseed hectarage of the Bist Doab is devoted to groundnut alone. Most of it is consumed by the oil mills. Some of the crop is also used as edible nuts. Groundnut flourishes well in lighter sandy soils. It needs moderate temperatures of 20° to 25° C and well distributed rainfall of at least 50 centimetres during its growing season. The requisite soils are available in those parts of the Bist Doab which have aeolian soils. The climate during its growing season, where such deposits are found, is also favourable.
In 1951, groundnut accounted for only 0.6 per cent (3,517 hectares) of the region's cropland, as against 1.3 per cent in Punjab (Map 4.25). Its proportion increased to 4.5 per cent (35,853 hectares) in 1966 (as compared to 3.7 per cent in the state), due largely to the increase in its demand and more remunerative nature in relation to many competing crops (Map 4.26). However, after 1966, area under groundnut started decreasing and by the end of study period in 1980, the crop covered only 1.7 per cent (16,898 hectares) of the total cropped area of the Bist Doab (1.5 per cent in Punjab). Introduction of Green Revolution technology during the post-1966 period and development of irrigation encouraged the farmers to divert some area from groundnut to crops like potatoes and rice. However, with reference to its position in 1951, it gained both in percentage area and absolute hectarage (Map 4.25 and 4.27). The magnitude of change in its cultivation ranges from an increase of 18.5 per cent in Dona assessment circle of Sultanpur tahsil to a decrease of 4.6 per cent in Dhaha Bet assessment circle of Nawanshahr tahsil (Map 4.28).

Out of a total of 35 assessment circles of the Bist Doab, 19 recorded increase between 0.3 and 18.5 per cent in its area. Dona belt (Dona Lehnda circle of Jalandhar tahsil, Dona circles of each of Kapurthala, Sultanpur and Nakodar tahsils) of the region, having sandy soils of aeolian origin witnessed high increase (between 5.7 and 18.5 per cent) in the cultivation of groundnut. As already stated these soils suit groundnut but are less favourable for rice, sugarcane and maize and thus largely encouraged its cultivation further. Besides, increase in yields and demand of groundnut played their own role. As a result
BIST DOAB
GROUNDNUT
(Data by Assessment Circles)

1951
As percentage of total cropped area

1966
As percentage of total cropped area

1980
As percentage of total cropped area

Change 1951-80

Significant Values
Highest: 5.5%
Lowest: 0.01%
Mean: 0.06%

Significant Values
Highest: 25.7%
Lowest: 0.01%
Mean: 4.9%

Significant Values
Highest: 25.0%
Lowest: 0.02%
Mean: 1.7%

Change in percentage
Increase
No change
Decrease

Source: Unpublished Revenue Records (Lai Kitabs)
these areas have become the centres of groundnut cultivation in the region. Rakkar circle of Hoshiarpur tahsil, where sandy soils along few seasonal streams were pressed under this crop, too recorded increase of 4.4 per cent in groundnut cultivation. Flood plains, where sub-soil water is close to the surface and soils are heavier, failed to record any notable increase in area under groundnut. The same is true of most of the hilly and foothill tract where relatively high rain and humidity discourage its cultivation.

In contrast to areas discussed above, eastern parts of Jalandhar tahsil, whole of Phillaur and parts of Nawanshahr tahsil experienced decrease, ranging between 0.1 and 0.4 per cent in groundnut cultivation. The soils of these areas are not that suitable for groundnut cultivation as those of the Dona tract. Due to the development of irrigation in these parts, rice, potatoes and maize captured some of the fields previously devoted to groundnut. The whole of Dasuya tahsil, Kandi circle of Hoshiarpur tahsil, Beat Manswal and Sirowal circles of Garhshankar tahsil, Dhak circle of Nawanshahr tahsil and Dhak and Manjki circles of Phagwara tahsil are the other areas where groundnut cultivation could not gain any foothold throughout the study period.

Thus, the Dona tract, where lighter sandy soils of aeolian origin furnish excellent conditions for the cultivation of groundnut registered higher increase. This tract already had high proportion of its area under groundnut in 1951 and recorded a substantial further increase. As a result, this tract displays the highest concentration of groundnut in the Bist Doab. In most other areas this crop gained a little or went down. Parts of the hills add
foothill plain had small proportion of their cropped area under this crop in 1951 and continued to be so with little change. The flood plains and other parts of the Bist Doab, where soils are heavier, are devoid of groundnut culture.

**Cotton (Gossypium species)**

Cotton is the most important fibre crop of the Bist Doab. Most of the cotton raised in the region is of indigenous (desi) variety and is grown for meeting the domestic requirements. Only an insignificant part of it enters the market.

Cotton is a subtropical crop. It needs hot and semi-dry climate, and well drained loamy soils. Temperatures ranging from 21° to 27° C, rainfall ranging from 50 to 90 centimetres during its growing season and bright sunny days during its picking season are required for its cultivation. High humidity and rainfall cause diseases to this crop and reduce its yield. Cotton does better if it is raised with irrigation in semi-dry climate. The plant is sensitive to excessive soil moisture conditions. It needs well drained soils which permit quick percolation of water. The requisite climatic conditions for its cultivation in the Bist Doab are not widely available. Therefore, it does not occupy an important position in the cropping pattern of the region.

