INTER-DISTRICT VARIATIONS IN WHEAT AND RICE RESPONSES :

A STUDY OF VARIATIONS IN THEIR PRODUCTION AND PRODUCTIVITY
IN

PUNJAB AND HARYANA

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SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF PHILOSOPHY

CENTRE FOR THE STUDY OF REGIONAL DEVELOPMENT
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School of Social Sciences

Jawahar Lal Nehru University

I certify that the dissertation entitled "Inter-District Variations in Wheat and Rice Responses" - A Study of Variations in Production and Productivity in Punjab and Haryana, by Mrs. Nalini Govind in fulfillment of Six Credits out of the total requirements of twenty-four credits for the Degree of Master of Philosophy of the University, is a bonafide work, to the best of my knowledge, and may be placed before the Examiners for their considerations.

Supervisor

Forwarded to
the Registrar

Chairman

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JANUARY 7, 1975 NALINI GOVIND

INTRODUCTION

An inter-district study of variations in production and productivity in any region is essential in order to locate those districts which have high production/productivity in order to concentrate our efforts on raising productivity in those districts. In fact, one of the aims of modern agriculture is to locate these districts which have high growth potential and raise their per capita yields.

In any plan to promote growth of agriculture and to have our plans include the accomplishing of a major transformation rather than a few modifications of the present pattern of farming, it is important to look far ahead in planning. When we speak of modernization of agriculture, it is the accomplishment of this major transformation. Modern agriculture is one in which (1) technology and efficiency of farming are continuously being improved through the use of improved machinery, pesticides, seeds and fertilizers. (2) The commodities produced on farms are changing constantly in response to change in consumer demand and to changes in cost of production brought about by changed technology. In other words, a modern agriculture is one which is highly dynamic and highly flexible and increasingly productive.

For the agriculture of any country to have these characteristics, it must be commercial agriculture with the market and transportation facilities, that can provide efficient mobility of farm products,

farm supplies, equipment credit, information and people to and from all of the farms of the country's agriculture.

Efficiency of Production:

Efficiency of production involves technical and economic efficiency. The farmer deals with the physical relationship between input and output, whereas, the latter deals with the cost price relationship between input and output. In other words we are interested in maximum efficiency with minimum cost. It is important in modern agriculture planning to identify regions having immediate high potential for agricultural growth. It is important to locate such areas where the response to inputs will be the best and fastest. With the technology already in hand, it is important to single out those areas which have access to improved technology. If irrigation is an important part of new technology, then those areas where irrigation is available and where it is not, should be identified.

Degree of Market Orientation:

Degree of market orientation will determine the growth of agricultural production. Farmers who have not previously been accustomed to buying and selling must therefore, acquire new skills and new attitudes with respect to farm operation and with respect to buying and selling if they are to increase production on their farms. Consequently, farmers in areas where the selling of agricultural products has been going on for some time can be expected to move into more commercial farm production more rapidly

than those in areas previously characterised by only subsistence farming. To get a rough estimate of the present degree of market orientation of the farms of an area, one has to observe what commodities flow through the local markets. This can be done through sample survey. Degree of market orientation helps in seeing place priorities only among areas that have immediate high potential for agricultural development. It is only in these areas that present degree of market orientation can be estimated. where a few farmers are already using the new technology, they can give information with respect to the yield response they are getting, cost of additional inputs, local prices they are receiving for their products and so on.

In regions where transportation is readily available and market towns are already well developed, existing local prices may or may not be dependable indices for use in establishing priorities among the immediate growth potential areas.

OBJECTIVES AND METHODOLOGY

The main objective of this study is to examine inter-district variations in the cultivation of wheat and rice in the Punjab-Haryana region.

In the first instance, it is intended to study variations in gross production of the two crops in terms of the area devoted to the respective crops, area irrigated of the respective crops and thirdly, in terms of the productivity index prepared by taking

yield trends with respect to a base year. In other words, this study will bring out the importance of factors resulting in extensive cultivation of the crop and therefore in increases in production of the crop concerned. As a first step, variations in cropping pattern have been studied over time and space. Factors influencing the variations in cropping pattern and the relative importance of crops over the years have been studied by taking into consideration, Net area sown, area under current fallows, area not cultivated other than current fallows, area under forests and gross area irrigated. Has gross cropped area increased due to increase in net area sown or has it more to do with increased irrigation resulting in reduction in current fallows or land hitherto classified as waste, coming under cultivation and so on.

Since there has been a distinct shift in cropping pattern towards rice-wheat crop rotation, a detailed study of rice and wheat has been undertaken.

As a second step, variations in production have been examined in terms of three explanatory variables mentioned earlier for all the districts of Punjab and Haryana. This type of our analysis is attempted with a view to establish whether the trend in production, over time, of wheat and rice is influenced by acreage increases or by yield increases caused by the introduction of better and modern practices of cultivation. This would help us to establish whether in the districts, yield per hectare is rising and whether it can be traced to any

particular year, and what is the position of wheat vis-a-vis rice in the districts.

Another objective of the study is to examine variations in yields of the two crops in terms of the following explanatory variables: (1) Area irrigated of the crop as a proportion to area under the crop, (2) area under high yielding varieties of the crop as a proportion to area under the crop, (3) number of tractors per hectare, (4) number of tubewells per hectare, (5) fertilizer consumption per hectare and (6) price index of the crop.

Such a study would help us to establish the relative importance of the variables in explaining yield changes over time. For this purpose the data for 1968-73 have been used. For a comprehensive study of the crop responses over the years, we need the data for a larger duration than the five years preferably for smaller units than the districts and also sample surveys of farms spread over the study area. However green revolution has been a relatively recent phenomenon and the scope of the study and the time constraints do not permit a more detailed study. The year by year analysis does provide insight into the crop responses for the years under study.

Inter-regional variations in the cropping patterns and crop intensity and related aspects have been studied by mapping each of the variables at two points of time. This enabled the analysis of the spatial and temporal shifts. The variations are shown with reference to state average and also by demarcating the areas having above and below state average. However, most districts

of Punjab are either at the state level or below state average, specially when the proportion of area of wheat under high yielding varieties to total area under the crop is considered. It would seem to suggest that the Punjab region, for the most part had already attained a certain level of yields or agricultural specialization. Hence, the impact of high yielding varieties is not as imposing as it would be expected of in an area where innovations are recent.

Rice offers better explanation in that, in areas of above state average, it might be due to change in cropping pattern in favour of wheat or other commercial crops because of price differences.

Inter-district variations in the cultivation of these two crops could be the result of several factors, both natural and economic. Hence, the study has in the first instance made an attempt to characterise different districts according to their natural conditions such as, topography, soils, irrigation etc. Variations in the acreage under wheat and rice or the cropping pattern over the years, have been attempted with a view to assess the spatial and temporal shifts in land-use pattern in preference to rice and wheat. Intensity of cultivation is studied by taking into consideration the extent of irrigated area under wheat and rice and their fluctuations over the years.

The statistical techniques used include multiple regression analysis and simple coefficient of correlation.

Punjab and Haryana although forming a contiguous region are assumed as separate states unless otherwise stated. This distinction is made in our analysis of variations in production of wheat and rice over time and land use pattern of all crops and wheat and rice in particular. This is due to the fact that data availability for Punjab was for the period 1950-71 (with two of three years gap) and for Haryana, for the period 1950-51, 51-56 and 1960-71. With gaps of 1968-69 and 1969-70, nine years data has been considered. The analysis for production and land use pattern variations has been done by assuming Punjab and Haryana as separate regions.

For mapping, the two states are again assumed as separate regions.

In our analysis of variations in productivity of wheat and rice, the two states are assumed as forming one region and the period covered is 1968-73.

The entire work is based only on secondary data, drawn mostly from the statistical abstracts of Punjab and Haryana and other bulletins issued by the respective Governments.

Tables relating to coefficient correlation between area irrigated of wheat and rice and their respective acreages over time, were prepared earlier by the author, for a term paper entitled, "Impact of Irrigation on Wheat and Rice Productivity" in Punjab, written for the M.Phil course.

Chapter I

MAIN FEATURES OF AGRICULTURAL DEVELOPMENT IN PUNJAB-HARYANA REGION 1951-71

Agriculture is the most important sector of the economies of Punjab and Haryana. This region is favoured by three important factors in its agricultural operations.

(a) a favourable manland ratio;

(b) a good irrigation system;

(c) the dynamism of the farmer which is partly expressed in the use of relatively better techniques.

Agricultural techniques are fairly advanced. Punjab has almost the largest coverage under improved seeds, fertilizers and hybridization of certain crops is already in progress. Advanced tools too are in use in the form of tractors, iron ploughs, electric pumps for tubewells and so on. The consolidation of holdings is well advanced. About 70 per cent of total land cultivated has already been consolidated.

Transport and marketing are important elements of progressive agriculture, and judged by this criteria, Punjab and Haryana leave a better marketing origin as compared to rest of the country. Road transport is also well developed.

Main Features of Agricultural Development in the Region During the Decade 1951-61

Between 1951-61, per acre yields of foodgrains in particular were higher than those for the country as a whole. But during this

period value of output per acre was lower than the national average. This was partly the result of an inferior cropping pattern which was due to lack of water for irrigation particularly in the districts of Hissar, Gurgaon, Rohtak and Mohindergarh. Rice had the highest value and was cultivated on 3.9 per cent of the cropped area. The parallel percentages for wheat, which is of lower value was 22 for Punjab and 7.6 per cent for all India. Gram and bajra, two low value crops accounted for nearly 31.7 per cent the cultivated area in Punjab as against 13.7 per cent for all-India.

There were a few high value cash crops like cotton, sugarcane and tea which covered a larger percentage of the cropped area in Punjab than in India. In general over the period 1951-62, with few exceptions, the cropping pattern remained markedly inferior. High crop productivity per capita and low value of output per acre, thus was a contrasting feature of the period. As such, the period 1951-62 was essentially a pre-green revolution period in the sense that green revolution in the sense of use of new seeds along with scientific inputs such as chemical fertilizers, pesticides, insecticides had made its impact felt in the region only after 1965. After this period, green revolution has increased agricultural incomes in the region.

Features of Agricultural Development in the Decade 1961-71

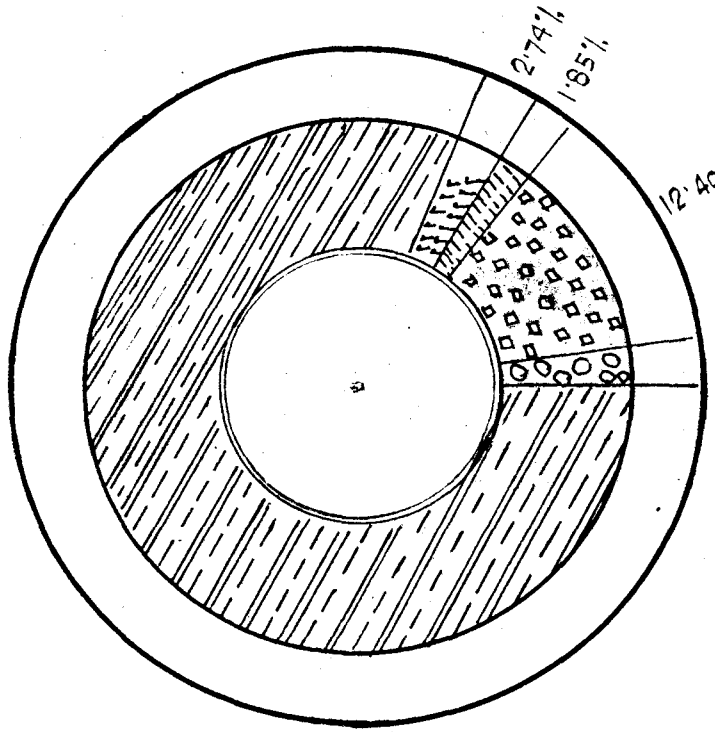
The main aspects of agricultural progress in the region during this decade are:

GRAPH I

LAND UTILISATION

PUNJAB

1970-71



FOREST

LAND NOT AVAILABLE FOR CULTIVATION

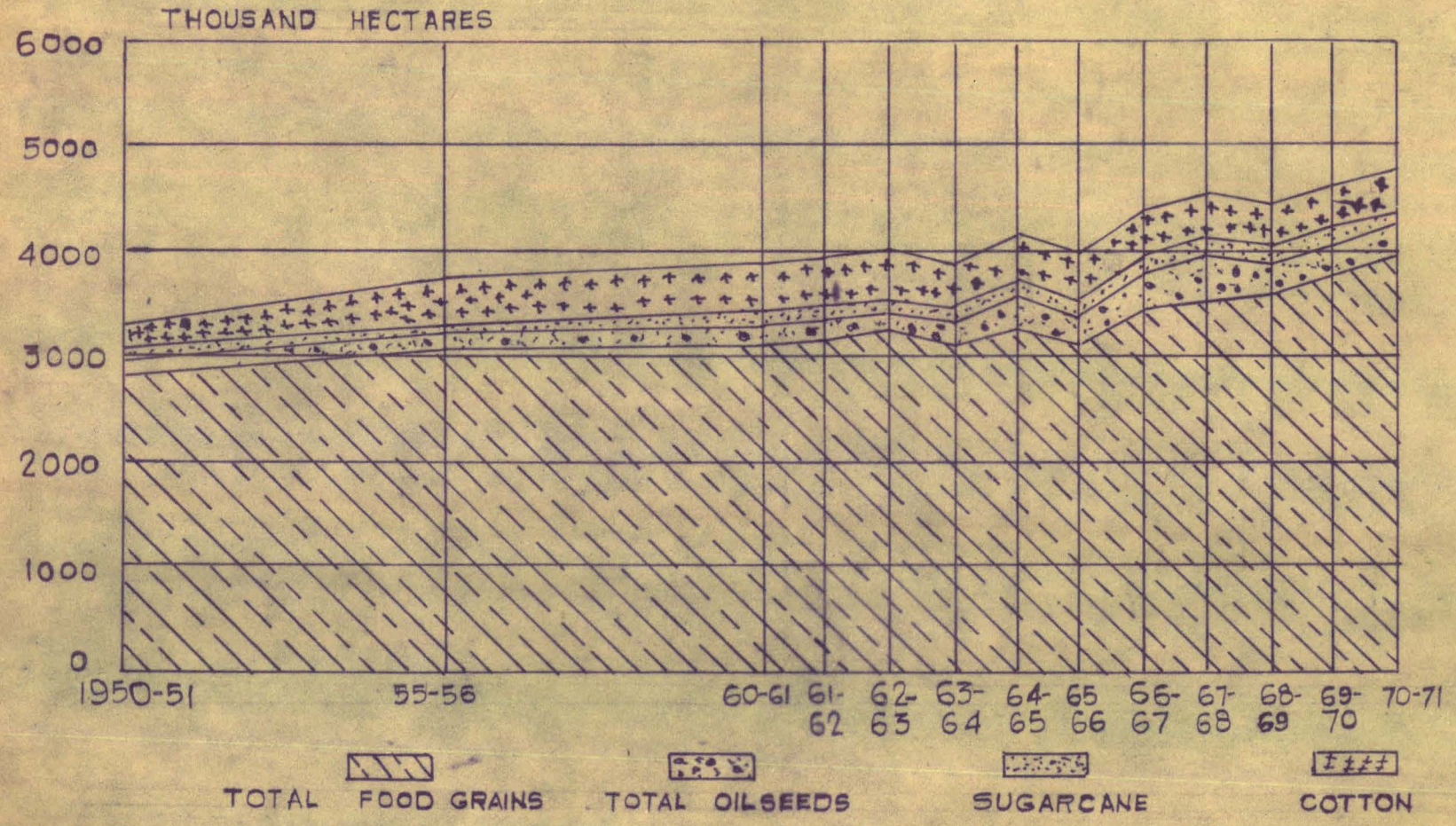
FALLOW LAND

OTHER UNCULTIVATED LAND EXCLUDING FALLOW LAND

NET AREA SOWN

GRAPH II A

AREA UNDER MAJOR CROPS
(PUNJAB STATE)



Land Utilization[1]: There was a slight increase in net area sown of 0.64 per cent. This was due to decrease in area not available for cultivation previously and decrease in fallow land.

It shows that much of fallow area available for CULTIVATION HAD already been brought under cultivation. The cultivable area per agricultural worker in Punjab came down from 2.23 hectares in 1961 to 1.76 hectares in 1971. There being very little land left now which can be brought under cultivation, further increase in agricultural production can be obtained by employing methods of intensive cultivation and multiple crops. Area sown more than once rose from 14.72 lakh hectares in 1969-70 to 16.25 lakh hectares in 1970-71, showing an increase of about 10.4 per cent. The cropping intensity increased from 136.6 in 1969-70 to 140.1 in 1970-71 because of rapid expansion in irrigation facilities.

Area Under Crops[1]: Area under food crops has been continuously rising from 31.02 lakh hectares in 1965-66 to 37.81 lakh hectares in 1969-70 and to 39.28 lakh hectares in 1970-71, showing an increase of 3.9 per cent in 1970-71. The rise in the area under foodgrains was mainly due to an increase in the area under high value crops like wheat, rice and crops like bajra, barley and gram have lost the area under them. The area under cereals rose from 24.58 lakh hectares in 1965-66 to 33.48 lakh hectares in

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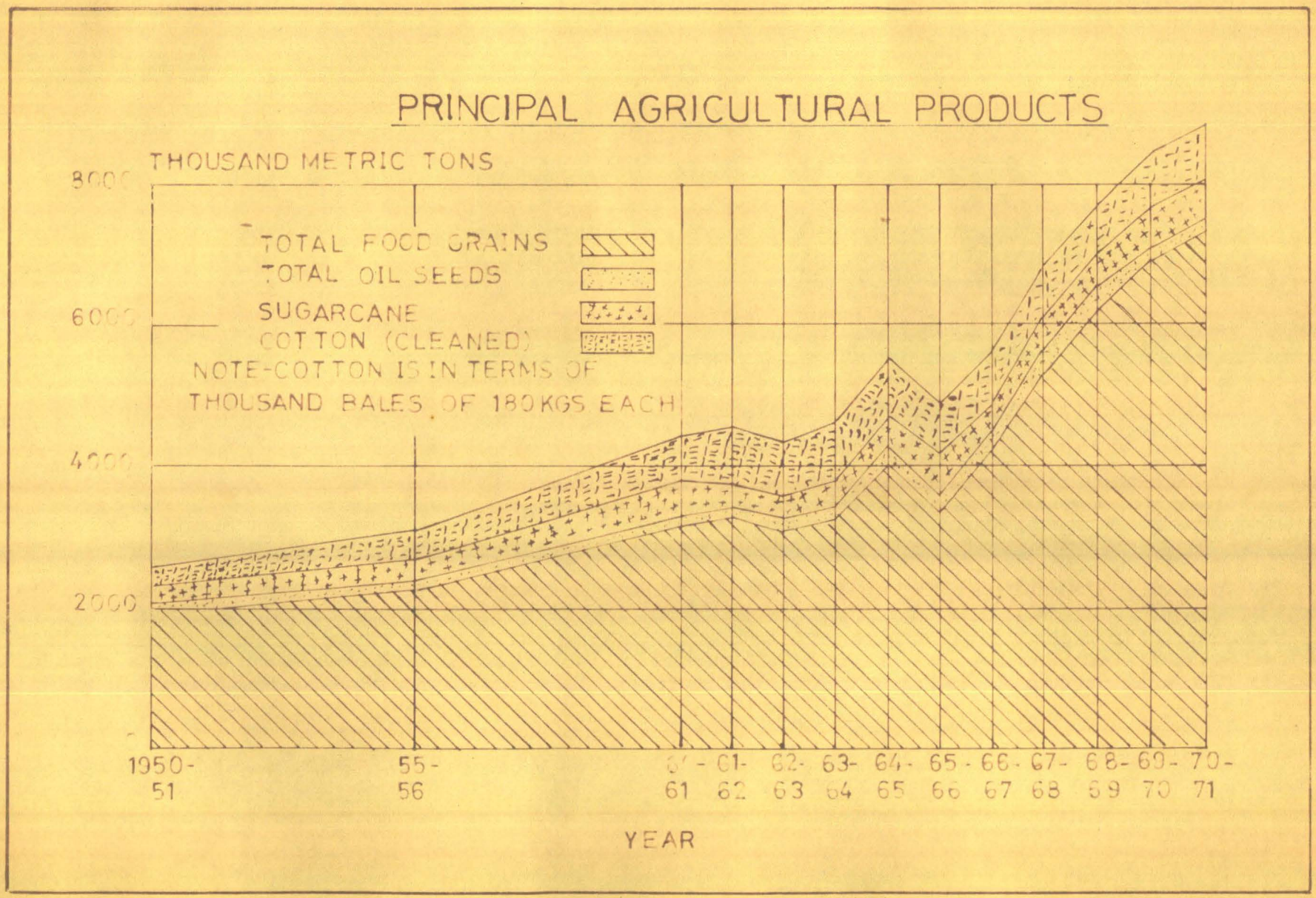
1/ See Graph I. (Source: Statistical Abstracts, Punjab). AND GRAPH II(A)

1969-70 and to 35.14 lakh hectares in 1970-71 showing an increase of 5 per cent in 1970-71. Wheat, rice and maize are the most important crops of the State. Wheat covered 65.42 per cent of total area under cereals and 58.5 of area under foodgrains during 1970-71. Area under maize increased from 5.34 lakh hectares in 1969-70 to 5.5 lakh hectares in 1970-71 covering 11.1 per cent of the area under cereals. Area under pulses had been declining. Gurdaspur, Amritsar, Ferozpur, Patiala and Hoshiarpur were the leading rice growing districts of the State. Area under gram covered 86.47 per cent of total area underpulses and 9.11 per cent of area under foodgrains in 1970-71. About 94 per cent of the area under gram is accounted for by the districts of Bhatinda, Ferozepur and Sangrur in 1970-71.