Cotton covered only 2.1 per cent (13,297 hectares) of the total cropped area of the Bist Doab in 1951, which declined marginally to 2.0 per cent (16,673 hectares) in 1966 (Map 4.29 and 4.30). However, its absolute
area increased by 3,376 hectares during this period. But after 1966, it started declining and came down to occupy only 0.9 per cent (9,244 hectares) of the total cropped area of the Bist Doab in 1980 (Map 4.31). Mounting competition from parallel crops, particularly after the introduction of Green Revolution technology largely brought this negative change in area under cotton during 1966-80. In contrast, its cultivation in Punjab increased continuously from 5.7 per cent in 1951 to 8.8 per cent in 1966 and further upto 9.6 per cent in 1980. As compared to the region, higher cultivation of cotton in the state throughout the study period is largely because environmentally more conducive areas for its cultivation fall outside the Bist Doab. Barring three assessment circles (Bet of Nawanshahr tahsil and Kandi and Rakkar of Garhshankar tahsil), whole of the Bist Doab recorded decrease ranging from 0.1 to 6.1 per cent in area under cotton (Map 4.32). The decline is relatively high in those areas where its proportion was higher in 1951. The increase in its cultivation in the three assessment circles mentioned above is only marginal (between 0.4 and 0.9 per cent).

As already stated, cotton at present (in 1980) covers only 0.9 per cent (9,244 hectares) of the total cropped area of the Bist Doab. A few assessment circles such as, Manjki and Dona of the Nakodar tahsil, Kandi and Rakkar of Garhshankar tahsil and whole of Phillaur tahsil, where enough of well drained soils are available, have slightly higher proportion (between 1.0 and 2.2 per cent) of their area under this crop. In remaining parts of the region, it covers less than 1.0 per cent of the total cropland (Map 4.31).
In brief, cotton occupied a small proportion of the cropland of the Bist Doab in 1951 which came down further during the study period. Less subservient physical environments for cotton and growing competition from parallel crops, such as rice and maize which do better under prevailing conditions, largely explain this situation. Whatever small amount of cotton is grown here, is of indigenous variety and is used for domestic requirements of the farmers.

Bajra (Pennisetum typhoideum, Pearl millet)

Bajra is a kind of coarse millet. It is raised as feed crop in Punjab, unlike dry areas of the country where it is normally produced as a cereal. Bajra needs semi-dry climate and lighter sandy and sandy loam soils. The crop is sensitive to waterlogging and flourishes well in areas receiving 40 to 65 centimetres of annual rainfall. The Bist Doab has higher rainfall than needed by this crop. Therefore, bajra does not grow well in the region. Secondly, it is no match to rice, maize and groundnut in cash returns. Its cultivation decreased from 2.5 per cent (15,580 hectares) of the total cropped area in 1951 to 0.4 per cent (3,520 hectares) in 1966 and to 0.1 per cent (985 hectares) in 1980 (Maps 4.33 to 4.36). Except Kandi and Sirowal circles of Balachaur tahsil (4.7 and 0.2 per cent respectively), Dona circle of Sultanpur tahsil (1.6 per cent), and Dona Charda circle of Jalandhar tahsil (0.1 per cent), where it is raised on light textured unirrigated soils, bajra disappeared from the agricultural scene of the Bist Doab.
Other Crops

Fodder, vegetables, pulses and oilseeds (other than groundnut) have been discussed under this head. Each of these is not a crop in itself but is a group of crops which have been clubbed together on the basis of their function, irrespective of the season during which they are raised.

Fodder Crops

Fodder refers to the crops which are cut green for feeding the livestock. Barsim (Egyptian clover, Trifolium alexandrinum), barley senji (Indian clover, Melilotus parviflora), and methe (Fenugreek, Trigonella foenumgraecum) of the rabi season; and jowar (Great millet, Andropogon sorghum), bajra (pearl millet), guara (cluster bean, Cyamopsis psoraloides) and maize of the kharif season are the major fodder crops produced in the Bist Doab. Due to heavy population pressure on land, permanent pastures in the Bist Doab, as also in the state, are altogether absent. Thus, livestock (dairy and draft) is fed on cultivated fodder. Fodder cultivation in the region experienced decline during the last thirty years. It occupied 23.6 per cent (148,668 hectares) of the total cropped area of the Bist Doab in 1951, which decreased to 17.6 per cent (141,990 hectares) in 1966 and to 12.0 per cent (119,489 hectares) in 1980 (Maps 4.37 to 4.39). The decrease in fodder cultivation is linked with the increase in its yields, brought largely by the introduction of improved fodder seeds, augmentation of irrigation and application of other measures of Green Revolution technology. Thus, more livestock could be fed from lesser fodder hectarage. It enabled the farmers to spare more land for growing market crops. Not to talk of the Bist Doab, the same type of trend in fodder
BIST DOAB
FODDER
(Data by Assessment Circles)

1951
As percentage of total cropped area

1966
As percentage of total cropped area

1980
As percentage of total cropped area

Change 1951-80
Change in percentage

MAP 4-37

MAP 4-38

MAP 4-39

MAP 4-40

Significant Values
Highest: 36.6%
Lowest: 5.9%
Mean: 23.6%

Significant Values
Highest: 26.8%
Lowest: 13.3%
Mean: 17.4%

Significant Values
Highest: 24.1%
Lowest: 7.1%
Mean: 18.6%

Source: Unpublished Revenue Records (LAH)
cultivation is true of the state as a whole where its proportion decreased from 16.6 to 16.2 per cent during 1951-66 and further to 11.0 per cent in 1980.

The decline in fodder cultivation in the Bist Doab varies strikingly from one part of the region to another (Map 4.40). Kapurthala, Sultanpur, Nakodar, Phillaur and Nawanshahr tahsils, most of Jalandhar and Phagwara tahsils and neighbouring parts of Garhshankar and Balachaur tahsils recorded high (over 8.0 per cent) decrease. These areas had over 15.0 per cent of their cropland under fodder in 1951 and therefore, offered greater scope for decline. The whole of Kandi-Rakkar belt of the Bist Doab and Sirowal belt in Hoshiarpur, Jalandhar and Phagwara tahsils recorded low (below 8.0 per cent) decrease in cultivation of fodder. Most of the Kandi-Rakkar area had low proportion of its cropland under fodder in 1951 and, therefore, recorded low decrease. A considerable part of the fodder need in these tracts is fulfilled by rough pastures which are available along hill slopes. But in the case of Sirowal tract, fodder occupied fairly high proportion of cropland in early 1950s. Despite that it registered low decline. This tract is dissected by seasonal streams but it is relatively flat and fertile. Thus, little rough pastures are available as compared to the Kandi-Rakkar belt. A larger part of the lighter sandy soils found along the seasonal streams continued to be devoted to fodder. This is more true of fodder crops of the kharif season.

In sharp contrast to the areas discussed above, fodder cultivation increased, though marginally, in Maira, Sirowal and Bet assessment circles
of Dasuya tahsil and Beat Manswal assessment circle of Garhshankar tahsil. Increase in fodder in case of Dasuya is mostly the outcome of increase in the cultivation of barsim (rabi fodder). This crop does well on mildly saline soils which were available in parts affected by waterlogging. However, in Beat Manswal circle of Garhshankar tahsil, the position is different. Here the increase is marginal (0.4 per cent) and is due to the expansion in area under kharif fodder.

Currently, fodder covers 12.0 per cent (119,489 hectares) of the total cropped area of the Bist Doab. Out of this, 7.5 per cent is raised during rabi season and the rest (4.5 per cent) during kharif season. Fodder cultivation displays striking areal variations in the study region (Map 4.39).

High concentration (above 15.0 per cent) of fodder is a characteristic firstly, of the areas where large urban centres such as Jalandhar and Phagwara are located. Most of the fodder raised in such areas is commercial in nature. It is produced to cater to the needs of large number of dairy cattle in and around urban centres. Secondly, fodder is raised over a larger share of cropland in parts of submontane zone in Garhshankar and Balachaur tahsils. Large tracts of lighter soils along the seasonal streams in this tract are devoted to fodder. Superior crops fail to do well on such marginal soils. Fodder occupies low percentage (below 10.0 per cent) of cropped area in flood plains, where a lot of emphasis is placed on more remunerative crops of wheat and rice. Also the availability of rough pastures along the rivers reduce the need for fodder to some extent. Kandi circle of Hoshiarpur tahsil and Kandi and Rakkar circles of Dasuya too fall in the same category. These areas are highly suitable
for the cultivation of wheat-gram and maize. Rough pastures too are available in fairly large amount. The remaining areas of the Bist Doab have moderate (between 10.0 and 15.0 per cent) proportions of their cropland under fodder crops.

Hence, fodder cultivation in the Bist Doab declined during 1951-80, in response to the increase in competition from more paying crops and introduction of high yielding fodder seeds. Greater decrease in fodder cultivation, however, has been a feature of the areas in which it occupied higher proportion of the cropland in 1951 and where irrigation recorded a substantial increase during the study period. All such areas fall in the upland plain and flood plains of the Bist Doab. However, in parts of the submontane zone, fodder covered higher percentages of the cropland in 1951 but registered low decrease. The conditions concerning irrigation and farming methods did not change in these parts, to any notable extent. Therefore, superior crops could not encroach upon the fodder hectarage to any significant extent. Currently, these parts, and areas around urban centres display higher concentration of fodder. Fodder occupies low proportion of total cropped area in the flood plains where wheat and rice offer strong competition. A few parts of the hilly zone where wheat-gram and maize gain more prominence, and cultivated area is limited, too have smaller proportion of their cropland under this group of crops.

Vegetables

Vegetables (including potatoes) constitute an integral part of daily food requirements of the people. This is more true of urban dwellers who
consume greater part of the total vegetable production. In order to keep
the supply perennial, a large number of vegetables are grown throughout
the year. Cauliflower (Brassica oleracea), pea (Pisum sativum), carrot
(Daucus carota), radish (Raphanus sativus), garlic (Allium sativum), turnip
(Barassica rapa L.), onion (Allium cepa), potato (Solanum tuberosum),
and coriander (Coriandrum sativum) are the major vegetables produced
in the region during winter season. Together, these covered 1.0 per cent
(10,370 hectares) of the total cropped area of the Bist Doab in 1980.
Tomato (Lycopersicum esculentum), brinjal (Solanum melongena), lady
finger (Hibiscus esculentus), chilli (Capsicum frutescens), cucumber (Cucumis
sativus), potatoes and elephant ear (Colocasia antiquorum) are the chief
summer vegetables of the region. These covered 1.8 per cent (17,959
hectares) of the region's total cropland in 1980. Potatoes are raised during
both the seasons. They account for about 63 per cent (18,847 hectares)
of the total area under vegetables. More emphasis on cultivation of potatoes
is due to their less perishable nature, better prices, wider market and
availability of cold storage facilities.