Non-food Crops: Area under oilseeds rose to an all time high figure in 1967-68 compared to 1961 and in 1971, it stood 2.95 lakh hectares. Groundnut is the major oilseed covering about 59 per cent of total area under oil seeds in 1970-71.

Area under sugarcane formed 2.25 per cent of the total cropped area in 1970-71 as against 2.71 per cent in 1969-70. It declined to 1.28 lakh hectares in 1970-71 from 1.49 lakh hectares in 1969-70. Sugarcane is produced in all most all the districts. Area under cotton has been gradually falling. It was the maximum in 1963-64 when it touched 5.11 lakh hectares in 1968-69, it was as low as 3.92 lakh hectares forming about 7.4 per cent of the gross area sown.

GRAPH II (B)


PRINCIPAL AGRICULTURAL PRODUCTS
THOUSAND METRIC TONS
8000
6000
4000
2000
TOTAL FOOD GRAINS
TOTAL OIL SEEDS
SUGARCANE
COTTON (CLEANED)
NOTE-COTTON IS IN TERMS OF
THOUSAND BALES OF 180 KGS EACH
1950-51
55-56
60-61
61-62
62-63
63-64
64-65
65-66
66-67
67-68
68-69
69-70
70-71
YEAR

It registered a marginal rise of 4.3 per cent in 1969-70 and once again fell to 4.09 lakh hectares forming 6.99 per cent of the total cropped area in 1970-71. Ferozepur, Bhatinda and Sangrur districts were responsible for having about 81 per cent of the cotton growing area of the state in 1970-71.

Production[1/]: In 1970-71, foodgrains recorded an all time high production. Wheat is the most important crop of the state which formed 70.4 per cent of the total foodgrain production. Maize contributed 12.3 per cent of total cereals and 11.8 per cent of total foodgrains. The production of maize increased by 9.8 per cent in 1970-71 and rice and bajra yielded 6.88 lakh tonnes forming about 9.8 per cent and 3.5 per cent of total cereals respectively. Production of rice increased 28.6 per cent in 1970-71. Production of gram and barley showed a declining trend. Jowar and other pulses also did not show a rising trend.

Production of Non-food Crops: Production of sugarcane (gur) recorded an all time high figure of 6.18 lakh tonnes in 1969-70, but fell by 14.7 per cent in 1970-71. This was mainly due to a fall in area under it.

The production of cotton which had declined from an all time best production of 8.52 lakh bales in 1963-64 to 8.04 lakh bales in 1969-70 rose again to 8.18 lakh bales in 1970-71, showing an increase of 1.7 per cent over 1969-70.

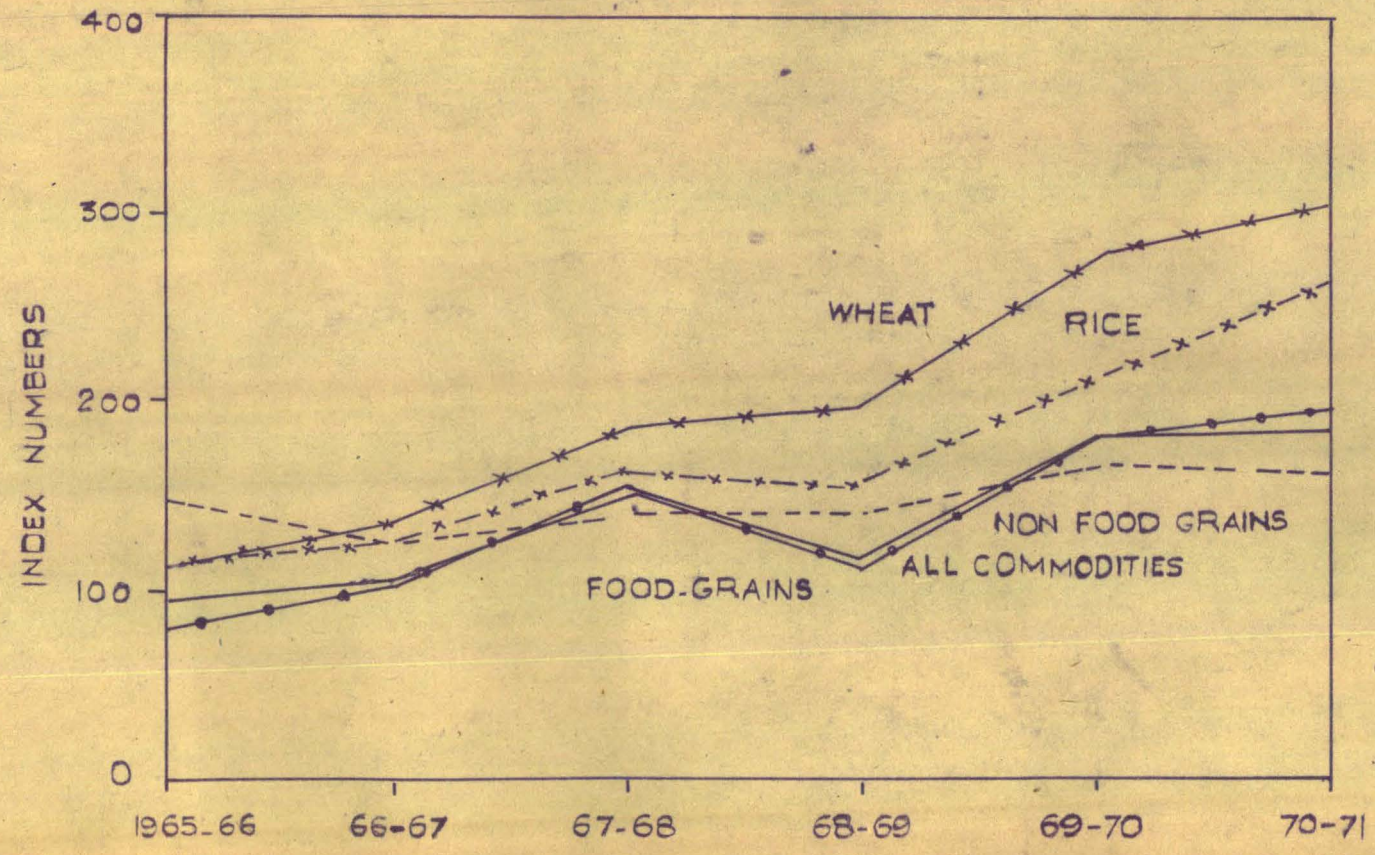
1/ See Graph IIB (Source: Statistical Abstracts, Punjab).

GRAPH III

PUNJAB

INDEX NUMBERS OF AGRICULTURAL PRODUCTION

BASE (1959=100)



The oilseeds gave a bumper crop in 1967-68 when their production touched the highest peak of 3.14 lakh tonnes in 1969-70 and rose to 2.33 lakh tonnes in 1970-71 showing thereby an increase of 9.4 per cent over the previous year. Out of the total production of oil seeds during the year 1970-71, groundnut alone contributed 1.69 lakh tonnes forming 72.5 per cent.

The index of agricultural production of all commodities with base as (1959-60 to 1961-62 = 100) has been progressively rising since 1965-66, the year of drought and Indo-Pak conflict. It rose from 115 in 1965-66 to 200 in 1969-70 and to 209 in 1970-71. Upto 1970-71, the increase was 87 per cent over 1965-66. The major contribution came from cereals whose index stood at 294 and among these, wheat index was the leading most with an index of 313 during the same period.[1/]

Role of High Yielding Varieties

Rice: Revolutionary increase in the agricultural production of Punjab has been due to increasing use of better and higher farm inputs and adoption of high yielding varieties of wheat, paddy, maize and bajra.

Total area under high yielding varieties of paddy has been rising since its introduction in the State. From a mere 17 thousand hectares in 1967-68, it rose to 130 thousand hectares

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1/ See Graph III. (Source: Statistical Abstracts, Punjab).

in 1970-71. The proportion of area under high yielding varieties of rice to total area under paddy improved significantly from 7.5 per cent in 1968-69 to 33.3 per cent in 1970-71. The average yield per hectare in 1969-70 of rice in Punjab rose from 1,490 kgs. to 1,765 kgs. in 1970-71. Although it was higher than All-India average, yet it was lower than Tamil Nadu and Jammu and Kashmir.

Wheat: Area under high yielding varieties of wheat rose from 6.21 lakh hectares in 1967-68 to 15.89 lakh hectares in 1970-71 which formed about 69.1 per cent of total area under wheat. Average yield per hectare of wheat in Punjab was the highest in the country during 1970-71, (2,238 kgs. per hectare).

Maize and Bajra: Area under high yielding varieties of maize rose from 0.29 lakh hectares in 1967-68 to 0.49 lakh hectares in 1970-71, forming about 8.8 per cent of the total area under it.

Area under high yielding varieties of bajra increased from 0.51 lakh hectares in 1967-68 to 1.26 lakh hectares in 1970-71 forming about 60.9 per cent of the total area under the crop. The average yield per hectare of bajra of 1,176 kgs. in Punjab has the highest in the country in 1970-71.

It is interesting to observe that although Punjab has only 2.9 per cent (1968-69) of the total net area sown of the country, it contributes 6.6 per cent of the total foodgrains.

It was second highest to Uttar Pradesh in wheat and maize production. Contributing 22.1 per cent of total wheat production and 11.6 per cent of total maize production in 1970-71.

The proportion of oilseeds production in the country formed about 2.5 per cent as compared to 21.1 per cent in Gujarat and 19.9 per cent in Uttar Pradesh. Groundnut, which is the major oilseed crop of the state contributed 2.8 per cent to total groundnut production in the country. However, the production of cotton in the state was 17.95 per cent of the total production in the country in 1970-71. Gujarat and Punjab together produced 52.4 per cent of the total cotton production in the country.

Finally, distribution* of households by the size of holdings cultivated by them shows that 16.9 per cent of the households cultivated land below 5 acres, within this group, the maximum number of households and operational holdings between 2.5 to 5 acres. Households with holdings between 5 - 10 acres formed about 27 per cent of the total. Twentyone per cent of the households cultivated land holdings varying in size between 10 - 30 acres. There were very few households (2.5%) who had operational holdings of the size of 50 acres and above. Nearly 50 per cent of households in Punjab (1970-71) cultivated between 10 - 30 acres.

*Source: Statistical Abstracts, Punjab.

In the region of Haryana, since its inception in 1966, green revolution has gone a long way. The use of new seeds, combined with scientific inputs like chemical fertilizers, insecticides and pesticides, commonly called the Green Revolution has resulted in large increases in productivity and output particularly in Punjab-Haryana region after 1966. Although Haryana region is yet behind that of Punjab in the case of many crops, yet, the region has registered significant increases in productivity when compared to All-India. This is illustrated by the data produced by Economic and Statistical Organization of the Government.

GROWTH OF STATE INCOME IN HARYANA AT 1960-61 PRICES

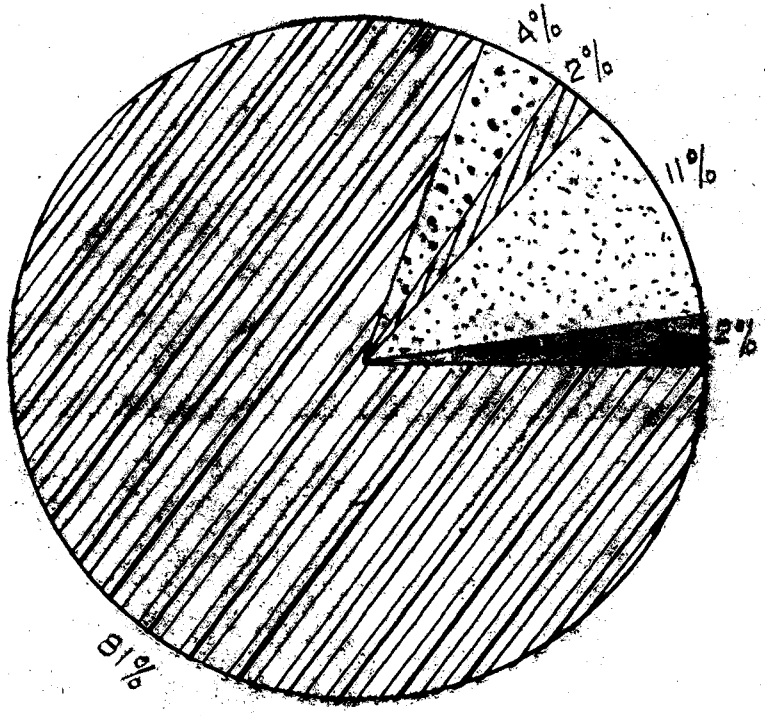
Sector	Primary sector	Secondary	Tertiary	All
State income during 1960-61 (Million Rs.)	1589.1 (62.7)	426.5 16.8	518.7 (20.5)	2534.3 (100.0)
State income during 1969-70 (Million Rs.)	2629.6	778.4	833.6	4241.6
Percentage of Total	62.0	18.4	19.7	100.0
Increase during 1960-61 to 1969-70	1040.5	351.9	314.9	1707.3
Annual growth rate % Haryana	5.8	6.9	5.4	5.9
Annual Growth Rate % Punjab	5.6	7.0	5.3	5.8

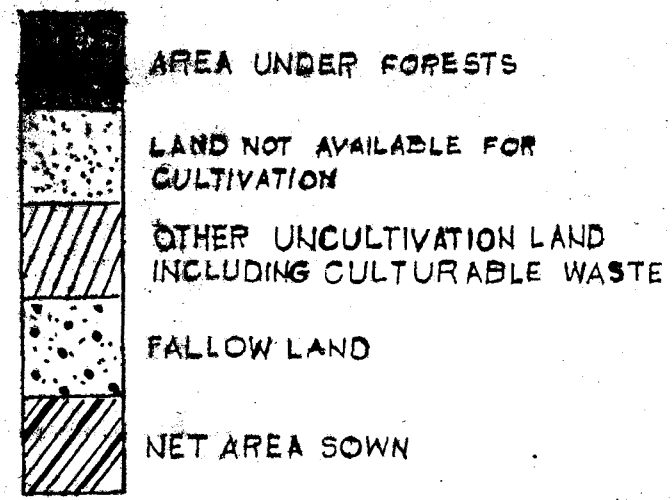
Source: Changing Structure of Agriculture in Haryana, Economic and Statistical Organization, Haryana Agricultural Abstracts.

Sixtyone per cent of the total increase in state income is provided by the primary sector.

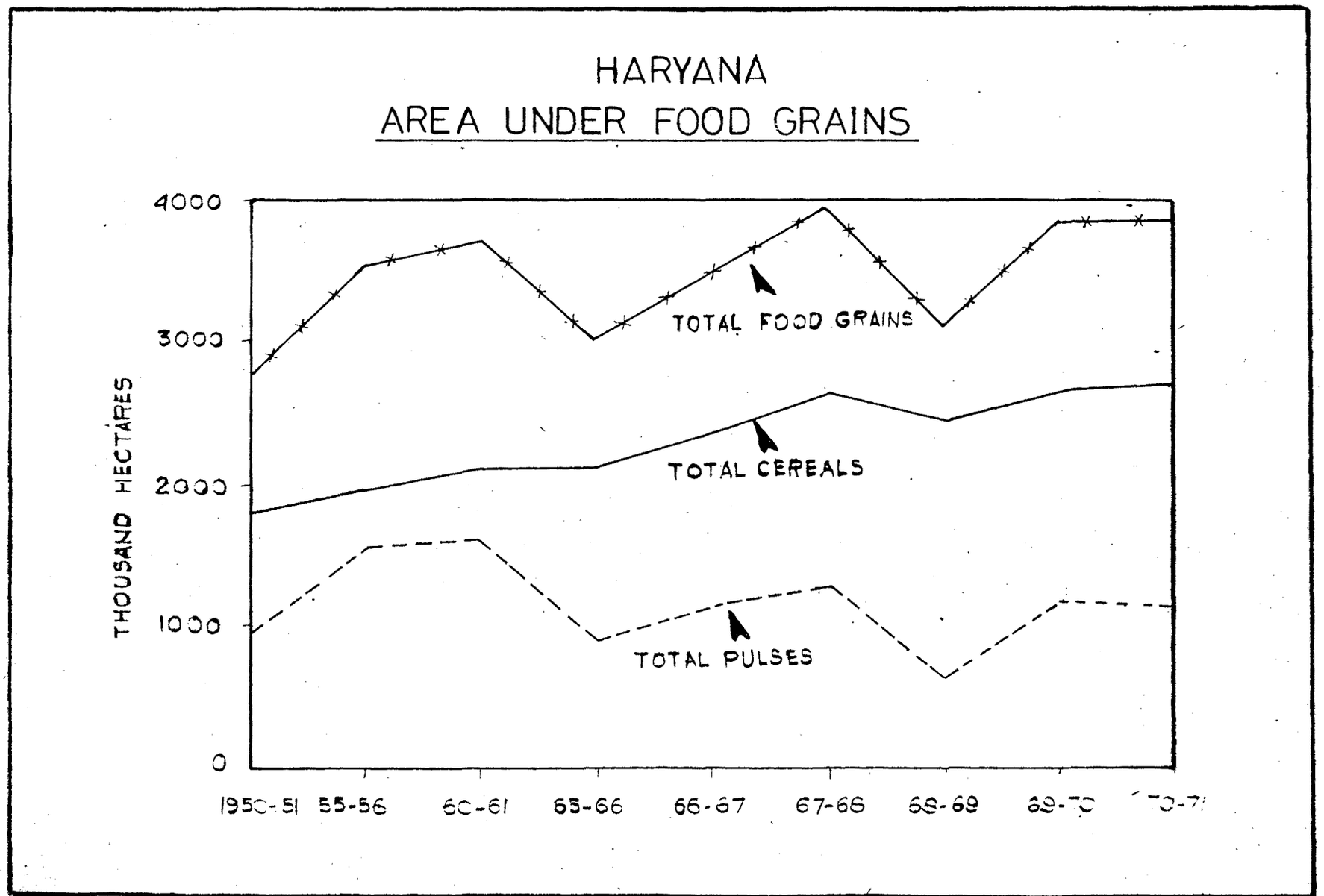
GRAPH IV

HARYANA
LAND UTILISATION
1970-71

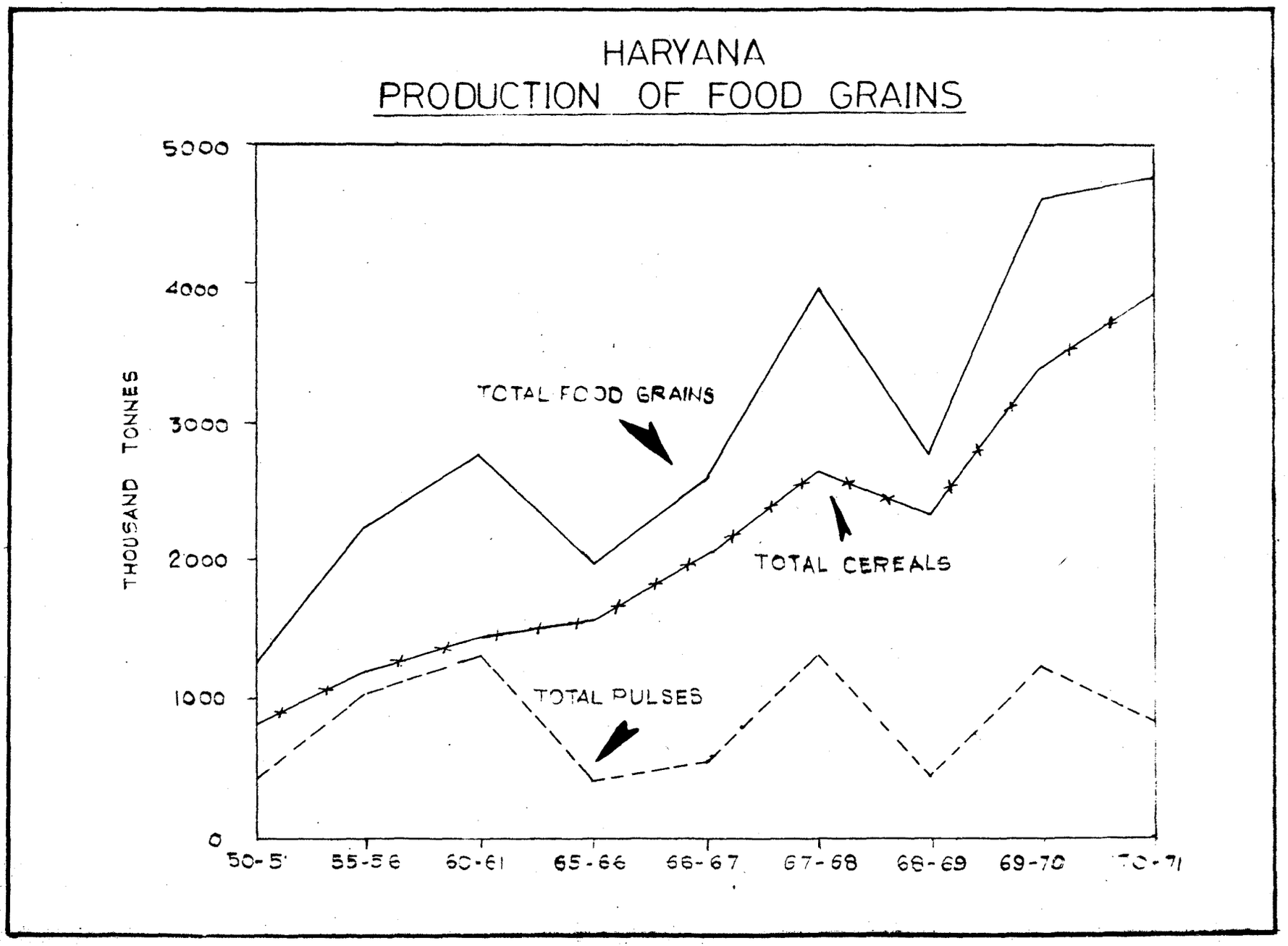




GRAPH V


HARYANA
AREA UNDER FOOD GRAINS
4000
3000
2000
1000
0
THOUSAND HECTARES
TOTAL FOOD GRAINS
TOTAL CEREALS
TOTAL PULSES
1950-51
55-56
60-61
65-66
66-67
67-68
68-69

GRAPH VI


HARYANA
PRODUCTION OF FOOD GRAINS
THOUSAND TONNES
5000
4000
3000
2000
1000
0
TOTAL FOOD GRAINS
TOTAL CEREALS
TOTAL PULSES
50-5
55-56
60-61
65-66
66-67
67-68
68-69
69-70
70-71

The main achievements in the field of agriculture in Haryana region have been the following:[1/]

(a) The total output of all foodgrains has nearly doubled over the period 1960-61 to 1969-70.