In 1951, vegetables both rabi and kharif (including potatoes),
occupied 0.8 per cent (5,127 hectares) of the total cropland of the Bist
Doab, which increased to 1.8 per cent (14,633 hectares) in 1966 and
to 2.8 per cent (28,329 hectares) in 1980 (Maps 4.41 to 4.43). Increase
in their demand due to increase in urban population and living standards
of the people largely explain this trend. Extension of area under vegetables,
however, has largely been facilitated by the increase in tube-well irrigation.
The development of means of transport which enabled their marketing
at urban places, even from longer distances, also played a positive role
in this regard. Their areal expansion, however, is uneven over different
parts of the Bist Doab (Map 4.44).
Maximum increase (above 3.0 per cent) in the cultivation of vegetables is a special feature of the catchment areas of the larger urban centres, such as Jalandhar, Phagwara, Hoshiarpur and Kapurthala. Ever growing demand by urban population accounts for this. In Bet area of Nawanshahr tahsil too vegetables recorded high increase due mainly to increase in the cultivation of potatoes. In rest of the region they could not gain much area and the increase in their proportion is well below the region's average. The increase in vegetable cultivation in the hilly tract and foothill plain is very low mostly due to the absence of any sizable town in the area and partly due to limited extension of the already low irrigation base.

As mentioned earlier, vegetables cover 2.8 per cent (28,329 hectares) of the total cropped area of the Bist Doab. Highly urbanized Jalandhar tahsil and adjoining parts of Hoshiarpur and Nakodar tahsils have the highest (above 5.0 per cent) concentration of vegetables. In these areas vegetable cultivation recorded maximum expansion during the study period. Impact of urban demand is clearly visible in the case of City Circle of Jalandhar tahsil where 42.6 per cent of the total cropped area is devoted to vegetables. In rest of the region, vegetables cover less than 5.0 per cent of the cropland. In most parts, these occupy less than 2.0 per cent of the area and are largely raised in small parcels for domestic use.

In brief, vegetable cultivation recorded notable increase in the region in response to their growing demand and increase in dependable tube-well irrigation. Relatively large increase, however, is a feature of the catchment
areas of bigger urban centres. As a result, these areas have the highest concentration of vegetables in the Bist Doab. Vegetable cultivation in urban surroundings is commercial in nature. In other areas of the Bist Doab vegetables are mostly grown for subsistence purposes in small pieces of land around the tube-wells and other sources of water.

Pulses

Pulses form an important part of the daily food needs of the rural as well as urban people. They are the major source of proteins. Besides, pulses act as important means of enhancing soil fertility by fixing nitrogen into the soil. Masar (Ervum lens), mash (Phaseolus radiatus), moong (Phaseolus mungo), moth (Phaseolus acornitifolius) and arhar (Cajanus indicus) are the major pulse crops raised in the Bist Doab. These may be grown separately or in combination with other crops like gram, maize and cotton. Pulses occupied 2.8 per cent (18,186 hectares) of the total cropped area of the Bist Doab in 1951 which decreased to 1.3 per cent (12,542 hectares) in 1980 (Maps 4.45 to 4.47). Growing competition from wheat and rice, increase in irrigation and introduction of Green Revolution technology resulted in diverting some of their area to these crops. In monetary returns, these failed to compete with other major crops. The decline in the cultivation of pulses is likely to affect the health standards of the people. Their prices have become prohibitive especially for the poor. Upto what extent their decrease in production and availability is going to influence the health standards of the people is a full fledged problem worth exploration.
The decrease in cultivation of pulses in the Bist Doab is directly related with their areal coverage in 1951 (Maps 4.45 to 4.48). The only exception is the parts of the foothill plain where irrigation did not gain much headway and relatively light soils are present in abundance over which pulses thrive well. In these areas, pulses were important in 1951 and continued to be so till today with smaller decline. In other parts of the region they could retain small traces of area by the end of the study period.

Oilseeds

Besides groundnut, til (Sesamum indicum), sarson (Brassica campestris L. var. glauca, rapeseed), toria (Brassica campestris L. var. toria Duth), raya (Brassica juncea, Indian mustard) and alsi (Linum usitatissimum) are important oilseed crops grown in the Bist Doab. Til is raised during kharif season and the remaining four are produced during rabi season. They are grown mostly for domestic consumption. Jointly, they accounted for 0.7 per cent (4,309 hectares) of the total cropped area of the region in 1951 (Map 4.49). Their proportion increased marginally to 0.9 per cent (7,597 hectares) in 1966 and again came down slighly to 0.8 per cent (7,531 hectares) in 1980 (Map 4.50 and 4.51). The proportion of oilseeds remained more or less stable despite the fact that their absolute hectarage nearby doubled during the study period (Map 4.52). Greater increase in total cropped area vis-a-vis area under oilseeds accounts for this. However, their share in the cropland continued to be small, because they are no match in yield and monetary returns to the crops which were offered support prices. These occupy relatively high proportion of the cropland in areas around the urban centres where sarson is raised as a green
vegetable and is sold for cash. The parts of the hilly zone and the foothill plain where relatively light soils are devoted to oilseeds under rainfed conditions, too have slightly higher proportion of their cropland under oilseeds.

**Crop Combination Regions**

Preceding discussion of this chapter relates to the systematic study of individual crops. Such an analysis has its own significance, for it gives an insight into the patterns, problems and prospects of a crop in an area. But no crop, howsoever important, is ever grown in isolation from others. Rather, a number of them are raised simultaneously, in close association with each other. In terms of areal strength, they are interconnected through cause and effect relationship.