(b) Wheat and rice output increased tremendously. Haryana is one of the four largest producers of wheat in the country. Rice output more than doubled and maize output registered a substantial increase.

(c) In Haryana, almost the entire increase of 68 per cent in foodgrains output during the sixties can be attributed to increases in productivity. This is because the total cultivated area under foodgrains increased by hardly 4 per cent. The yield per acre of principal crops in Haryana is higher ~~in Haryana~~ compared with India as a whole, although, it is still behind Punjab in the case of many other crops.

(d) This technological advance in agriculture in Haryana has led to an increase in income and in the standard of living of cultivators and has also affected the distribution of income between regions. This is the result of green revolution. Wet regions have higher incomes than dry regions. The increase in income of cultivators leads to a greater demand for scientific

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1/ See Graphs IV, V and VI. Source: Statistical Abstracts, Haryana.

inputs and gives additional impetus to economic growth. Northern regions (Ambala, Karnal and Jind) seem to be better off than the Southern region (districts of Gurgaon and Mohindergarh). The central regionsoccupie an intermediate position.

(e) Gains due to green revolution have been reported by all categories irrespective of size of holdings.

It may however be true that progressive peasants who have higher incomes are in a better position to adopt the new methods and have been able to register substantial increases in income. Cultivators sowing between 5 and 20 acres of land have experienced highest relative gains in income.

SUMMARY

To summarize the features of agricultural development in Punjab-Haryana region, the following appears to be the different stages by which agriculture of this region has passed through.

Initially, it was an area of extensive agriculture with limited irrigation. Growth of millets and some cash crops was the main feature.

In the second stage, irrigation was extended and intensification of cultivation was the result.

Thirdly, soil conservation, construction of irrigation channels etc., reduced the problem of soil erosion resulting in the expansion of cultivated area.

Fourthly, further intensification took place in newly irrigated areas while those in Stage II switched over to modernization thus indulging in cultivation of cotton etc.

In the fifth stage, extension of irrigation and the ensergence of large scale reclamation of lands created problems of water logging etc., which was conducive to rice growing. Many such lands were suitable for growing rice. In the next stage, came the green revolution with its impact on specialization in particular crops of which wheat and rice were very significant. Then came the internal and external pressure for growing food crops and raising their production to attain agriculture self-sufficiency, which resulted in the crop rotation of rice-wheat which is peculiar and not common in other regions. This combination has now become sensitive to the market forces and shortages of fertilizers etc. Therefore there are signs of, once again, a change towards another stage of agricultural specialization - dairying, cultivation of barley, fodder crops and in some region groundnut and cotton cultivation seem to be round the corner.

DISS
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and (3) The Alluvine plains. The districts of Simla and Kangra (then in Punjab) constituted the Himalayan tract as they lay in the outer ranges of Himalayas.

Ambala, Hoshiarpur and Gurdaspur fall in the region forming the narrow strip of the territory between the Himalayas and the Indo-Gangetic plains and are most prosperous. This has a sub-montane terrain and area to the South-West has low rainfall and low irrigation.

The third and the largest natural region is the upper Indo-Gangetic plains; and alluvial plains are among the more fertile areas in the country. As this plain stretches towards the south its fertility begins to decline, e.g., Mohindragarh district which lies to the south is the most backward district in Haryana. This region has a varied climate ranging from alpine to hot and dry. The annual rainfall is between 30"-40". In the Himalayan tract, it averages around 100" and rain decreases on the sub-montane region.

So far as the districts are concerned, Ferozpur followed by Bhatinda, Sangrur and Amritsar have the largest geographical area in sq.kms.; respectively in Punjab. In Haryana, Hissar followed by Karnal and Rohtak have the largest geographical area in sq.kms. (1971 census).

The basic characteristics of the districts in Punjab and Haryana pertaining to soil, rainfall etc., are given in Chart I at the end of this chapter.

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As one moves westwards and southwards, rainfall decreases. The major part of the precipitation in Punjab occurs in the months of July to September and winter rains from December to February. There rains though small are crucial for spring harvest.

There are three principal snow fed rivers in Punjab-Haryana region. They flow through the western part of the state and are an important source of irrigation in the region. The absence of snow fed rivers in the east has adversely influenced the cropping pattern as well as agricultural productivity in the region. The region as a whole has a fairly well provided system of irrigation which has been an important factor in raising yields. Nearly two thirds of irrigation is by canals and the rest by wells. Very little use is made of tank irrigation.

CLARIFICATION OF AGRICULTURAL LAND IN PUNJAB AND HARYANA

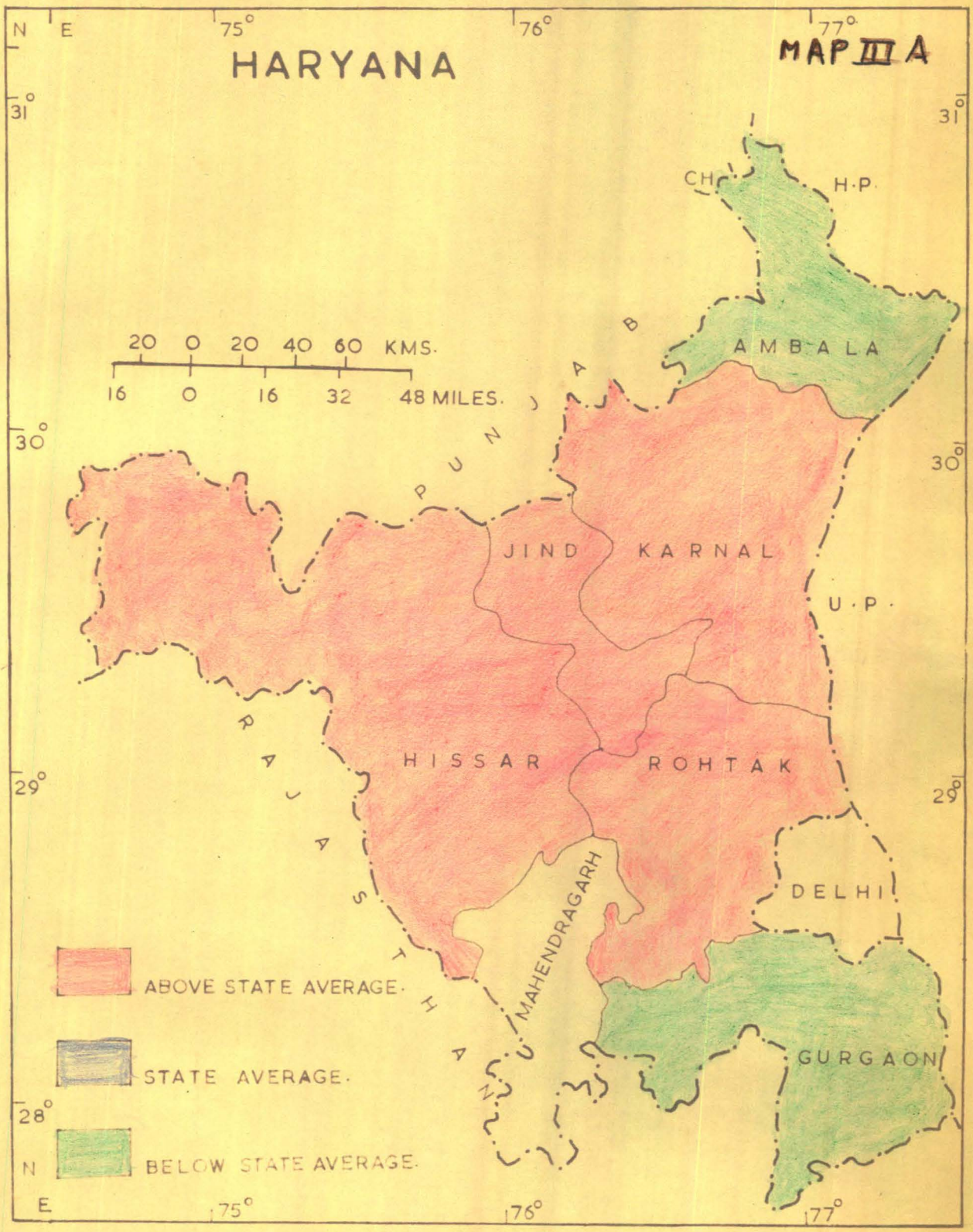
The land use pattern prevailing in any region is conditioned among other things by the physical conditions prevailing there like rainfall, soil etc. In this paper, it is studied with respect to six factors, viz., (1) Gross cropped area: This includes total covered with crops during the year. In case, different crops are raised during the year on the same land, the same area is counted more than once. (2) Net Area sown: The areas sown more than once during the year is counted once only.

(3) Area under current fallows: This denotes cultivable land which after abandonment remains uncultivated for a long period called "old fallow" and which are kept uncultivated during the current year are also called current fallows. (4) Other uncultivated land excluding current fallows: This denotes land available for cultivation but not taken up for cultivation or abandoned latter on for one reason for another. It includes cultivable waste, permanent pastures and other grazing land and miscellaneous tree crops. (5) Area under forests: This includes actually forested area or the lands classified or administered as forest under any legal enactment. In Punjab-Haryana region, it has increased sharply in certain years due to definitional changes. (6) Gross area irrigated: This refers to the total area under all crops that is irrigated.

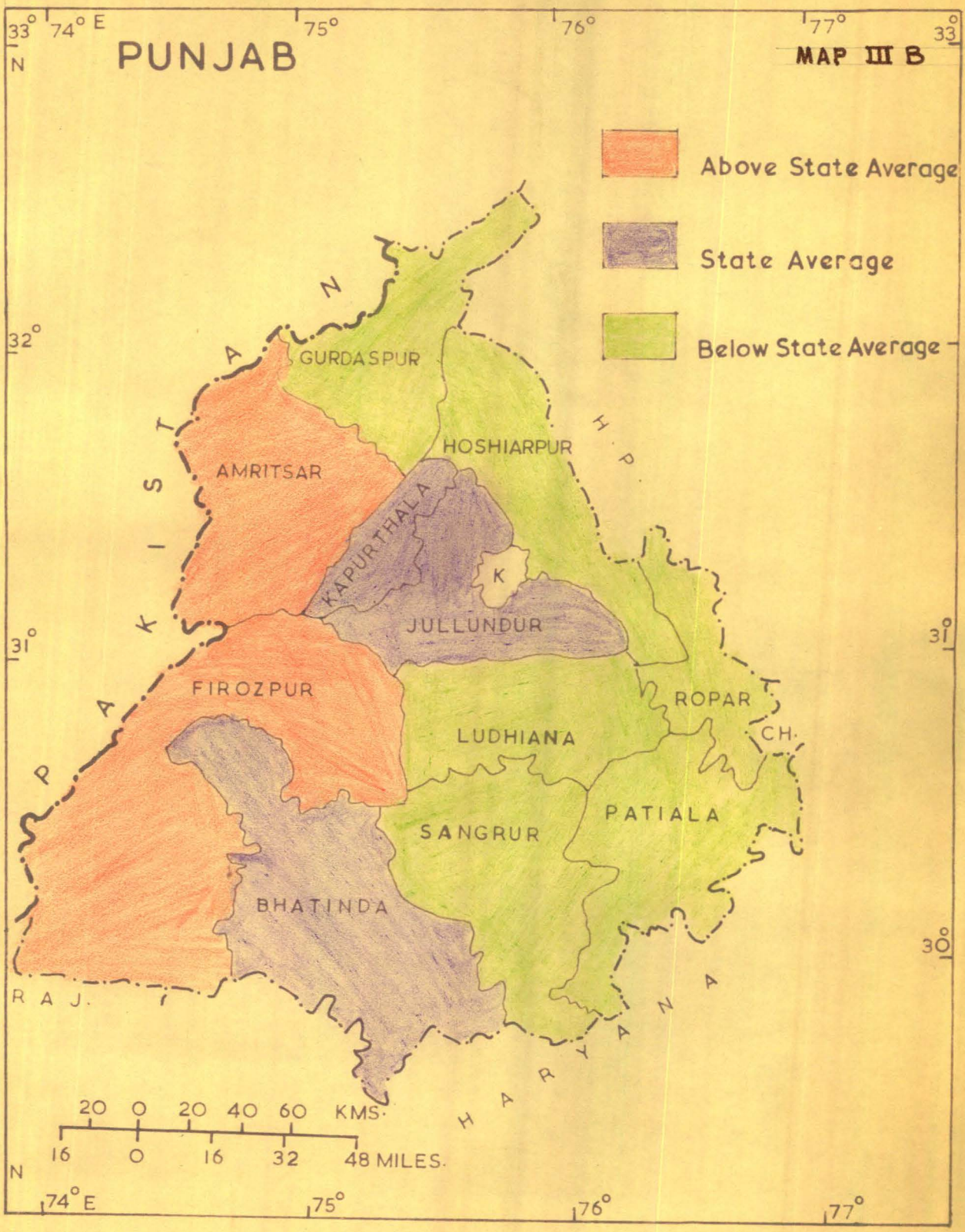
For Punjab as a whole, with 1951 as base, in 1960, the total cropped area increased by 20 per cent and with 1961 as base, in 1971, it increased by 20 per cent. This increase could be explained mainly by increase in gross area irrigated and to a certain extent therefore by fall in current fallows and other uncultivated land excluding current fallows. The gross area irrigated increased by 60 per cent in 1971 over 1961.

In Haryana, gross cropped area increased by 43 per cent in 1971 as compared to 1951. Gross area under irrigation increased by 166 per cent in 1971 as compared to 1951. The increase in gross cropped area is the result of increase in irrigation.

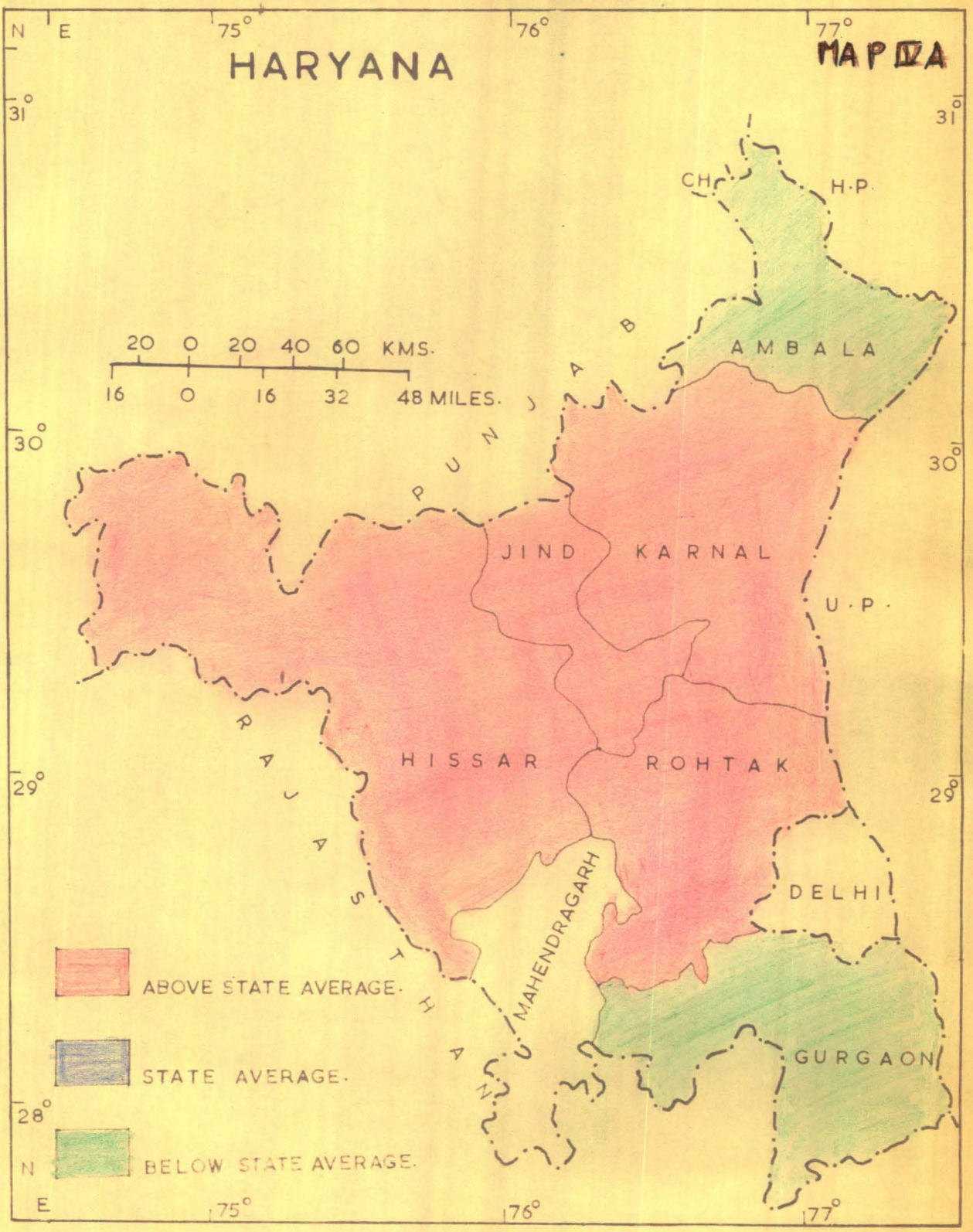
GROSS AREA IRRIGATED AS A PERCENTAGE OF TOTAL CROPPED AREA 1961.



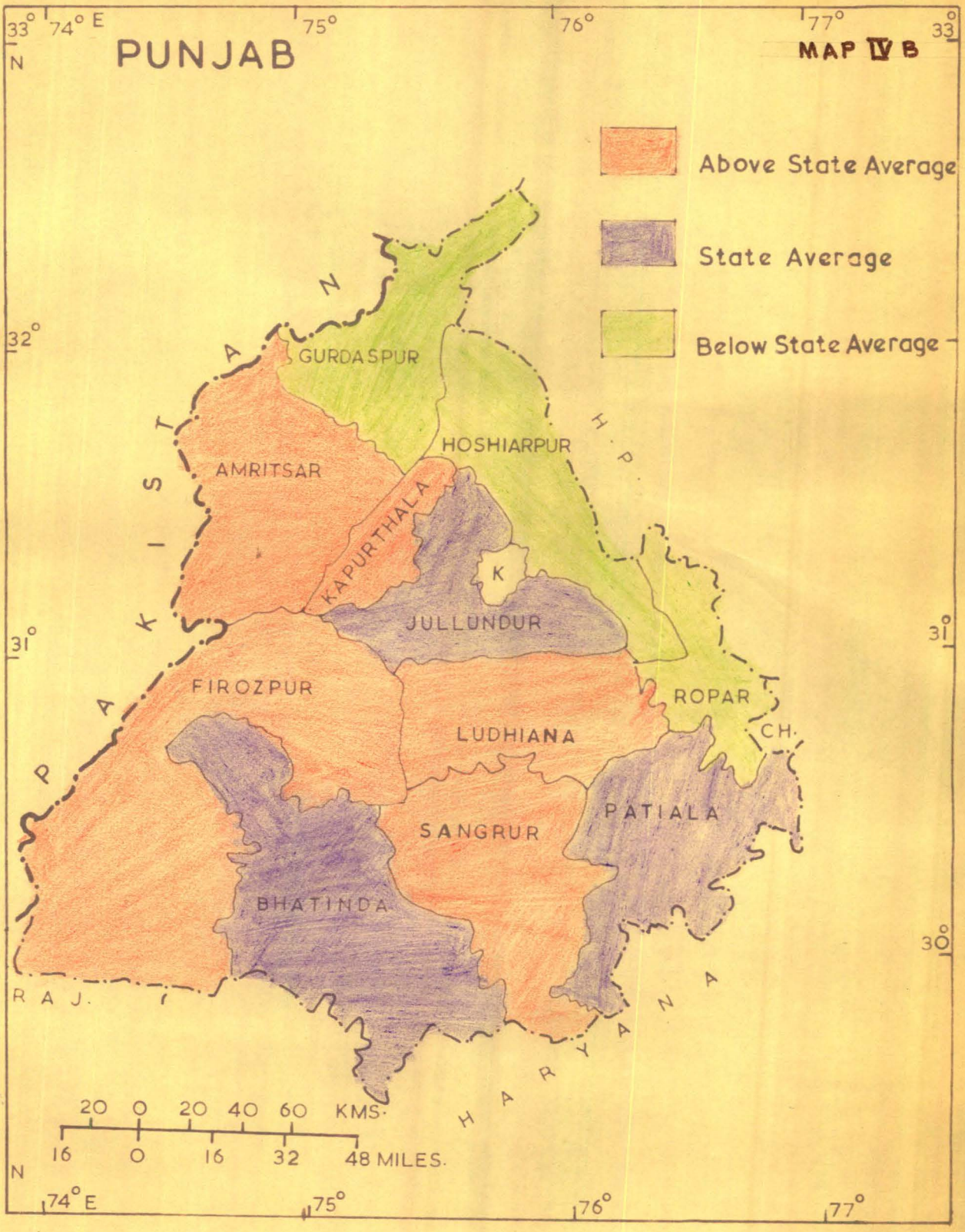
GROSS AREA IRRIGATED AS A PERCENTAGE OF TOTAL CROPPED AREA 1961



GROSS AREA IRRIGATED AS A PERCENTAGE OF TOTAL CROPPED AREA. 1971.



GROSS AREA IRRIGATED AS A PERCENTAGE OF TOTAL CROPPED AREA 1971



In both Punjab and Haryana, there was a steep rise in area under 'forests' in certain years due to definitional changes. In certain years therefore, fall in total cropped area may be attributed to this.

Net area sown increased by 7.8 per cent in 1971 as compared to 1951 in Punjab. In Haryana, it increased by 19 per cent in 1971 as compared to 1950.

In general, we may say that in both Punjab and Haryana total cropped area has increased steadily over time, with few exceptions. However, it is important to bear in mind that total cropped area cannot increase rapidly after a certain limit. To the extent that land reclamation is possible and irrigation helps in bringing current fallows and other uncultivated land excluding current fallows, under cultivation, total cropped area will increase. The geographical area remains more or less constant in a region and total cropped area as a percentage of total geographical area is likely to increase or decrease depending upon the changes in the six factors we have considered. Gross area under irrigation has increased sharply particularly after 1960 and this explains the increase in total cropped area. See Maps III-A & B and IV-A & B, facing page 24.

Agricultural land classification in the Districts

In the districts of Punjab and Haryana, a similar trend as that in the states is witnessed. In all the districts, total cropped area has increased over time steadily, with few

exceptions. Here again, in most districts, gross area irrigated has increased sharply which explains partly the fall in fallows or dry land left uncultivated resulting in increase in gross cropped area. In the case of districts, also, the increase is sharp after 1961 and particularly after 1966-67. This is true in almost all the districts of Punjab and Haryana. The percentage variations in the six factors in terms of which land classification has been presented is given in (Tables VI-A to VI-T) at the end of this chapter.

Crop intensity in a district also depends upon the availability of irrigation. In both Punjab and Haryana districts, crop intensity has increased. The comparison between 1961 and 1971 gives as the following picture districtwise.

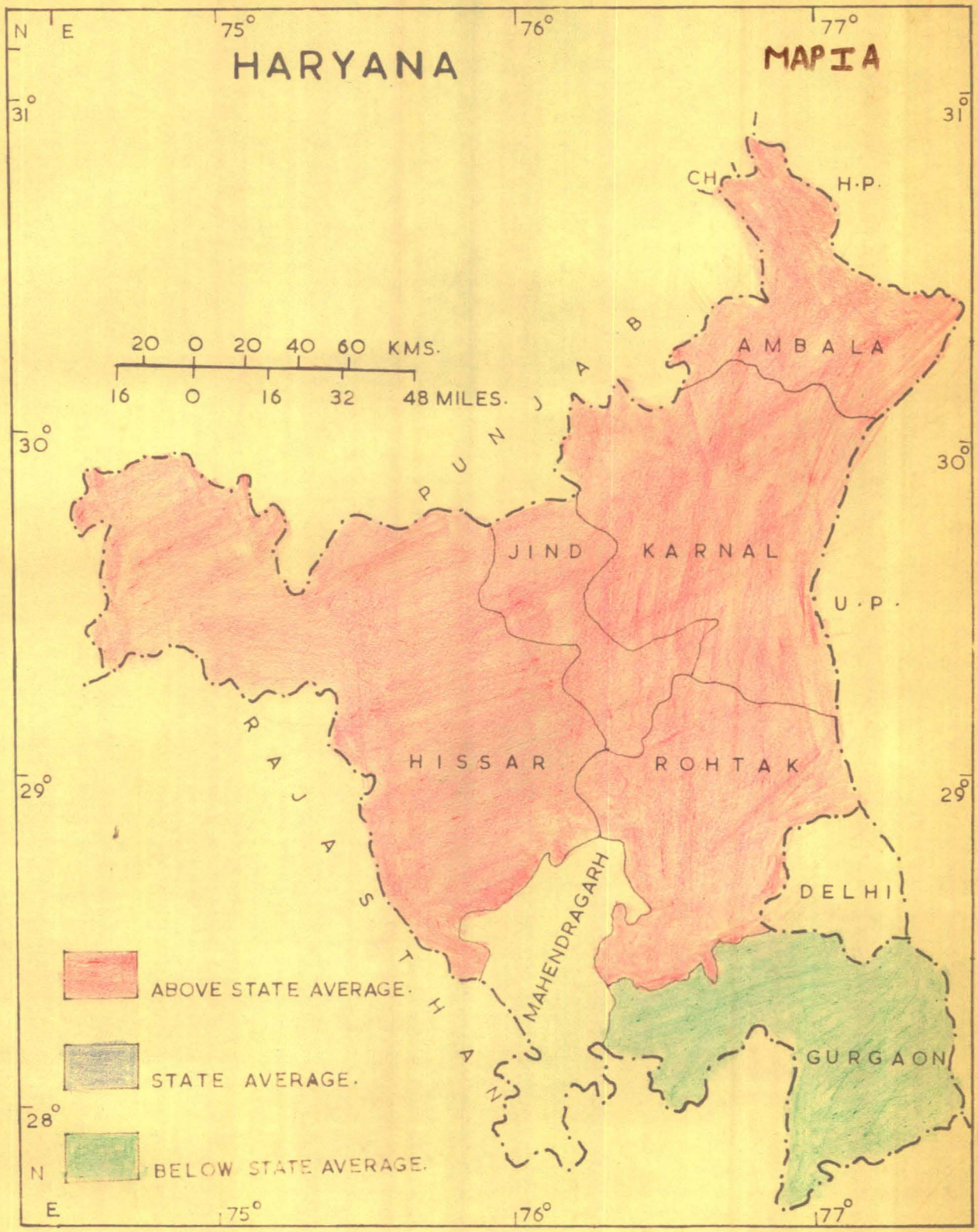
Crop intensity is measured by gross cropped area ÷ Net area sown.

Table I

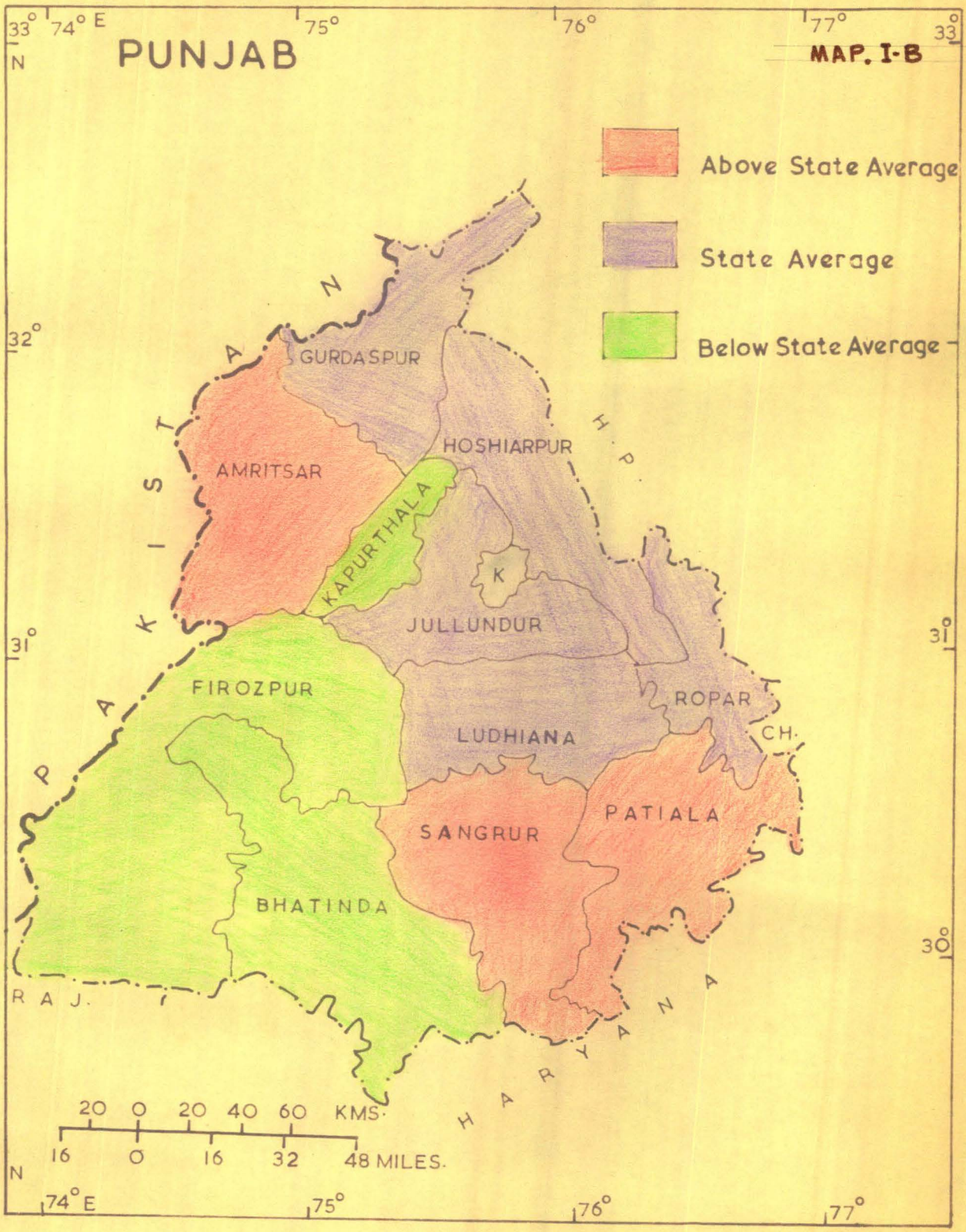
Crop Intensity

P U N J A B			H A R Y A N A		
	1961	1971		1961	1971
STATE	1.2	1.4	STATE	1.3	1.4
Districts			Districts		
Gurdaspur	1.4	1.4	Hissar	1.3	1.3
Amritsar	1.4	1.5	Rohtak	1.3	1.4
Jullundher	1.2	1.6	Gurgaon	1.2	1.3
Kapurthala	1.1	1.2	Karnal	1.4	1.5
Hoshiarpur	1.3	1.4	Ambala	1.3	1.5
Ropar	1.2	1.6	Jind	1.3	1.5
Ludhiana	1.3	1.5			
Ferozpur	1.2	1.3			
Bhatinda	1	1.3			
Sangrur	1.3	1.4			
Patiala	1.3	1.4			

CROP INTENSITY
1961

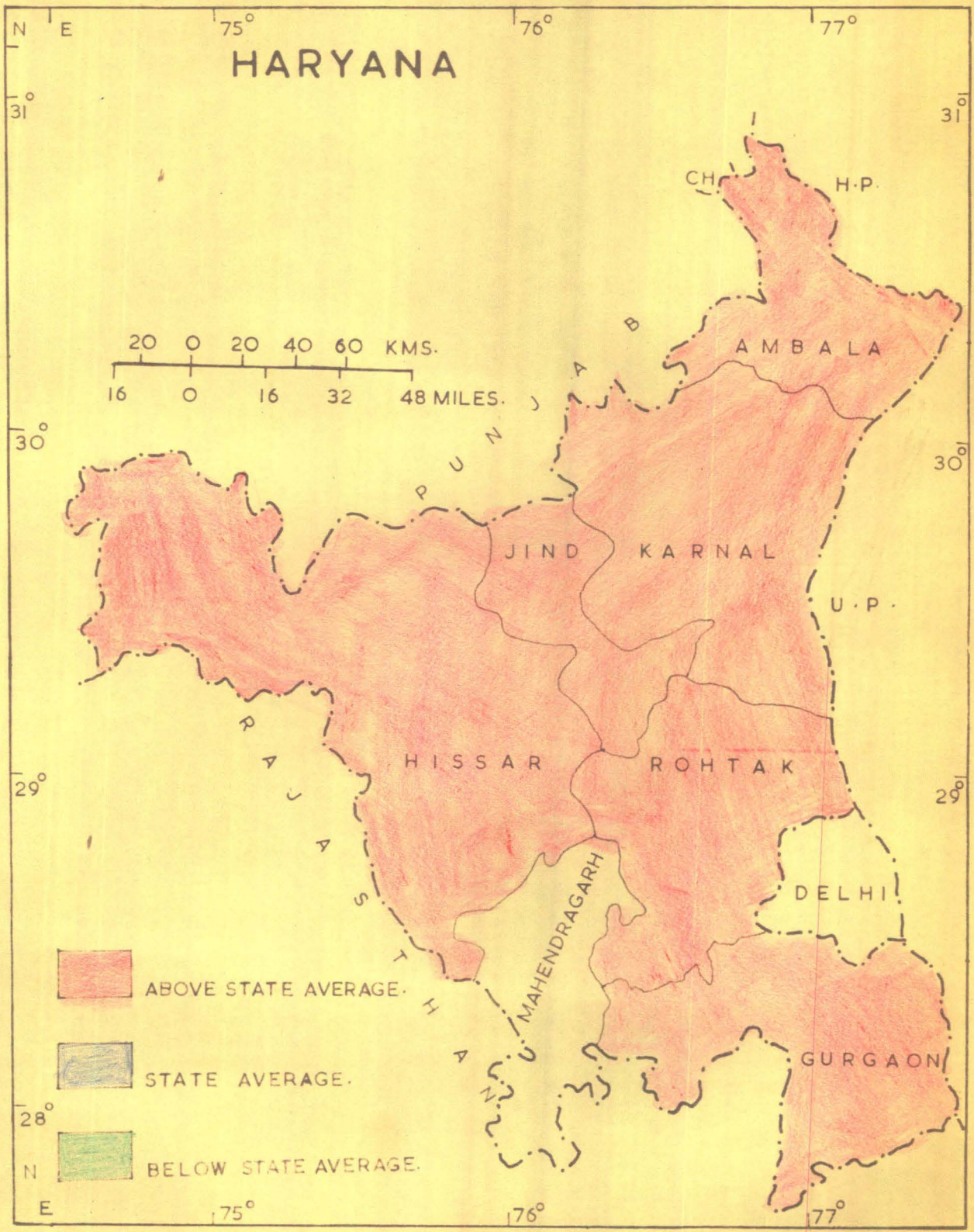


CROP INTENSITY 1961

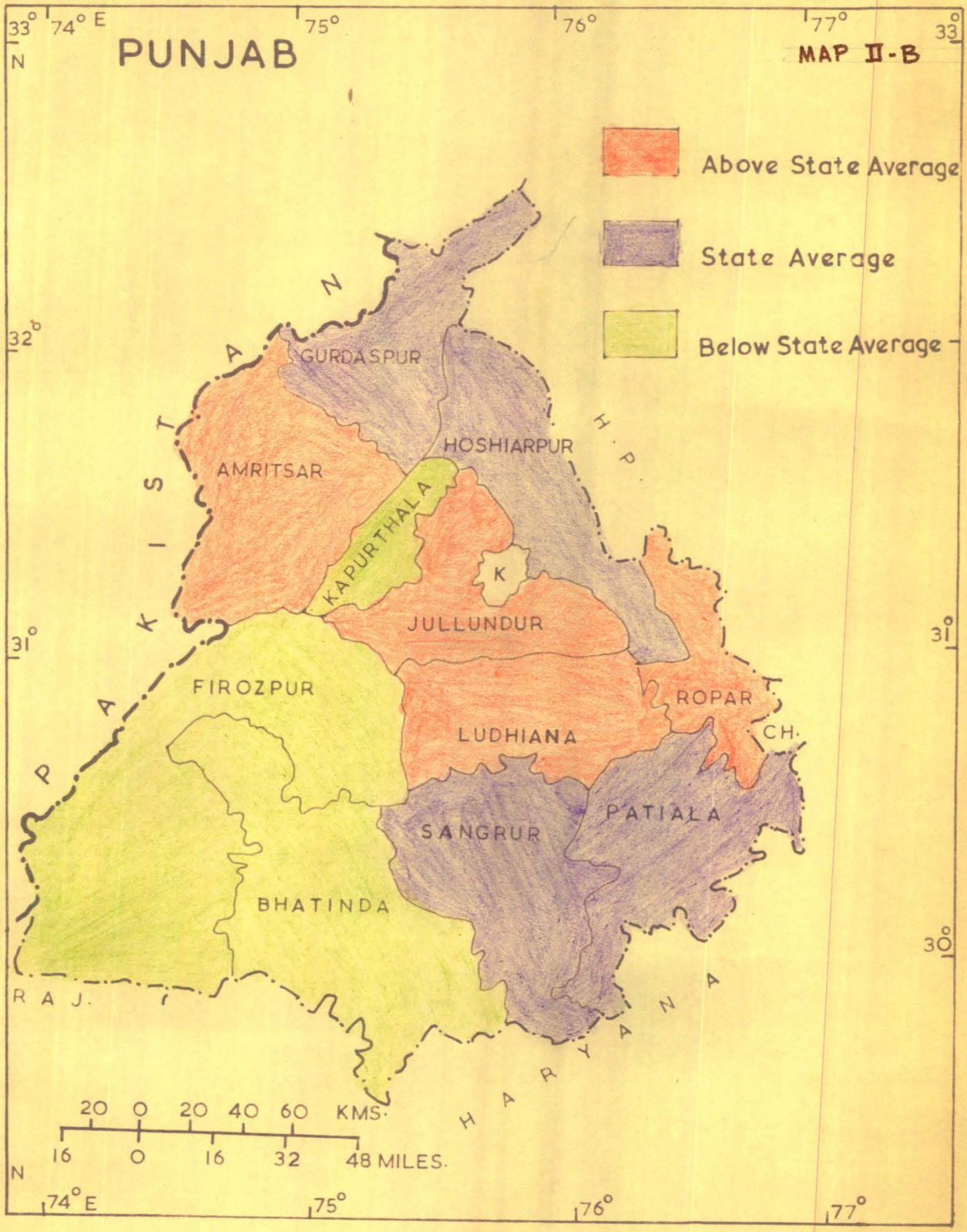


MAP II A

CROP INTENSITY
1971



CROP INTENSITY 1971



In all the districts of Punjab and Haryana, crop intensity has increased marginally or remained the same. It has not fallen anywhere. The relative portion of districts is shown clearly in (Maps I-A, B, and II-A, B, facing page 26).

II-B(a)

Coefficient of correlation between gross cropped area and net area sown and gross cropped area and gross area irrigated is worked out for two time blocks in Punjab and only one time block in Haryana. The time blocks for Punjab are 1950-60 and 1961-71. For Haryana, it is 1961-71. The table below presents the values derived.

Gross cropped area (x) Gross area irrigated (z) and Net area sown (y)

Table II

	x and y		x and z		t values (x & y)		t values (x & z)	
	1950-61	1961-71	1961	1971	1961	1971	1961	1971
Gurdaspur	-0.24	-.05	-.76	.0002	-.698	-3*	-4.6*	.001
Amritsar	.0002	.018	-.54	.011	.001	.054	-1.8	.098
Jullundher	.013	-.003	.004	.230	.04	-.01	.009	.708
Kapurthala	.034	.0027	.02	-.010	.09	.008	.05	-.03
Hoshiarpur	.054	.004	.002	.06	.15	.012	.006	.18
Ludhiana	.001	-.021	.05	.024	.003	-.06	.024	.072
Ferozpur	.29	.139	.66	.02	.86	.42	2.48*	.06
Bhatinda	.097	-.11	-.2	.011	.275	-.33	-.668	.033
Sangrur	-.086	0.08	.411	.007	-.240	.27	1.2	.021
Patiala	.021	.006	.0102	.02	.240	.017	.240	.06
Hissar	-	.95	-	.23	-	.25	-	2.23*
Rohtak	-	-.15	-	.06	-	-.401	-	.134
Gurgaon	-	.13	-	.02	-	.116	-	.044
Karnal	-	.0006	-	.096	-	.002	-	.215
Ambala	-	.0023	-	.035	-	.01	-	.078
Jind	-	.07	-	.23	-	.19	-	2.23*

*Denotes significant t value.