The systematic study of individual crops, therefore, does not provide a composite picture of the crop associations actually existing in a region. Thus, the study of crop combinations is inescapable for comprehensive understanding of the crop geography of a region. The demarcation of crop combination regions is a pre-requisite for such an exercise. The idea of studying crops in their combinational associations was pioneered by Weaver (1954). In his view, the identification and delineation of crop associations is significant in three ways: (i) it gives an adequate understanding of the geography of individual crops occupying various positions in a combination; (ii) each crop combination region is an integrative reality in itself that demands definition and distributional analysis, and (iii) such regions help in the formation of still more complex structure of valid agricultural regions.
Weaver initiated a quantitative technique based on standard deviation for identifying crop combinations. His method is known as 'minimum deviation method'. This method was tested by a number of geographers in different parts of the world. Some of them succeeded in delimiting viable regions with this method while others failed to do so. Those who failed, either modified it to suit their study area or discarded it and devised new methods (Doi, 1959; Rafiullah, Athwale, 1966; Dayal, 1967). Its failure normally occurs in those areas where agriculture is basically subsistence and a wide variety of crops is grown during a year. This is especially true of the developing countries of the world. In the present study, Weaver's original method did not yield appropriate combinations. A large number of crops appeared in most of the combinations, thereby making them more complicated. Thus, its modified version given by Doi (1959) was used in this study. Doi's modified version gave simpler and more realistic combinations and thus was adopted. Using this method, the crop combinations for the years 1951 and 1980 of the Bist Doab were calculated, mapped and compared to study the change in this regard (Map 4.59 and 4.60).

Changes in crop combinations

Crop combinations in the Bist Doab experienced considerable change over the study period. Monoculture (single crop) is a rare phenomenon, even in most developed parts of the world. The same is absent in the Bist Doab too. Two crop combination appeared only in two assessment circles in 1951 but extended to eight assessment circles in 1980 (Table 4.2 and 4.3). Similarly,
Table 4.2

Bist Doab: Crop Combinations, 1951

<table>
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<tr>
<th>Sr. No.</th>
<th>Name of the combination</th>
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<th>Name of assessment circle</th>
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three crop association was present in 10 assessment circles of the region in 1951 but it appeared in 20 assessment circles in 1980 (Map 4.59 and 4.60). On the other hand four crop combination figured in 14 assessment circles in 1951 and shrank to 5 units in 1980. The multi-crop combinations too came down in their areal spread from 9 to 2 units during 1951-80. The increase in two or three crop combinations, the decrease in four and multi-crop combinations and the decrease in number of crops appearing in various combinations reflects a clear trend towards the simplification of crop combinations. Greater emphasis on those crops which became more remunerative by diverting area from the less paying ones brought this change. In this process, the crops which recorded decline in their area disappeared from most of the combinations thereby making them simpler. A few, which were altogether absent in the previous combinations, made their appearance by 1980. Rice appeared only in two combinations pertaining to two assessment circles of the Bist Doab in 1951. But by 1980, it entered in five combinations spreading over 21 assessment circles of the region. Groundnut is a new addition into the crop combinations in 1980. Wheat, maize and fodder improved upon their ranks. Relative positions of wheat-gram and gram, however, came down in most of the combinations. Bajra and sugarcane which were present in 1951 in some combinations disappeared by 1980. The relative importance of various crops recorded considerable ups and downs during the study period. Supremacy of wheat as first ranking crop of the region remained unchallenged (Map 4.53 and 4.54). It stood first in 19 assessment circles in 1951 and strengthened its position further. By 1980, it emerged at the first rank in 26 assessment circles. Improvement in its rank took place over the whole of the upland
BIST DOAB
First Ranking Crops
1951
(Data by Assessment Circles)

BIST DOAB
First Ranking Crops
1980
(Data by Assessment Circles)

BIST DOAB
Second Ranking Crops
1951
(Data by Assessment Circles)

BIST DOAB
Second Ranking Crops
1980
(Data by Assessment Circles)

Source: Unpublished Revenue Records (Lai Kitabs)
plain where considerable development of irrigation helped it to extend its fold. In these areas, it relegated fodder to the lower ranks. It overtook wheat-gram and maize in some units in the hilly and foothill zone, and vegetables in the City Circle of Jalandhar tahsil.

Fodder was the largest second ranking crop of the region in 1951 (Map 4.55). It was followed by wheat and wheat-gram. It occupied second place in 17 (out of a total of 35) assessment circles mostly falling in the flood plain and foothill plain regions. By the end of the study period in 1980, fodder was replaced from second position by rice in the flood plains and by maize in foothill plain (Map 4.56). Besides, groundnut is another second ranking crop of the Bist Doab. From amongst the third ranking crops, fodder is the largest although its position was occupied by maize in 1951 (Map 4.57 and 4.58). The other third ranking crops of the region are maize and rice.

A brief analysis of the prevailing crop combinations of the region, however, is essential for understanding its crop geography more comprehensively (Map 4.60).