The values are negative between x and z in Gurdaspur, Bhatinda and Amritsar (1950-61). In 1961-71 it is negative in Kapurthala. This could be attributed to particular reasons like, the farmer not using irrigation intensively. Certain crops can be grown with less of water. In such cases, the source of irrigation that he has, may be used only when he grows crops requiring more water. This is perhaps true of farmers who are economically worse off.

Again when crop acreage fluctuation are marked by sensitiveness to changing prices, then crop acreage fluctuation may result in fluctuations in irrigated area in certain years which may result in a negative correlation. This may be particularly true in areas where cash crops predominate.

The values of coefficient of correlation between x and z are positive in all other districts of Punjab and Haryana. But the values are rather low and t values are significant only in a few districts like Gurdaspur, Hissar and Jind. The values of the coefficient of correlation between x and y though low, are positive in most districts. The negative value could be explained partly by the fact

Table III

Percentage of Area Under Wheat and Area Under Rice to Area Under All Crops

	Gurdaspur		Amritsar		Jullundher		Kapurthala		Hoshiarpur		Rupar		Ludhiana		Ferozpur		Bhatinda		Sangrur		Patiala	
	W	R	W	R	W	R	W	R	W	R	W	R	W	R	W	R	W	R	W	R	W	R
1951-52	37	11	30	4	34	1	39	4	32	4	-	-	29	1	27	3	17	-	17	1	39	3
1952-53	36	11	31	6	37	1	42	5	34	5	-	-	31	1	27	3	20	-	20	1	32	4
1953-54	35	12	29	6	36	1	41	5	35	5	-	-	29	1	26	4	18	-	18	1	34	5
1954-55	38	12	26	5	35	1	40	6	33	5	-	-	30	1	28	2	17	-	17	1	43	4
1955-56	37	12	27	6	35	1	38	7	33	5	-	-	30	1	30	2	18	-	18	1	23	3
1956-57	31	13	29	6	34	1	37	8	34	4	-	-	31	1	31	3	20	-	20	1	21	3
1957-58	36	14	30	7	34	1	36	10	33	7	-	-	31	1	28	3	21	-	21	-	23	4
1958-59	49	13	32	7	34	2	38	10	33	7	-	-	31	1	31	4	21	-	21	1	19	3
1961-62	37	14	29	8	33	3	37	10	31	11	-	-	33	1	32	4	22	-	22	1	23	6
1962-63	38	17	31	9	33	3	36	12	38	11	-	-	37	1	31	4	34	-	34	1	32	7
1963-64	41	14	31	9	35	3	40	12	38	10	-	-	30	1	32	4	34	-	34	1	34	7
1964-65	33	16	34	10	35	3	35	11	37	10	-	-	33	1	33	4	37	-	37	1	33	7
1965-66	35	17	36	12	37	1	34	11	41	10	-	-	30	1	32	4	38	-	38	1	31	7
1966-67	36	18	30	13	38	1	35	12	40	8	-	-	31	1	31	4	40	-	40	1	30	7
1967-68	37	19	40	13	36	1	35	15	31	9	-	-	38	1	40	4	41	-	41	1	30	7
1968-69	29	37	40	14	37	3	39	16	38	9	-	-	46	1	38	6	32	-	32	1	41	9
1969-70	36	29	42	15	49	7	43	15	37	9	-	-	48	1	39	6	42	-	42	1	46	11
1970-71	29	31	30	17	46	4	43	15	38	9	-	-	48	1	39	6	43	-	43	1	48	13

Table IV

	Hissar		Rohtak		Gurgaon		Karnal		Ambala		Jind	
	W	R	W	R	W	R	W	R	W	R	W	R
1960-61	9	1	21	.46	12	-	23	12	20	12	12	1
1961-62	9	1	19	.76	14	-	25	13	23	9	16	1
1962-63	9	2	18	1	14	-	24	12	27	11	13	1
1963-64	10	1	21	1	15	-	26	12	22	13	12	2
1964-65	10	1	20	1	17	-	26	14	22	15	15	2
1965-66	10	1	24	1	16	-	28	16	20	14	18	1
1966-67	9	1	23	1	17	-	27	14	21	14	14	2
1967-68	10	1	23	2	18	-	28	16	22	12	15	2
1968-69	-	-	-	-	-	-	-	-	-	-	-	-
1969-70	-	-	-	-	-	-	-	-	-	-	-	-
1970-71	14	1	28	2	24	-	38	19	30	12	22	3

In all the districts, wheat area as a proportion of area under all crops is higher than rice area. Wheat and rice together occupy a large proportion of area under all crops in all the districts. This proportion will be much higher if we compare the area under the two crops to total area under foodgrains only. In other words, wheat and rice are the two most important food-crops and rice in particular, although, grown over a smaller area is grown mainly for export and almost the entire rice production constitutes marketable surplus in Punjab and Haryana.

Wheat is the staple diet of the region as a whole and therefore, is grown on the largest part of the area devoted to cereals.

It will be noted that in most districts, area under the two crops has increased over time but there are a few districts where it has fallen marginally. On the whole area under rice has remained steadier than area under wheat.

The fluctuation in area under wheat and rice as a proportion to area under all crops is understandable because, in particular years, some other crop may have taken the place of the crop whose area has fallen. This may be due to a better price prospect of the other crop. In the case of wheat, shift may have taken place to cultivation of say, gram.

The percentage increase in area under wheat and area under rice and area irrigated under the two crops is clear from Tables VII-A to VII-T, given at the end of the Chapter III.

In Punjab state as a whole, with 1950 as base year, area under wheat increased by 31.79 per cent in 1960. In 1971, with 1961 as the base, it has increased by 142 per cent. The area under rice in the same years increased by 62.7 per cent in 1960 over 1950 and by 72 per cent in 1971 as compared to 1960.

In the state of Haryana, area under wheat increased by 211 per cent in 1971 as compared to 1950 and area under rice increased by 258.6 per cent in 1971 as compared to 1950. It is thus, evident that in both Punjab and Haryana, area under wheat and rice have increased sharply over the earlier years. In haryana, area under rice has increased more sharply than area under wheat.

In Punjab, area under rice has increased more sharply than area under wheat in 1960 over 1950. But in 1971, as compared to 1960, area under wheat has increased more sharply than area under rice.

The rates of increase in area under wheat and rice in Punjab and Haryana are quite contrasting.

One of the important factors influencing acreage under a crop is availability of irrigation. In Punjab irrigated area of wheat increased by 11.6 per cent in 1960 as compared to 1950 and by 142 per cent in 1971 as compared to 1961. In general, a rising trend in area under wheat is associated with a rising trend in area under irrigation of the crop.

A similar trend is obviously witnessed in the case of rice too. Area irrigated of rice increased by 79.3 per cent in 1960 as compared to 1950 and by 92.47 per cent in 1971 as compared to 1961.

In Haryana, area irrigated of wheat increased by 166.4 per cent in 1971 as compared to 1960 and area irrigated of rice increased by 144 per cent in 1971 as compared to 1960.

While area under wheat increased more sharply than area under rice in Punjab after 1960, the area under irrigation, of wheat also increased more sharply than area under irrigation, of rice.

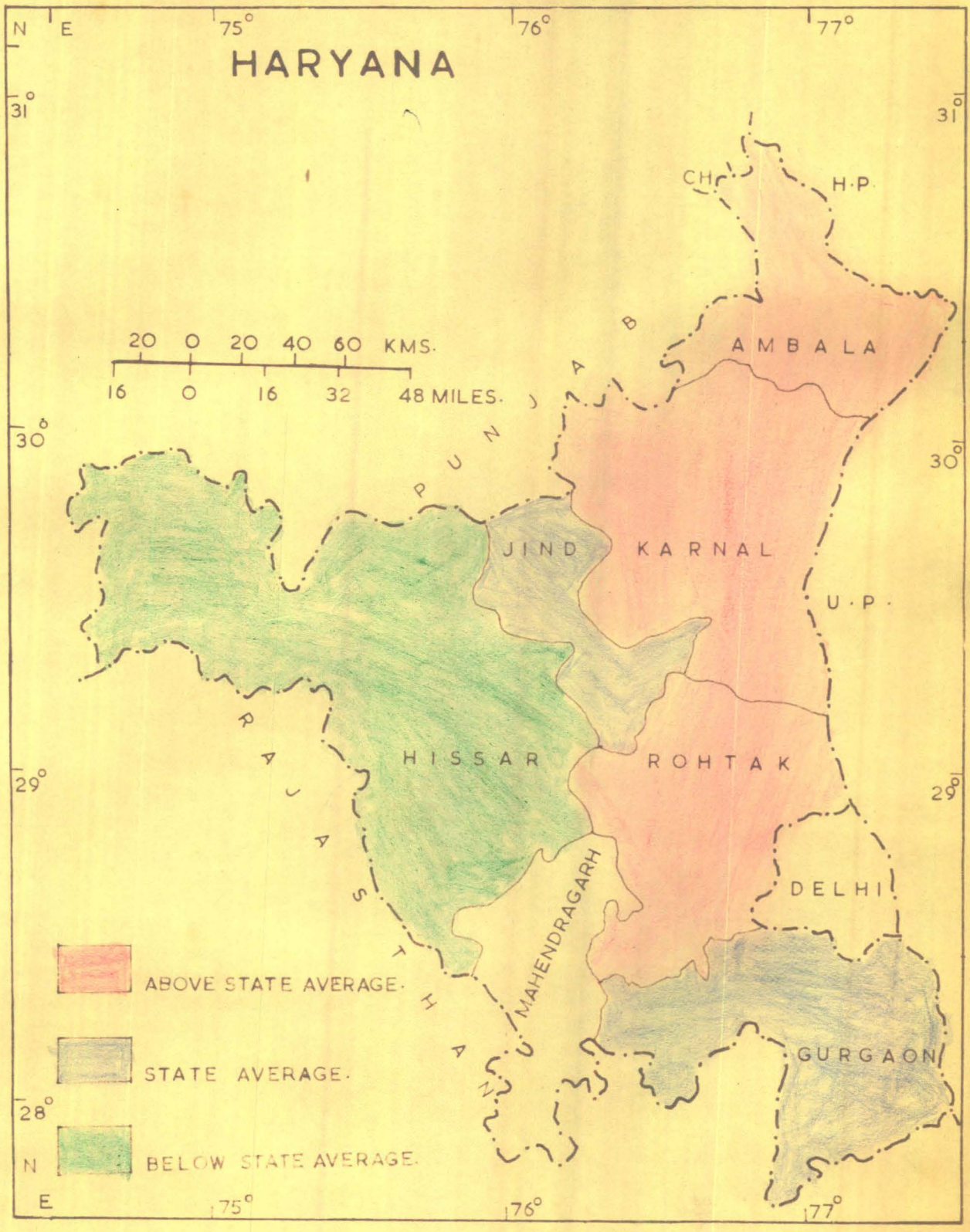
In Haryana however, although acreage under rice rose more sharply after 1960 as compared to acreage under wheat, the area under irrigation, of wheat increased more sharply than area irrigated, of rice.

In other words in both Punjab and Haryana region, (1) the acreage wheat and rice increased overtime, (2) area under irrigation, of wheat and rice increased over time and the former increased more sharply than the latter, and (3) in the region as a whole, area under irrigation has increased more sharply after 1960 (after Bhakra Nangal). This is corroborated by the fact, the gross area irrigated of all crops, in Punjab-Haryana region, is also sharper after 1960.

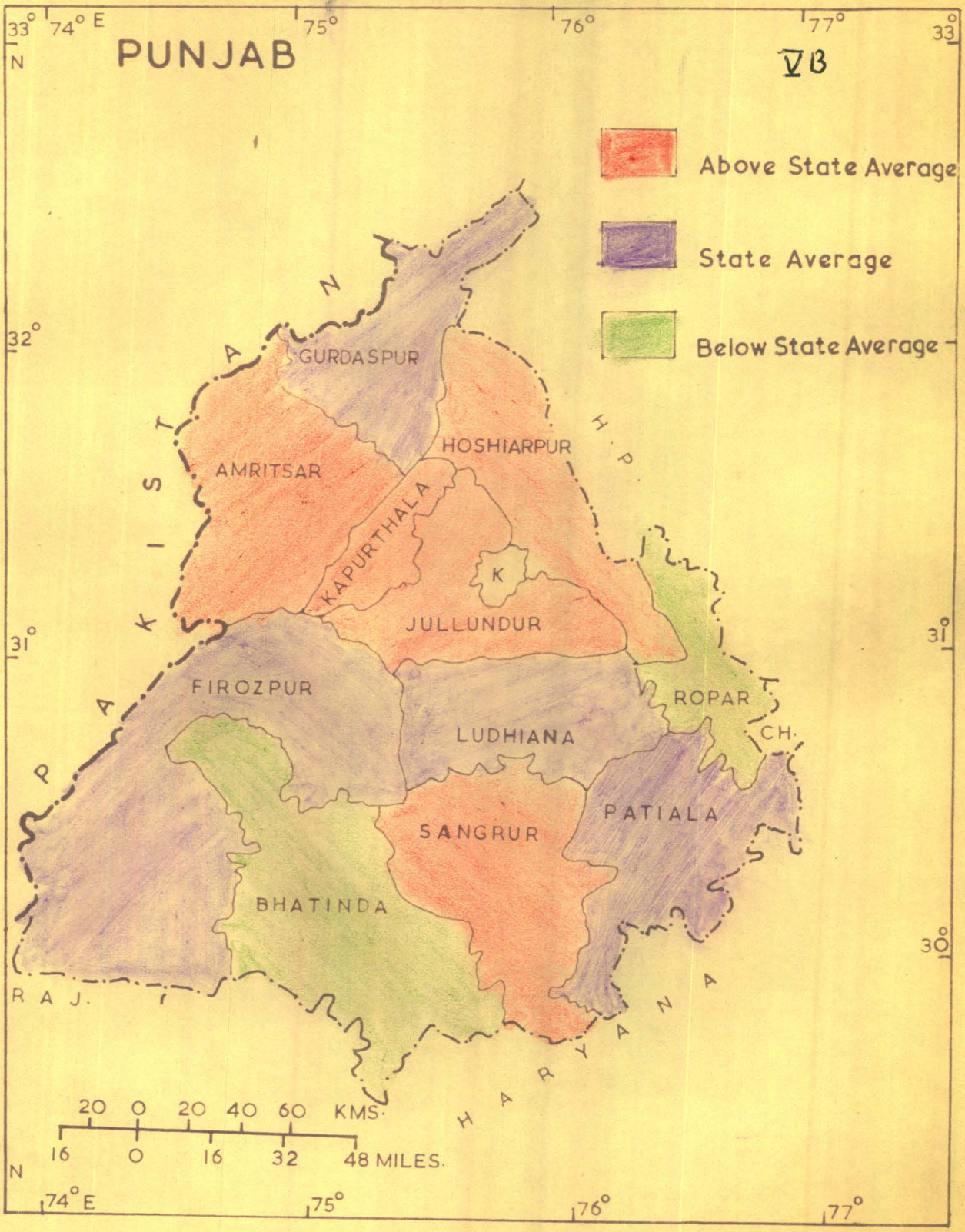
Another factor influencing acreage under a crop is the value of the crop concerned. This aspect has not been considered here, due to the difficulty involved in getting districtwise data relating to the prices of particular crops. The information is however available at the state level but it would be quite arbitrary to use this to find out explanations for inter-district variations in ~~averages~~ acreages under two crops. Any statistical attempt to do the same would eliminate the common factor viz., the price element and ultimately we will be actually explaining the problem with reference to production, rather than to value of crops. But value of crops is an important factor in determining acreages. A higher value crop will induce farmers to devote more land to that crop; specially where commercial crops are grown. Rice is a good example here. Almost the entire rice production is exported out of the region. This could partly be attributed to the profitability of growing the crop.

Coming to an inter-district comparison, in almost all the districts, area under wheat and rice have increased. The tables (VII-A to VII-T) showing percentage variations in area, production and yield per hectare over time (given at the end of Chapter III) clearly reveal that in most of the districts, in 1971 as compared to 1961, area under rice and area irrigated of rice have increased faster than the corresponding increase in area under wheat and area irrigated of wheat. Sangrur district is an exception. In this district, both area under rice and area under irrigation of rice have fallen towards the end. The nine years' average shows that the values are positive in most of the districts. The t values are highly significant in districts bearing the sign (*). In this period this is true particularly because after 1960, irrigation made its impact felt in Punjab over a wide range and increases in area under wheat and rice took place. In Sangrur, the value is negative for rice and this is obviously due to the fact that both acreage under rice and area irrigated of rice have maintained a falling trend particularly after 1965. But for wheat, the value is highly significant. After this period, irrigation has been an important factor in raising yields rather than in increasing area. Rice has perhaps been replaced by some other crop, like cotton, in Sangrur. In districts where the two (area and irrigation) have moved together, it is obvious because, unless water is available rice cannot be grown. Ferozpur is another exception. In this district area under wheat and area irrigated of wheat increased faster than area under rice and area irrigated of rice. The inter-district variations where any, are clear from the Maps.