1. **Wheat-rice region**

Wheat and rice form an important combination of the Bist Doab. It spreads over 6 (out of 35) assessment circles mostly falling in the flood plains of the two rivers. On an average, these two crops cover 72.5 per cent (wheat 46.7 per cent and rice 25.8 per cent) of the total cropland of this
BIST DOAB
Crop Combination Regions
1951
(Data by Assessment Circles)

Wheat
Fodder
Groundnut
Vegetables

Source: Unpublished Revenue Records (Lal Kitabs)
combination region. Their combined strength, however, varies between 70.4 and 80.9 per cent in different assessment circles having this combination. Wheat everywhere ranks first and occupies more than 50 per cent of the cropped area of each of these assessment circles. Rice ranks second all through and covers between 16.7 and 35.2 per cent of their cropland. Fertile, moisture retentive, silt loam soils of the flood plains furnish excellent conditions for the cultivation of wheat during rabi and rice during kharif season. Both these crops are highly remunerative and have assured market. Thus, this combination is highly rewarding. The rotation of these two crops is most common and they draw the same type of soil nutrients. Thus, wheat-rice combination is exhaustive of soil. Maize, fodder, sugarcane and vegetables too are raised in this region, although they do not appear in the combination.

2. **Wheat-maize and maize-wheat region**

Wheat and maize form a distinct combination in Retli assessment circle of Nawanshahr tahsil in the south and Rakkar assessment circle of Dasuya tahsil in the north. On an average, the two crops share 43.4 and 30.7 per cent respectively of the total cropped area of this combination. But these occupy alternate ranks in the two circles. Wheat stands first in Retli whereas maize outranks wheat in Rakkar. The former is fairly flat, intensively irrigated and has sandy loam soils. Under these conditions wheat does well during winters and maize during summers. Rice, fodder and sugarcane follow these two crops, though they fail to appear in the above stated combination. Rakkar circle, being located in the submotane zone has lighter soils.
and scanty irrigation where wheat faces stronger competition from wheat-gram. Thus, it loses its first position to maize and maize-wheat combination is the result. Apart from the two crops appearing in the combination, wheat-gram, pulses and oilseeds are also cultivated.

3. Wheat-rice-maize and wheat-maize-rice region

Spreading over 7 out of 35 assessment circles, this combination covers more area than others. It appears in Dhak and Dhaha Bet circles of Nawanshahr tahsil, whole of Phillaur tahsil, Manjki circle of Phagwara tahsil, Bet circle of Balachaur tahsil and Maira and Sirowal circles of Dasuya tahsil. The constituent crops cover 79.1 per cent of its total cropland. Of this, 44.6 per cent is under wheat alone. Remaining 34.5 per cent is shared almost equally by rice and maize. Wheat and rice are important as usual. Maize too covers considerable area and thus appears in the combination. This region has enough of well drained fertile alluvial soils which provide good conditions for growing maize. Rotation of wheat with rice and maize is most common. Fodder, sugarcane, vegetables, cotton, pulses, wheat-gram and oilseeds are the other crops raised in the areas falling within this combination region.

4. Wheat-rice-fodder region

A combination of wheat, rice and fodder is confined to Dona Lehnda and Dona Charda assessment circles of Jalandhar tahsil, Sirowal assessment circle of Phagwara tahsil and Bet assessment circle of Sultanpur tahsil. The three crops jointly cover 80.8 per cent of the total cropped area of this region. Wheat ranks first everywhere and occupies 46.0 per cent of the cropland.
With 22.2 per cent of the cropped area, rice comes next. Superior position of these two crops in the combination is obvious. Fodder comes at third place. Its greater demand in the urban centres of fairly large size accounts for its larger areal coverage. Vegetables, maize, sugarcane and groundnut are other crops raised in this crop-association region.

5. **Wheat-maize-fodder and maize-wheat-fodder region**

Sirowal assessment circle of each of the Hoshiarpur, Garhshankar and Balachaur tahsils is marked with the association of wheat, maize and fodder. These three crops, constitute 78.8 per cent of the total cropped area of this belt. Of this, more than half (40.3 per cent) is covered by wheat alone. Accounting for 24.9 and 13.6 per cent of the total cropland respectively, maize and fodder come next in areal coverage. In this tract maize occupies second place due to porous soils and less developed irrigation. Such conditions suit this crop but are not that conducive for rice. Maize outranks even wheat in Sirowal circle of Balachaur tahsil because of the same reason. Fodder occupies third place in both cases. Along with their mutual rotation, wheat and maize are commonly rotated with fodder crops. Sugarcane, vegetables, pulses, cotton, gram, barley and oilseeds are the other crops grown in this region.

6. **Wheat-rice-groundnut region**

Wheat, rice and groundnut form a separate combination in the Dona belt stretching in parts of Kapurthala, Sultanpur and Nakodar tahsils. The three crops occupy 80.9 per cent of the total cropland of this region.
Wheat with an average area of 46.8 per cent and rice with 18.3 per cent ranks first and second. Those parts of this tract, where soils are heavier, are devoted to rice. Wheat of course is raised on wide variety of soils under irrigation. Groundnut occupies third position (15.8 per cent). Cultivation of this crop is associated largely with vast tracts of sandy soils of aeolian origin which are more suitable for groundnut. Fodder, maize, cotton, gram, sugarcane and pulses are also grown in this region.

7. Wheat-maize-gram' and wheat-gram'-wheat-maize region

Combination of wheat, maize and wheat-gram sprawls over Kandi assessment circles of the Dasuya and Hoshiarpur tahsils. The combination crops cover 87.3 per cent of the total cropped area. Wheat and maize account for 31.3 and 30.7 per cent respectively of its cropland and a mixed crop of wheat-gram occupies the remaining 25.3 per cent. A larger share of the cropland under wheat and maize is obvious. Mixed cultivation of wheat and gram is due to wider availability of lighter soils and limited development of irrigation. Under these conditions, wheat-gram outranks wheat and maize in more hilly and choe infested Kandi circle of Hoshiarpur tahsil. Mixed cropping reduces the risks involved in the failure of wheat or gram raised separately. Besides, fodder, gram, pulses and oilseeds are also cultivated in this region.