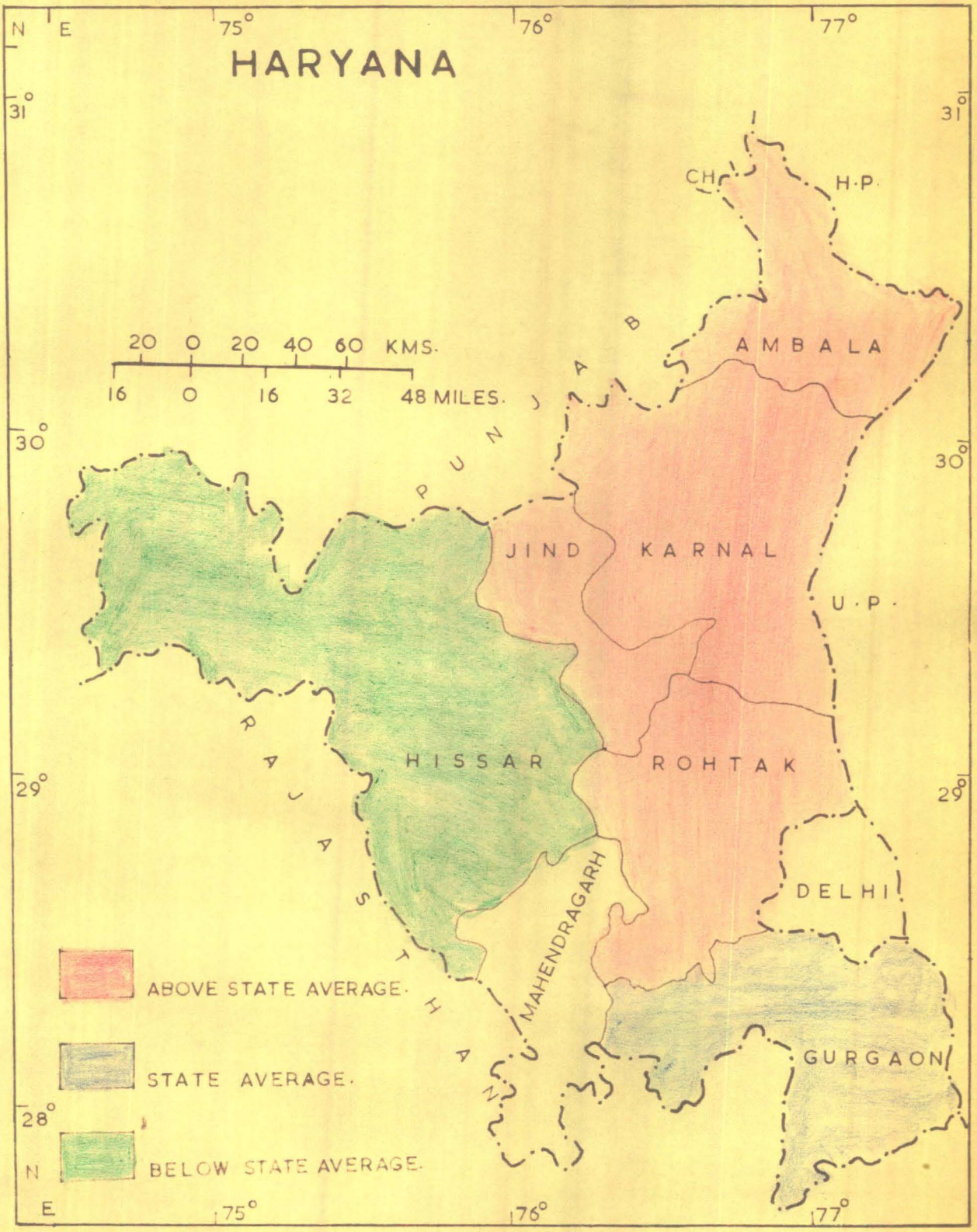
PROPORTION OF AREA UNDER WHEAT TO AREA UNDER ALL CROPS 1961 (V) A



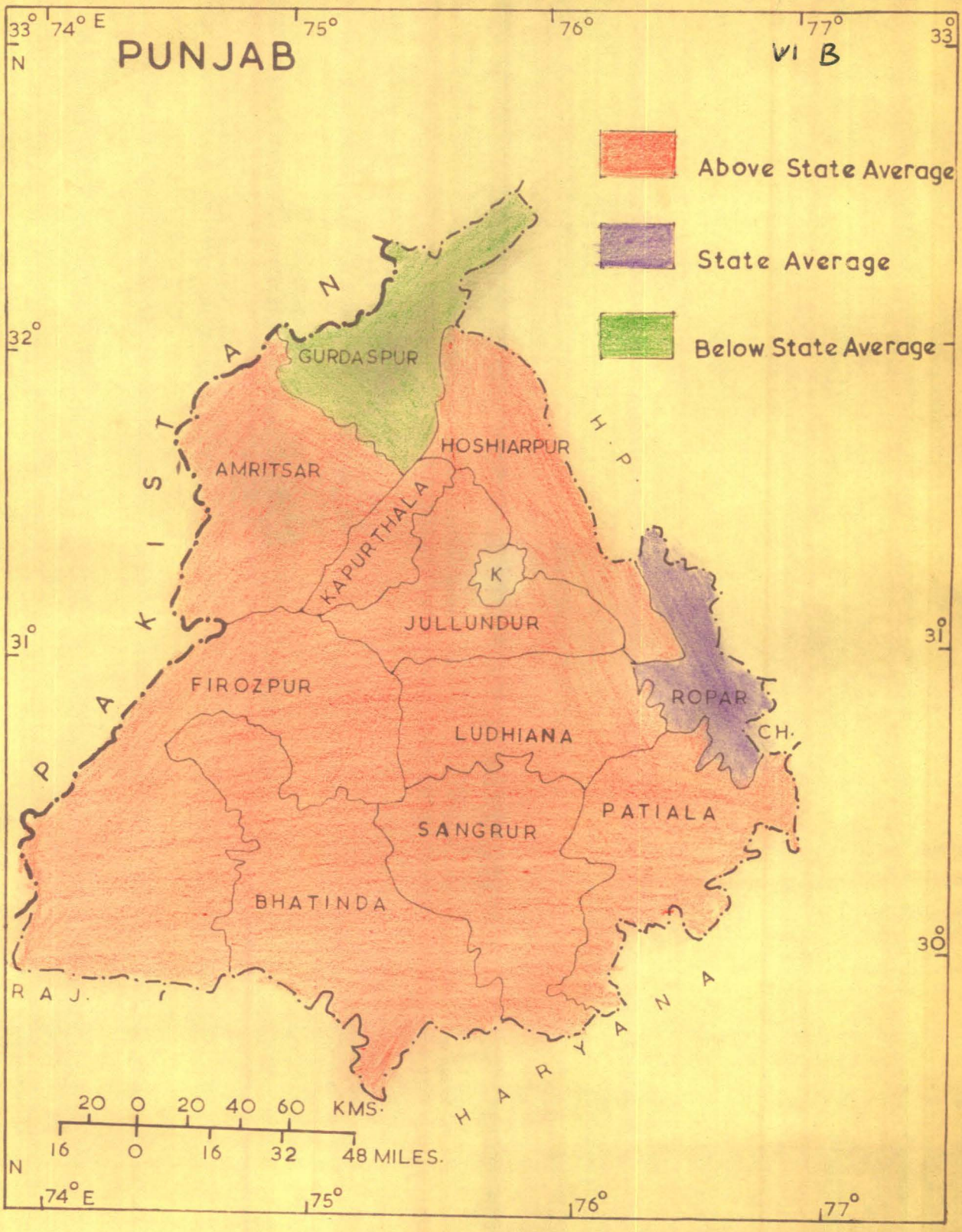
PROPORTION OF AREA UNDER WHEAT TO AREA UNDER ALL CROPS 1961



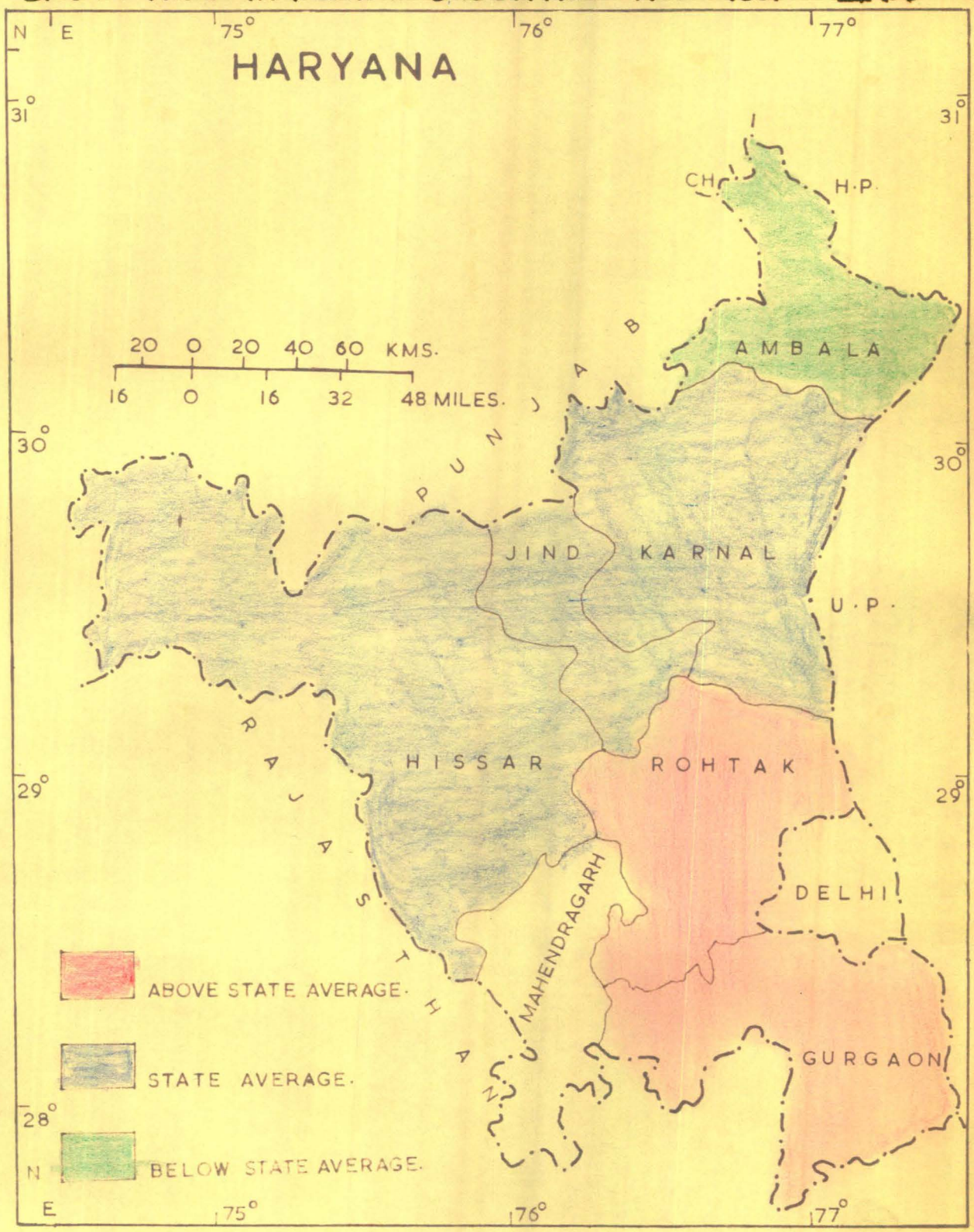
PROPORTION OF AREA UNDER WHEAT TOAREA UNDER ALL CROPS 1971 VI (A)



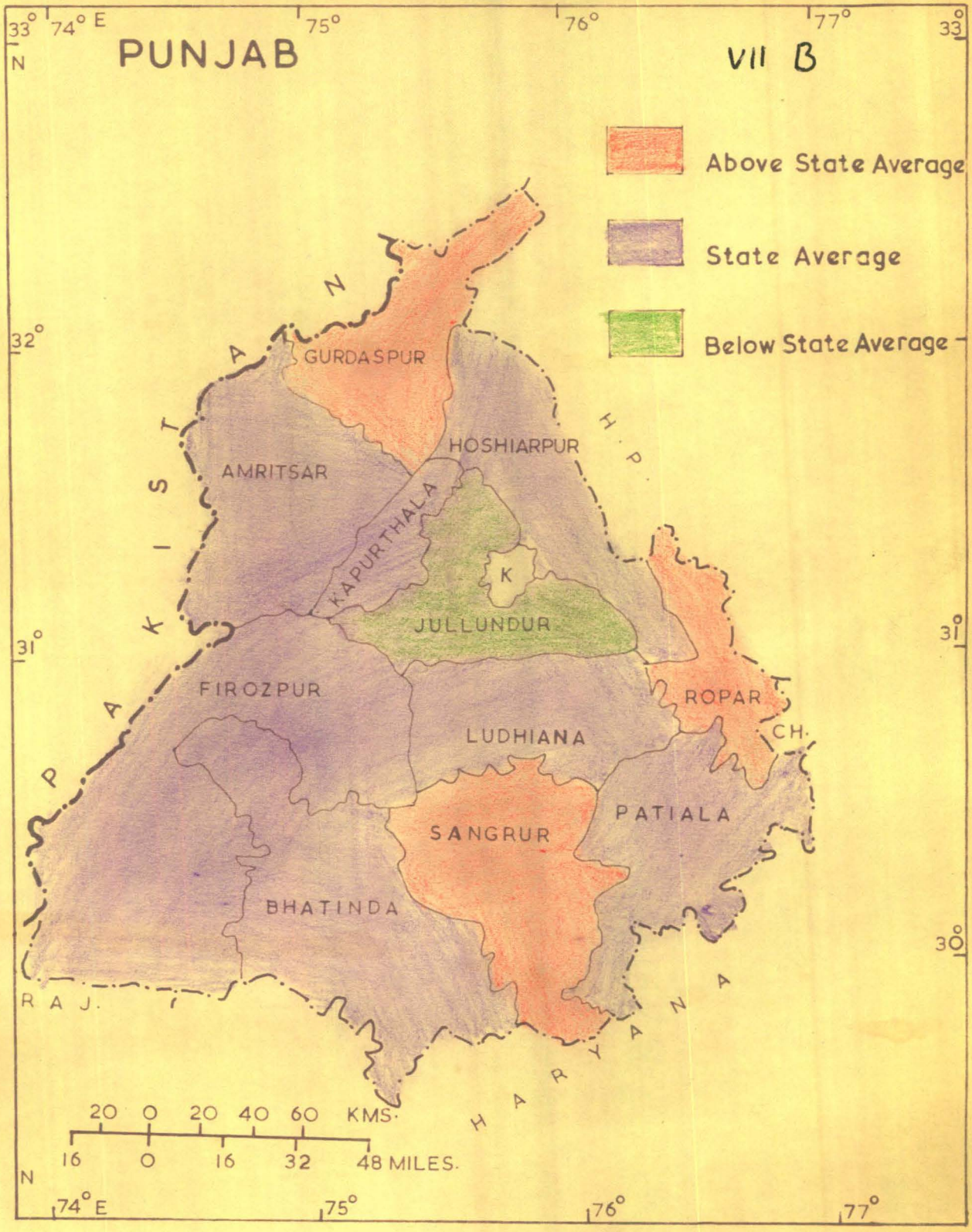
PROPORTION OF AREA UNDER WHEAT TO AREA UNDER ALL CROPS 1971.



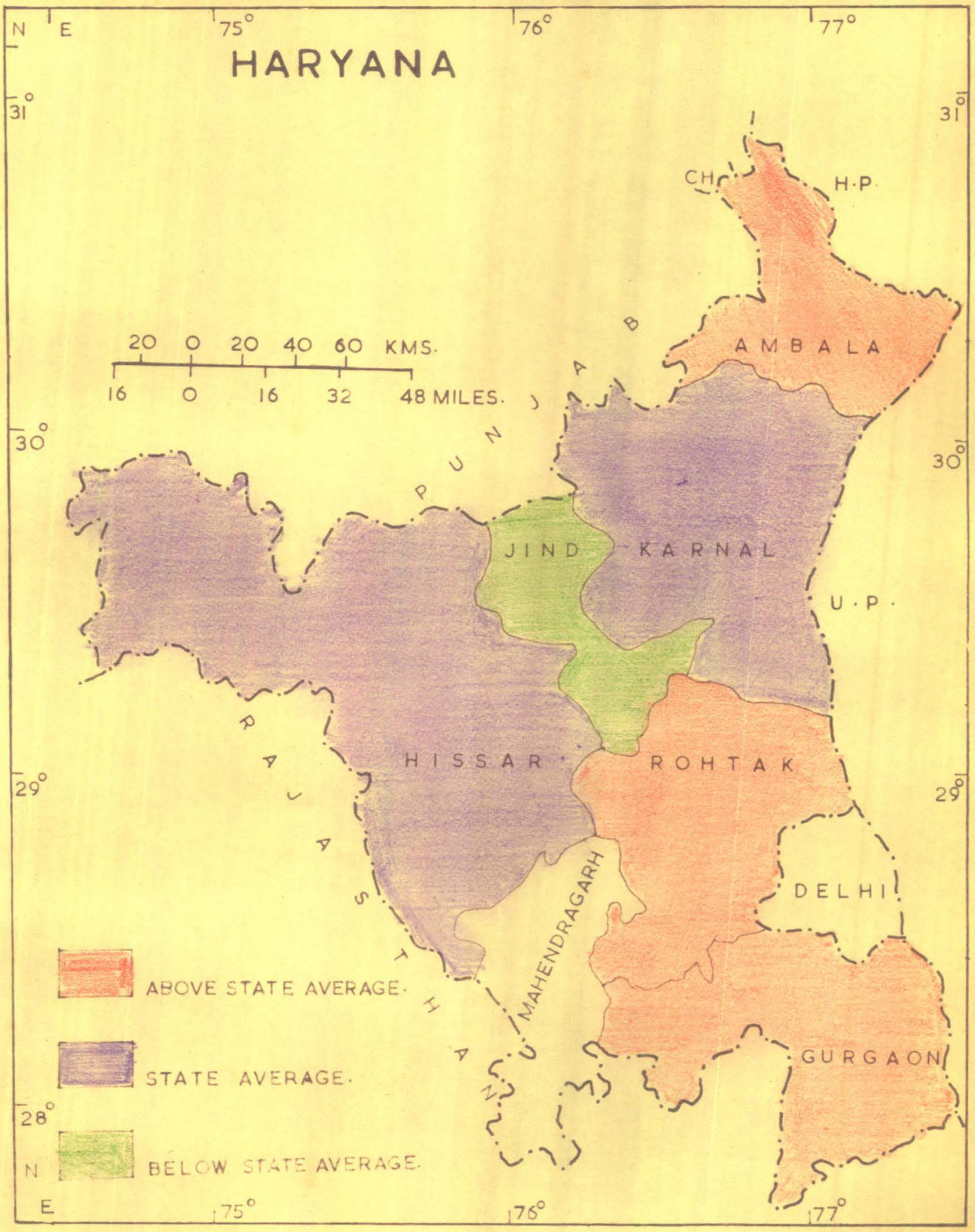
AREA OF WHEAT IRRIGATED AS A PERCENTAGE OF GROSS AREA IRRIGATED UNDER ALL CROPS 1961 VII (A)



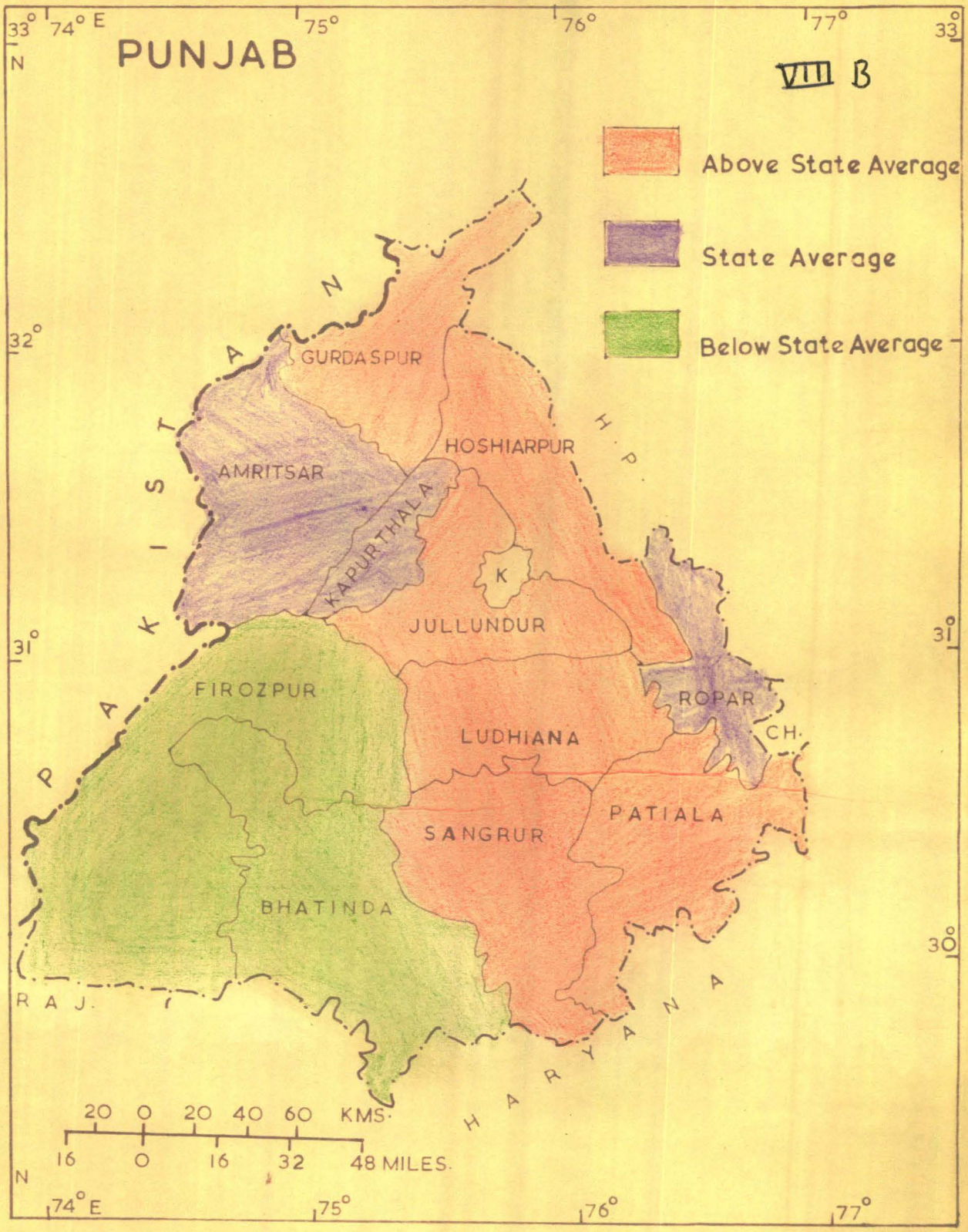
AREA OF WHEAT IRRIGATED AS A PROPORTION OF GROSS AREA IRRIGATED UNDER ALL CROPS 1961.