8. Vegetables-wheat-fodder region

Vegetables-wheat-fodder combination is restricted only to City Circle of Jalandhar tahsil. Occupying 96.2 per cent of the total cropland,
these three crops make almost a clean sweep in areal coverage. Vegetables alone account for 42.6 per cent of the cropped area. Wheat (30.7 per cent) and fodder (22.9 per cent) follow in order. The City Circle, as its name indicates comprises the city of Jalandhar and its immediate surroundings. Due to a very heavy demand for fresh vegetables by the urban people, the farmers concentrate on vegetable cultivation. Fertile alluvial soils and intensive irrigation (93.3 per cent of its net area sown is irrigated) are other favourable factors. Likewise, fodder is grown to meet the requirements of dairy cattle in and around the city. It is a commercial crop and is marketed either directly or through dairy products. Therefore, along with vegetables, fodder constitutes a highly rewarding combination in monetary terms. Wheat, of course, is important as usual. All other crops raised in this region are of minor importance and cover very little proportion of the cropland. They include groundnut, pulses, rice, oilseeds, maize and sugarcane.

9. **Wheat-maize-fodder-wheat-gram' region**

Cultivation of wheat, maize and fodder in association with wheat-gram (mix) make a separate combination in Rakkar circle of Hoshiarpur tahsil and Rakkar and Beat Manswal circles of Garhshankar tahsil. On an average, wheat stands first (29.4 per cent) and is followed by maize (22.6 per cent), fodder (15.9 per cent) and wheat-gram (13.3 per cent) in order. The mixed cultivation of wheat and gram is preferably practised unirrigated fields having poor soils. Maize gains importance during rainy season, as it does better than
most other crops under prevailing environments. Most of the fodder grown here belongs to the kharif season. Marginal soils of these units are largely devoted to its cultivation. Pulses, barley, oilseeds and groundnut are other crops grown in this association region.

10. **Maize-wheat-fodder-gram region**

The combination of maize, wheat, fodder and gram covers only Rakkar assessment circle of Balachaur tahsil. Actually, it is an extension of the preceding region and has similar environmental set up. The type of crops raised is almost the same. But wheat (25.5 per cent) is dominated though marginally by maize (26.0 per cent). Fodder (21.3 per cent) remains at the third place. It differs from the preceding combination region in terms of cultivation of gram (9.6 per cent) as an individual crop over a significant proportion of the cropland. Mixed cultivation of wheat and gram covers 7.6 per cent of the total cropped area and failed to enter into the combination. Sugarcane, pulses and oilseeds are other crops of the region.

11. **Wheat-rice-maize-fodder region**

Sirowal assessment circle of Jalandhar tahsil is characterized by a combination of wheat, rice, maize and fodder. These four crops jointly occupy 87.3 per cent of the total cropped area of this region. Out of this, 43.5 per cent is covered by wheat alone. Other crops forming the combination account for 16.4, 14.6 and 12.8 per cent of the cropland respectively. This region is transitional to wheat-maize-fodder region located towards its east
and wheat-rice-fodder region towards its west. In terms of the extent of cultivation and irrigation it is more close to the latter and in terms of type of soils it resembles the former. Therefore, maize of the eastern and rice of the western region appear in the combination. Wheat and fodder, of course, are common. Other crops which do not appear in the association but are grown are sugarcane, vegetables, gram, groundnut and cotton.

12. Multi-crop region

Multi-crop region in the present case, refers to an association region of five crops. These five crops are fodder (22.4 per cent), maize (20.6 per cent), 'wheat-gram' (16.0 per cent), gram (14.1 per cent) and wheat (13.5 per cent). The region comprises the Kandi assessment circle of Garhshankar and Balachaur tahsils. Being hilly, the region is infested by seasonal streams. Its soils are poor and irrigation is limited. Under such conditions fodder crops and maize do well during kharif season. Wheat mixed with gram does better during rabi season and pushes wheat to a lower position. Besides, oilseeds, pulses, bajra, cotton and sugarcane are also cultivated though they fail to appear in the combination.

In short, wheat is the leading food and cash crop of the Bist Doab. It occupies first rank in all but two combinations in the region. Rice is the largest second ranking crop and identifies itself with the flood plains. Along with wheat it appears into the combination in these riverine tracts. Dona belt is especially known for groundnut cultivation. This crop follows wheat and rice in the combination in these areas dominated by aeolian soils. In
more urbanized central parts of the upland plain, fodder gains prominence. It follows wheat and rice in the combination over here. Area around Jalandhar city, however, is a special case where a considerable emphasis is laid on vegetable and fodder cultivation due to their heavy demand. Thus, a combination of vegetables, wheat and fodder is a characteristic of the city circle of Jalandhar tahsil. Maize is important in the foothill plain where well drained soils furnish excellent conditions for its cultivation. In this tract it comes next to wheat in the combination. Fodder too is abundantly grown in this zone of lighter soils. Thus, an association of wheat, maize and fodder is the result. However, in northern and southeastern parts of the upland plain, wheat, rice and maize appear in most of the combinations. Eastward, in the hilly zone, more than four crops join to form a combination. Here, mixed cropping of wheat and gram becomes significant due to highly restricted irrigation and lighter soils and thus enters into the combination along with fodder, maize, gram and wheat. The variations in the crop combinations from one part of the Bist Doab to another are largely the function of the differences in the development of irrigation, type of soils and surface configuration.