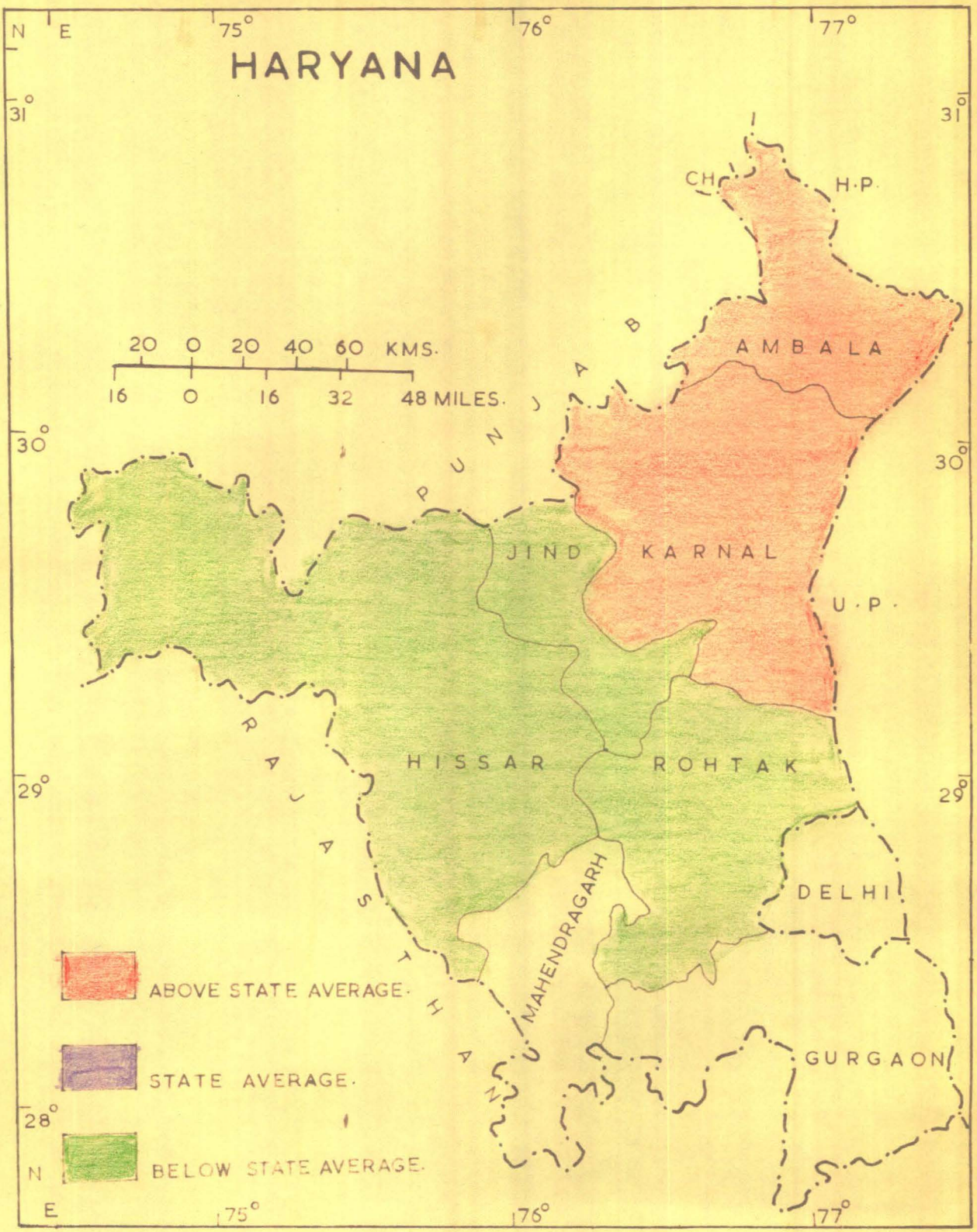
AREA OF WHEAT IRRIGATED AS A PERCETAGE OF GROSS AREA IRRIGATED UNDER ALL CROPS 1971 VIII(A)



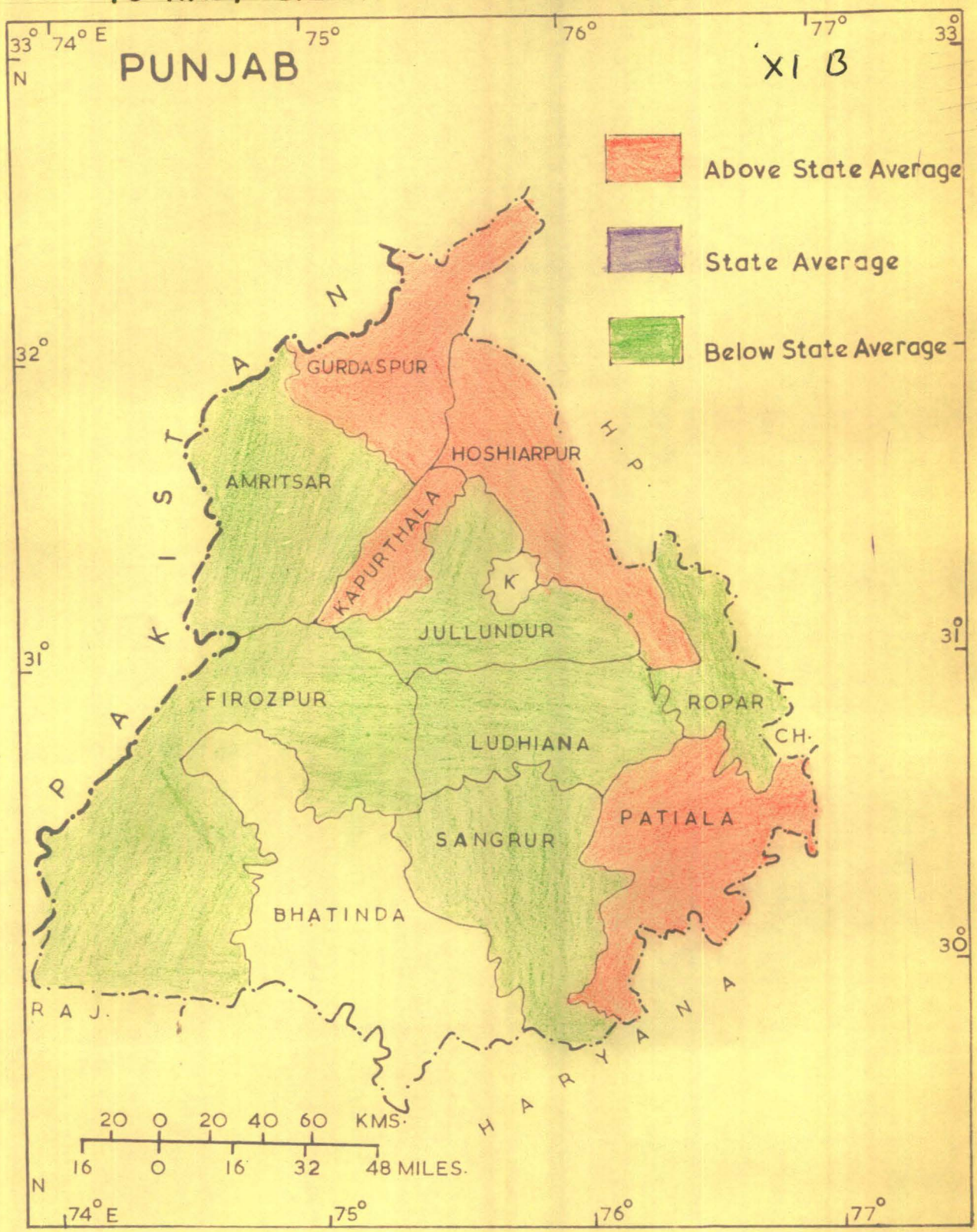
AREA OF WHEAT IRRIGATED AS A PERCENTAGE OF AREA IRRIGATED UNDER ALL CROPS 1971.



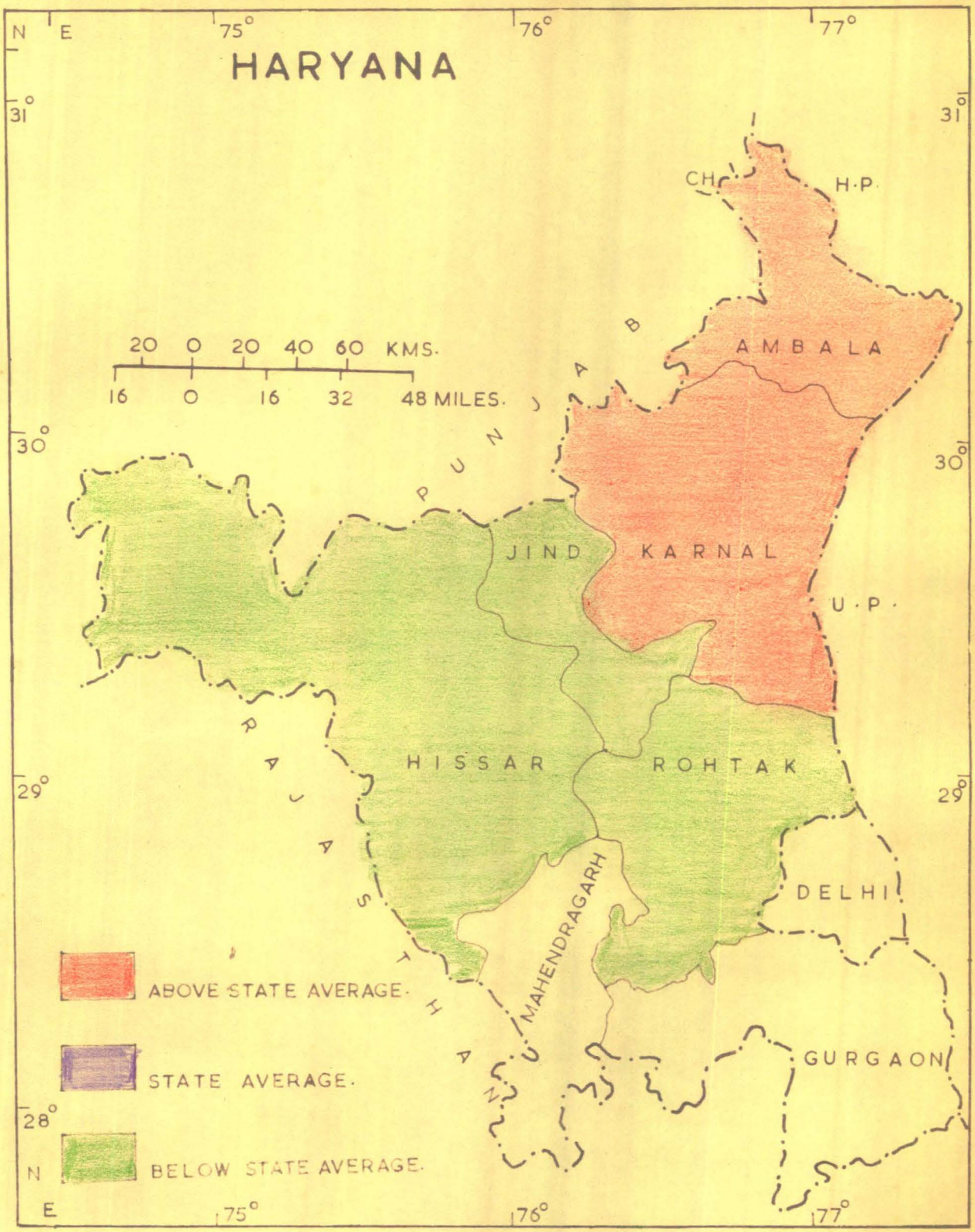
PROPORTION OF AREA UNDER RICE TO AREA UNDER ALL CROPS 1961 XI (A)



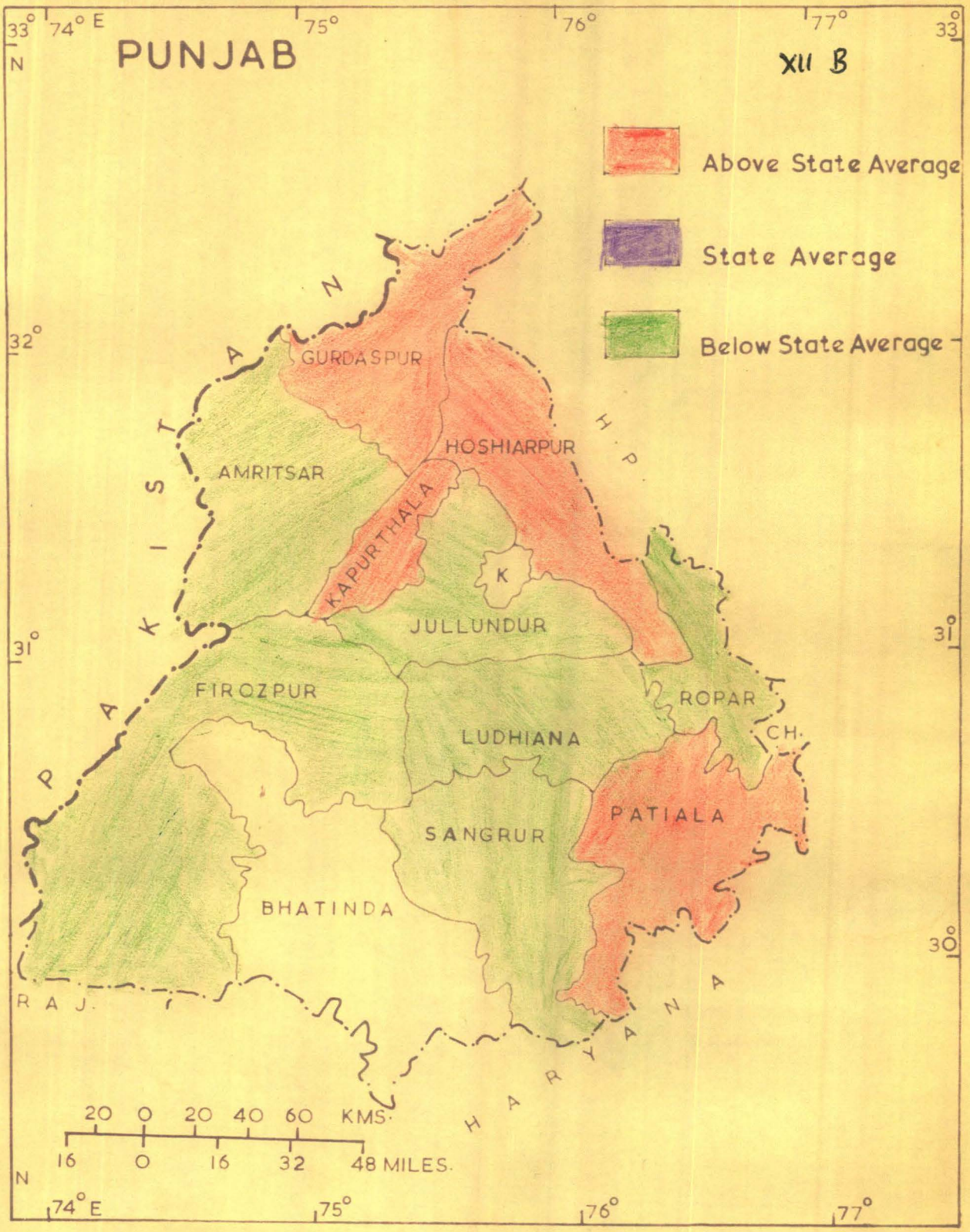
PROPORTION OF AREA UNDER RICE TO AREA UNDER ALL CROPS 1961



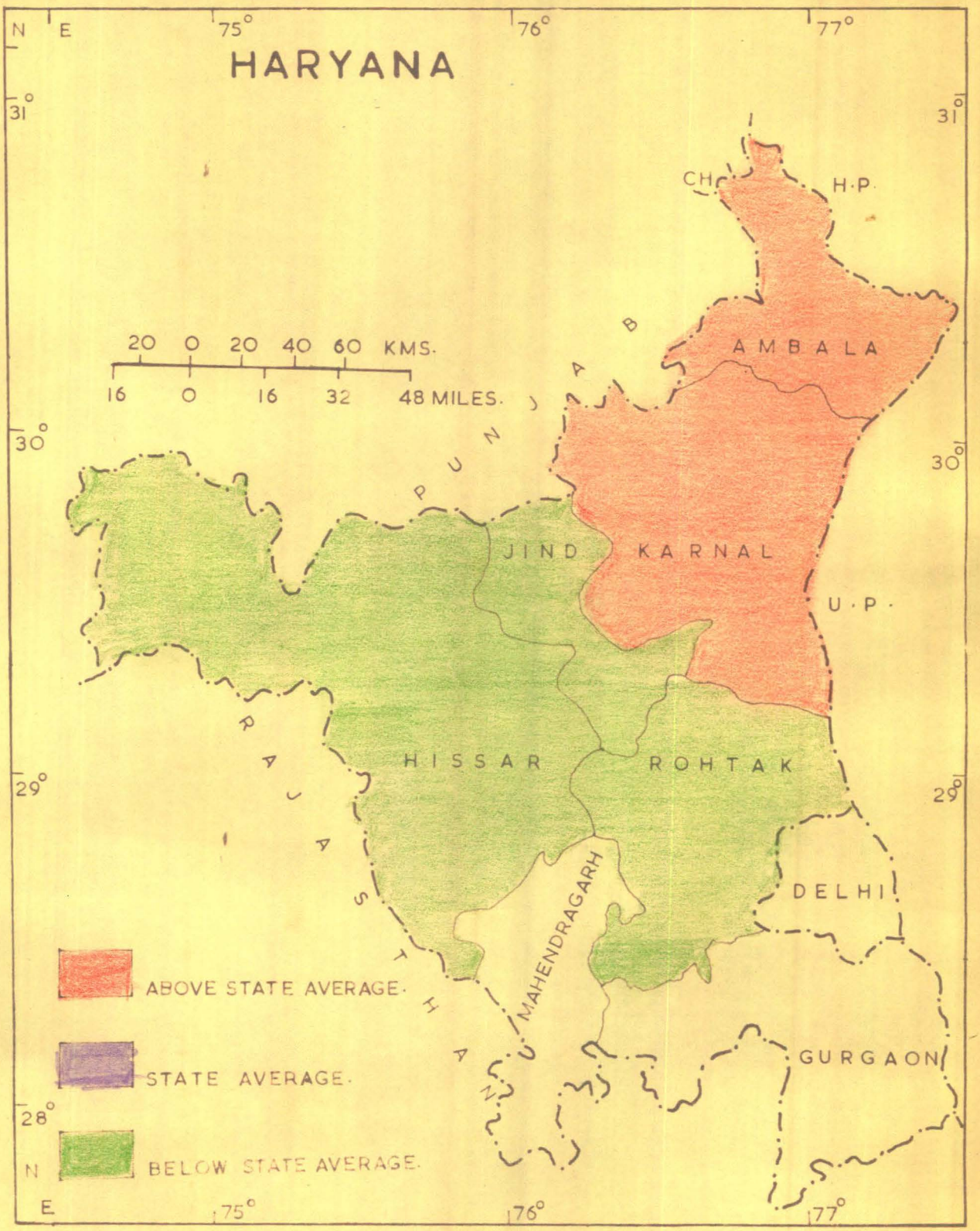
PROPORTION OF AREA UNDER RICE TO AREA UNDER ALL CROPS 1971- XII (A)