Conclusion

Rationalization of cropping pattern on commercial lines is a special feature of the agricultural land use of the Bist Doab during the last 30 years. All those crops which have become more remunerative in due course of time have gained area mostly by capturing land from less paying competing crops. Among the gainer crops, wheat and rice are the most important.
of high yielding variety seeds and creation of assured market for them by way of support prices and guaranteed purchases by the state agencies largely explain this trend. Development of irrigation, distribution of chemical fertilizers and disease controlling chemicals through credit facilities, extension services and increase in mechanization mostly facilitated the shift in cropping pattern in favour of wheat and rice. Vegetables and groundnut are other crops which gained area. The increase in area under vegetables is associated with the increase in urbanization and improvement in living standards of the people. Maize gained in absolute hectarage but remained stationary in proportional terms. On the other hand, wheat-gram, fodder, sugarcane, cotton and bajra recorded decline both in absolute hectarage and relative position. Under the changed situation in farming these could not compete with parallel crops in monetary returns. Change in dietary habits of the people and increase in farmers' general awareness towards farming too contributed to this transformation.

Wheat recorded upward trend in almost all parts of the Bist Doab. It encroached upon the area occupied by wheat-gram, fodder crops and gram. Some of the newly reclaimed lands too were pressed under this crop. Rice gained in flood plains where soil moisture conditions are highly suitable for its cultivation. It captured considerable proportion of the cropland in the upland plain too where irrigation recorded a substantial development on already high base. It replaced maize, sugarcane and cotton from many fields in these areas. Groundnut witnessed increase in Dona belt of the upland plain where aeolian soils furnished excellent conditions for its success. Areas around major urban centres, such as Jalandhar, Phagwara and Hoshiarpur, where the demand
for vegetables increased due to increase in urban population, witnessed expansion in vegetable cultivation. Maize registered increase in the foothill plain and the hilly zone where well drained soils and higher rainfall provide good environments for this crop. Introduction of improved seeds and resultant increase in its yields too provided a fillip to this crop. Most of the sugarcane, cotton, bajra and jowar (fodder) hectarage was diverted to maize in these tracts. Due to porous soils and less developed irrigation, rice failed to compete with maize in these areas. Cotton too could not withstand competition from maize due to less favourable climate.

In general, the quantum of change in the cropping pattern has been the highest in the fertile and flat upland plain and a few parts of the foothill plain. Substantial development of irrigation, greater use of improved farm methods and machines, and increase in urbanization account for this. The areas associated with the hills and the dissected foothill plain recorded the lowest over-all change in this regard for obvious reasons. The flood plains, however, are transitional to these two types of areas in terms of total change in cropping pattern.

Greater emphasis on foodgrains is another chief characteristic of the cropping pattern of the Bist Doab. They occupied nearly four-fifth of the total cropland of the region in 1980 (as against two-third in 1951). Wheat ranks first. It is the staple food and one of the chief cash crops of the people. No other crop of the region competes it in terms of areal coverage
and consumption. Rice comes next and dominates the cropland use of the flood plains where silt-loam moist soils provide ideal conditions for its cultivation. Fairly developed irrigation also facilitates its cultivation in these areas. Its position is very strong in most of the upland plain too. Considerable development of irrigation in these areas speaks for this. Maize, wheat-gram, mash and masar are other foodgrains raised in the Bist Doab. Maize is important in the foothill plain and the hilly zone. Its cultivation is preferred in these areas due to lesser irrigation and well drained lighter soils. Because of similar reasons, wheat-gram (mixture) and gram also occupy a considerable share of the cropland in these tracts. Fodder ranks high among non-foodgrains. It is raised everywhere and accounts for more than one-tenth of the total cropped area of the Bist Doab. In the absence of pastures it provides feed for dairy and draft cattle. Vegetables, sugarcane, groundnut and cotton follow fodder in order. Cultivation of vegetables is important in areas around major urban centres of Jalandhar, Phagwara and Hoshiarpur. Similarly, sugarcane concentrates around the three sugarcane processing centres located at Phagwara, Nawanshahr and Bhogpur. Groundnut is confined more specifically to the Dona belt which has lighter sandy soils of aeolian origin. Cotton is grown only to cater to the domestic needs of the farmers.

Crop combinations in the Bist Doab simplified during 1951-80. Number of crops in each combination and number of multi-crop combinations declined. Greater emphasis on selected crops by diverting area from others brought this change.

Diversion of area to foodgrains (wheat and rice) went a long way in eliminating food shortages, increasing commercialization of agriculture,
enhancing the income and living standard of the farmers. But it reduced crop
diversification and brought most of the blemishes of a specialized cropping
pattern. The exhaustion of soils accelerated. Reduction in area under leguminous
crops, such as pulses, oilseeds etc. reduced the enrichment of soil through
natural process. It also reduced their availability and enhanced their demand
and price. Such a trend especially in pulses is likely to affect the health of
the poor who depend heavily on them as a source of protein. Thus, a more
diversified but remunerative cropping pattern should be strived for. This may
be achieved by putting greater emphasis on the cultivation of vegetables,
fruits, sugarcane, pulses and oilseeds. Invention of high yielding seeds and
creation of market for them, similar to wheat and rice, will help achieving
this goal.