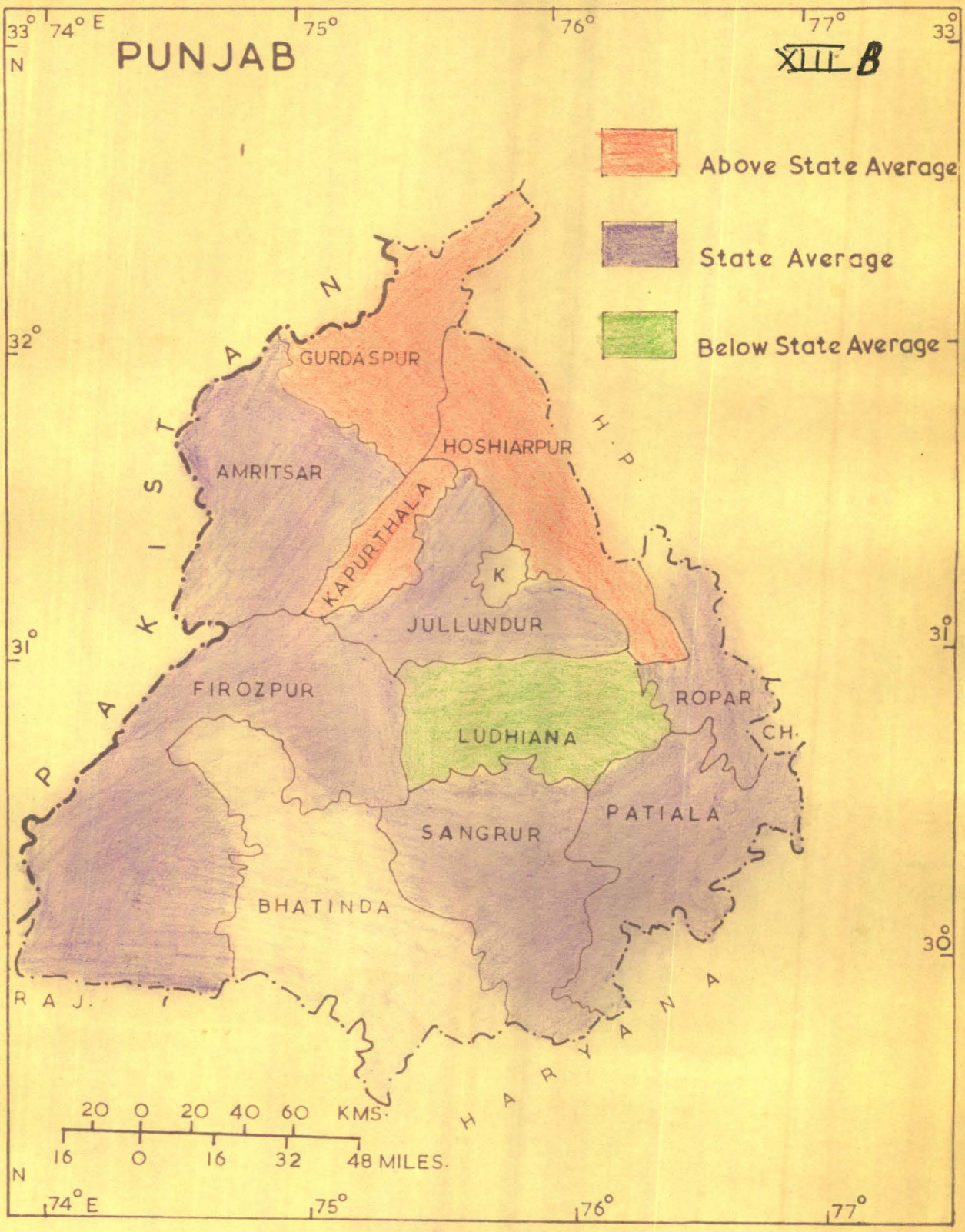
PROPORTION OF AREA UNDER RICE TO AREA UNDER ALL CROPS 1971



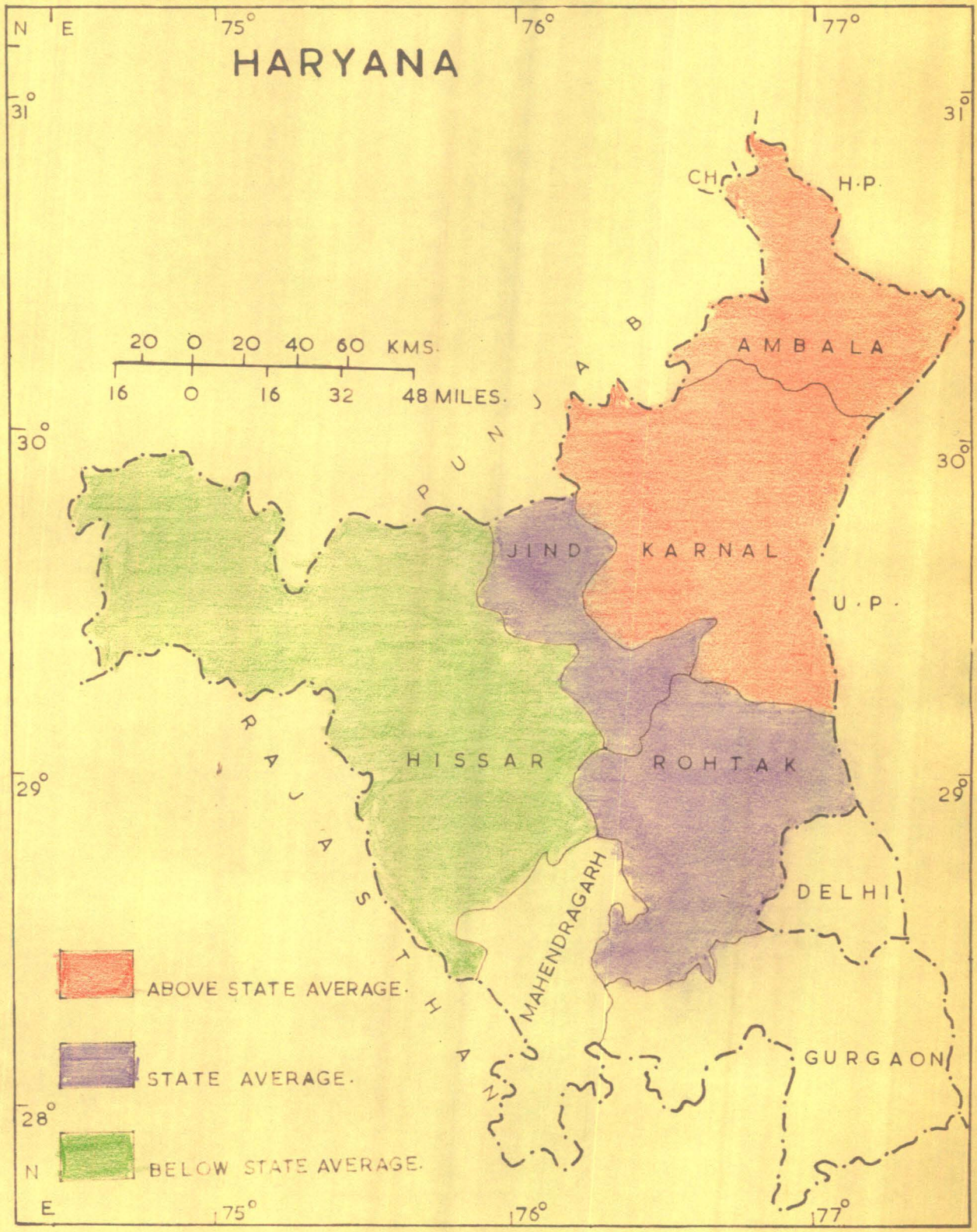
AREA OF RICE IRRIGATED AS A PERCENTAGE OF AREA IRRIGATED UNDER ALL CROPS 1961 XIII(A)



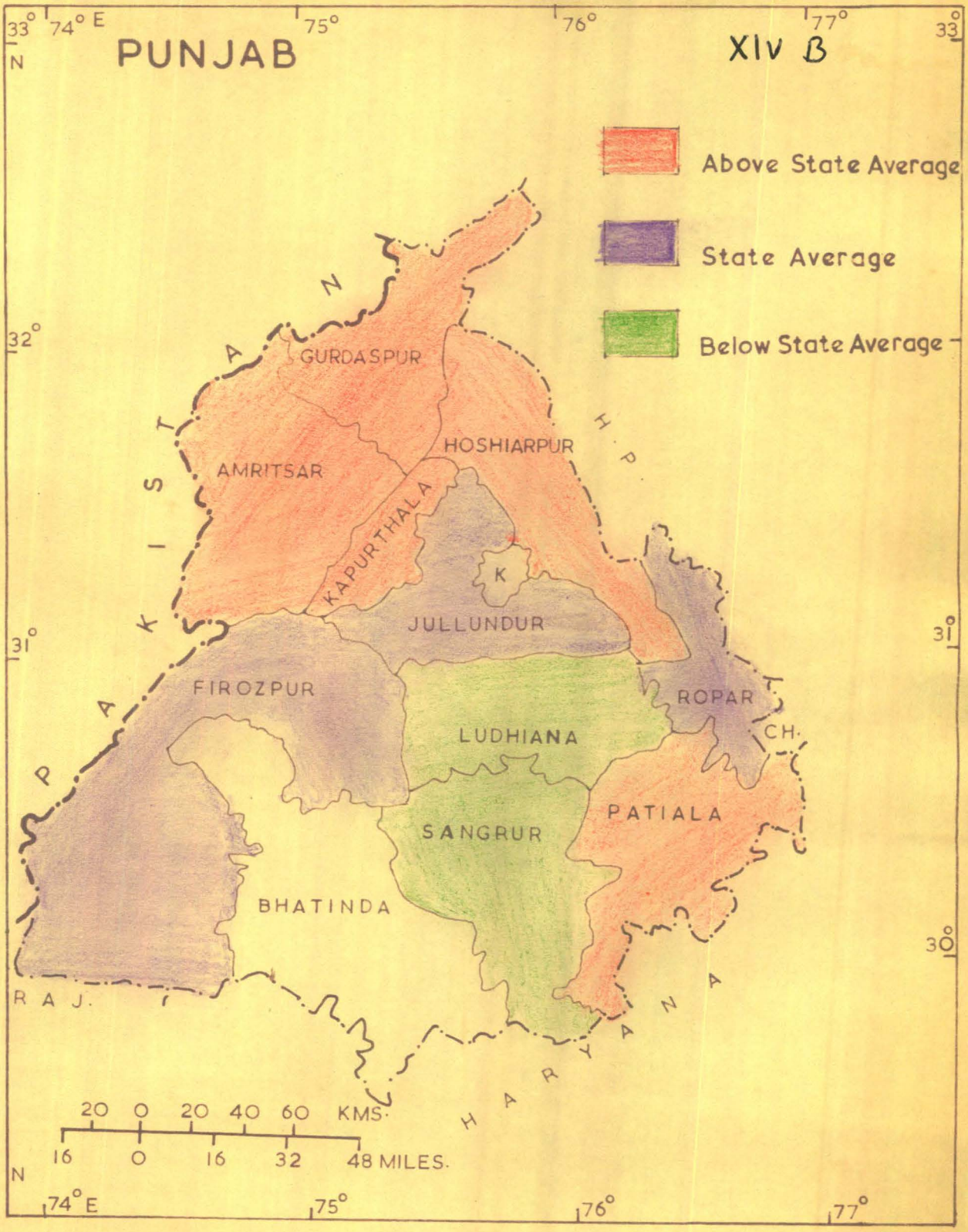
AREA OF RICE IRRIGATED AS A PROPORTION OF GROSS AREA IRRIGATED UNDER ALL CROPS 1961



AREA OF RICE IRRIGATED AS A PERCENTAGE OF AREA IRRIGATED UNDER ALL CROPS 1971 - XIV(A)



AREA OF RICE IRRIGATED AS A PERCENTAGE OF GROSS AREA IRRIGATED UNDER ALL CROPS 1971.



In general, both area under wheat and rice have increased steadily with increase in area under irrigation of the two crops, in the districts of Punjab-Haryana region. See Maps V-A, B, VI-A, B, VIII-A, B, XI-A, B, XII-A, B, XIII-A, B, and XIV-A, B, all facing page 36.

The values of coefficient of correlation between area irrigated (x) and area under wheat and area under rice (y) is given below districtwise in Punjab-Haryana region.

Table V

	Wheat		Rice	
	C.C.	t Value	C.C.	t Value
STATE	.65	4.25*	.96	9.09*
Gurdaspur	.09	.23	.60	1.98
Amritsar	.76	3.06	.91	5.5*
Jullundher	.44	1.29*	.98	12.96*
Kapurthala	.71	2.65*	.86	4.37*
Hoshiarpur	.03	.07	.85	4.25*
Rupar	-	-	-	-
Ludhiana	.23	.62	.97	10.47*
Ferozpur	.45	1.34	.50	1.5
Bhatinda	.90	5.3*	-	-
Sangrur	.96	9.09*	-.56	-1.78
Patiala	.30	.83	.83	3.88*
Hissar	.96	9.09*	.91	5.5*
Rohtak	.60	2.0	.10	.26
Gurgaon	.82	3.77*	.52	1.61
Karnal	.81	3.77*	.38	1.1
Ambala	.72	2.71*	.57	1.9
Jind	-	-	-	-
Mohindergarh	.52	1.61	-	-

*stands here for significant values.

To sum up the chapter:

1. In Punjab-Haryana region as a whole, area under wheat has increased less sharply but area irrigated of wheat has increased more sharply than the corresponding changes in rice. This is true in most districts.

2. Gross cropped area has increased steadily over the years due to fall in area current fallows and other uncultivable land with extension of irrigation, or due to lands reclaimed.

3. Crop intensity $\left(\frac{\text{Gross cropped area}}{\text{Net area sown}}\right)$ has increased in 1971 as compared to 1961. It has not fallen in any district. This shows that the farmers in Punjab-Haryana believe in crop intensification.

4. Gross area irrigated has increased sharply in all the districts, particularly after 1960.

Having studied the pattern of land classification and trends therein, over time, relating to all crops and to wheat and rice in particular, it is now relevant to examine the inter-district variations in production and productivity of the two crops over time. To what extent are acreage under the crop, and area irrigated of the crop important in explaining changes in production and what are the factors influencing yields ? What are the other factors in combination with the above two factors that may explain variations in production and yield of wheat and rice ? This forms the subject matter of our next chapter.

MAP- 1

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Table VI(A)

Percentage Increase and Decrease

(PUNJAB)

Years	Total cropped area	Net area sown	Area under current fallows	Area not cultivated other than fallows	Area under forest	Total irrigated area
1950-51	Base	Base	Base	Base	Base	Base
1951-52	-7.28	- 4.48	+37.00	+ 0.6	- 6.6	-
1952-53	- 5.22	- 3.46	-32.52	- 2.6	- 6.9	+ 2.61
1953-54	+ 0.01	1.69	+ 3.56	-12.1	+ 2.4	+ 5.8
1954-55	+11.26	4.86	-19.21	-15.6	+ 3.0	+14.07
1955-56	+18	7.10	-34.3	-19.9	+ 4.0	+15.24
1956-57	+19.44	8.99	-40.33	-28.06	+14.18	+16.5
1957-58	+18.71	8.99	-33.7	-30.7	+14.28	+16.5
1958-59	+23.15	11.28	-47.8	-39.3	+16.02	+21.2
1959-60	+20.4	11.23	-45.7	-42.0	+12.82	+21.8
1960-61	Base	Base	Base	Base	Base	Base
1961-62	+ 1.62	2.04	-13.7	-11.5	- 2.8	+ 1.8
1962-63	5.26	2.2	-21.7	-12.15	-2.8	+ 6.9
1963-64	3.21	2.8	-22.6	-24.7	- 2.8	+ 8.4
1964-65	8.30	3.8	-29.7	-25.88	+111.42*	+14.7
1965-66	3.31	1.2	+ 1.2	-26.66	+137.14*	+18.4
1966-67	9.27	3.5	-16.61	-31.7	+122.85*	+27.1
1967-68	14.98	6.2	-51.11	-34.11	+125.71*	+30.18
1968-69	11.74	4.8	-33.5	-48.8	+225.91*	+44.3
1969-70	16.20	7.1	-52.0	-61.5	+242.85	+54.13
1970-71	19.99	7.8	-55.9	-63.5	+251.42	+60.25

*The sudden increase in percentage of area under forests is due to a change in the definition adopted in the classification of land as forests.

Table VI(B)

Percentage Increase and Decrease

(HARYANA)

Years	Total cropped area	Net area sown	Area under current fallows	Area not cultivated other than fallows	Area under forest	Total irrigated area
1950-51	Base	Base	Base	Base	Base	Base
1955-56	+30.0	+10.6	-52.9	-20.4	+33.3	+14.9
1960-61	+32.4	+14.0	-53.9	-44.9	+166.6	+44.08
1961-62	+29.9	+15.1	-52.4	-47.9	+116.6	+50.6
1962-63	+28.7	+16.5	-56.4	-52.7	+166.6	+62.4
1963-64	+28.7	+16.7	-51.2	-59.1	+162.5	+70.9
1964-65	+32.2	+16.9	-52.7	-62.2	+237.5	+70.6
1965-66	+17.5	+11.8	-17.4	-62.8	+237.5	+77.8
1966-67	+32.8	+14.7	-36.2	-74.3	+279.16	+107.4
1967-68	+48.7	+17.8	-56.8	-74.3	+283.3	+112.6
1968-69	+17.07	+ 9.7	+ 5.6	-77.3	+283.3	+122.7
1969-70	+42.7	+18.9	-60.3	-79.9	+304.16	+157.8
1970-71	+43.18	+19.5	-63.05	-81.7	+312.5	+166.4

Table VI(C)

Percentage Increase and Decrease

Years	Total cropped area	Net area sown	Area under current fallows	Area not cultivated other than fallows	Area under forest	Total irrigated area
Districts of Punjab State						
GURDASPUR						
Base 1950=100						
1951-52	- 4	+ 9	-49	-31	10	- 6
1952-53	- 2	+ 3	-20	- 4	11.1	+ 0.08
1953-54	- 2	+ 4	-74	- 4	0	+ 6
1954-55	+ 4	+ 4	-74	- 6	0	+ 8
1955-56	+ 5	+ 0.5	- 8.4	- 3	0	+ 0.9
1956-57	- 7	+ 4	-28.9	- 3	0	+ 5.4
1957-58	- 5	- 5.3	+32	- 3	0	- 7.2
1958-59	-11	+ 8	+32	-60	+222*	-10.9
1959-60	+ 5	- 3	+12	-	+222*	0
Base 1960=100						
1961-62	- 2	0	0	0	0	-15
1962-63	+ 4	0	0	0	0	- 6
1963-64	+ 5	+ 2	-10	-	0	+ 6
1964-65	+11	+ 7	-43	-	+25	+15
1965-66	+14	+18	-	-	+25	-
1966-67	+21	+17	-98	-	+25	+38
1967-68	+20	+17	-98	-	+25	+26
1968-69	+20	+19	-	-	+33.3	+43
1969-70	+98	+20	-	-	+33.3	+68
1970-71	+103	+21	-98	-	+33.3	+60

* The sudden increase in area under forest in 1958-60 is due to a change in the definition of forests.

Table VI(D)

Percentage Increase and Decrease

Years	Total cropped area	Net area sown	Area under current fallows	Area not cultivated other than fallows	Area under forest	Total irrigated area
AMRITSAR						
Base 1950=100						
1951-52	+ 1.33	+ 0.4	-11	+12	-	+ 6.6
1952-53	+ 0.08	+ 0.11	- 7	+12	-	+10
1953-54	+ 8.6	+ 0.3	- 9	+13	-	+17
1954-55	+ 8	+ 1.19	-14	+11	-	+11
1955-56	+ 9	+ 3	- 9	+11	-	+ 8
1956-57	+ 7	+ 4	-37	+ 6	-	+ 4
1957-58	+ 4	+ 2	-24	+ 4	-	+11
1958-59	+10	+ 2	-27	+ 2	-	+ 5
1959-60	+ 4	0	-10	+0.71	-	+ 5
Base 1960=100						
1961-62	+ 9	+ 8	-46	0	-	+17
1962-63	+20	+ 8	-48	0	-	+17
1963-64	+13	+ 6	-39	0	-	+16
1964-65	+19	+ 7	-43	0	-	+20
1965-66	+11	+ 4	-24	0	-	-
1966-67	+22	+ 6	-37	0	-	+25
1967-68	+22	+ 7	-44	0	-	+24
1968-69	+28	+16	-57	-40	-	+34
1969-70	+28	+19	-56	-58	-	+35
1970-71	+44	+20	-57	-59	-	+41

Table VI(E)

Percentage Increase and Decrease

Years	Total cropped area	Net area sown	Area under current fallows	Area not cultivated other than fallows	Area under forest	Total irrigated area
JULLUNDHER						
Base 1950=100						
1951-52	- 4	- 6	+62	- 5	-	+20
1952-53	+ 1	+ 2	+24	+17	-	+23
1953-54	- 1	- 3	+33	-49	-	+21
1954-55	+ 5	- 3	+30	-49	-	+30
1955-56	+13	- 2	+19	-52	-	+34
1956-57	+15	+ 1	- 8	-99	-	+32
1957-58	+13	+ 4	+13	-	-	+30
1958-59	+12	+ 5	0	-	-	+27
1959-60	+15	+ 5	+ 1.5	-83	-	+26
Base 1960=100						
1961-62	- 2	- 0.7	+ 8	-	-	- 6
1962-63	+ 5	+ 0.7	+ 5	-	-	+ 0.9
1963-64	- 2	- 2.2	+ 5	-	-	+ 1.7
1964-65	+12	+ 1.8	-27	-	-	+16.5
1965-66	+ 3	+ 0.7	-17	-	-	+19
1966-67	+10	-14	+46	-	-	+26
1967-68	+16	-12	-33	-	-	+26
1968-69	+17	-12	-41	-	-	+39
1969-70	+18	- 8	-46	-	-	+49
1970-71	+21	- 8	=50	-	-	+49

Table VI(F)

Percentage Increase and Decrease

Years	Total cropped area	Net area sown	Area under current fallows	Area not cultivated other than fallows	Area under forest	Total irrigated area
KAPURTHALA						
Base 1950=100						
1951-52	- 4	+ 3	- 1.0	- 3.7	-	+15
1952-53	0	+11	- 9	-12.3	-	+25
1953-54	+ 8	+22	-17	-27	-	+27
1954-55	+13	+25	-22	-28	-	+31
1955-56	+23	+27	-76	-33	-	+37
1956-57	+25	+32	-28	-59	-	+41
1957-58	+29	+42	-48	-40	-	+41
1958-59	+35	+45	-57	-37	-	+53
1959-60	+33	+48	-62	-37	-	+61
Base 1960=100						
1961-62	+ 2.3	+ 2	-20	+ 5	-	+ 1.2
1962-63	+14.17	- 0.8	+10	-95	-	+34
1963-64	+18.1	+ 4	-50	-95	-	+41
1964-65	+25	+ 8	-20	-95	-	+43
1965-66	+24	+12	-40	-95	-	-
1966-67	+25	+17	-80	-95	-	+43.0
1967-68	+25	+16	-80	-	-	-
1968-69	+22	+14.2	-60	-	-	+44
1969-70	+22	+17	-60	-	-	+57
1970-71	+22	+18	-70	-	-	+61

Table VI(G)

Percentage Increase and Decrease

Years	Total cropped area	Net area sown	Area under current fallows	Area not cultivated other than fallows	Area under forest	Total irrigated area
HOSHIARPUR						
Base 1950=100						
1951-52	+ 1	-19	- 7.2	+10.4	0	+22
1952-53	- 3	-18	- 1.8	-36	0	+20
1953-54	+ 0.3	-19	- 1.8	-38	0	+23
1954-55	+ 2.0	-18	- 5.4	-57	0	+27
1955-56	+ 3	-18	+ 5.4	-87	0	+10
1956-57	+ 4	-19	+ 7.2	-48	0	+16
1957-58	+ 5	-17	-16.3	-61.8	0	+11
1958-59	+13	-19	- 5.4	-50.8	0	+ 9.6
1959-60	+10	-19	- 7	-60	0	+ 9
Base 1960=100						
1961-62	- 0.3	0	-17	- 7.6	0	-23
1962-63	+ 5	0	-23	+31	0	-11
1963-64	+ 4	0	-23	+38	0	- 9
1964-65	+ 9	+ 0.8	-23	+31	+66	- 9
1965-66	+ 7	- 0.1	+ 6	+15	+66	-
1966-67	+12	+ 0.4	-11.7	+ 7	+33	+30
1967-68	+13	+ 3.0	-41.1	0	+33	+ 6
1968-69	+11.4	+ 3.0	-41.1	0	+66	+83
1969-70	+14	+ 6	-76.4	0	+100	+116
1970-71	+20	+ 7	-76.4	-15	+66	+118

Table VI(H)

Percentage Increase and Decrease

Years	Total cropped area	Net area sown	Area under current fallows	Area not cultivated other than fallows	Area under forest	Total irrigated area
RUPAR						
Base 1950=100						
1951-52	-	-	-	-	-	-
1952-53	-	-	-	-	-	-
1953-54	-	-	-	-	-	-
1954-55	-	-	-	-	-	-
1955-56	-	-	-	-	-	-
1956-57	-	-	-	-	-	-
1957-58	-	-	-	-	-	-
1958-59	-	-	-	-	-	-
1959-60	-	-	-	-	-	-
Base 1960=100						
1961-62	+ 6	0	- 5	+ 7	0	-
1962-63	+ 5	0	- 5	+13	0	-
1963-64	+ 2	+ 9	- 5	0	0	-
1964-65	+ 7	+ 9	- 5	0	+67	-
1965-66	+ 3	0	0	0	+67	-
1966-67	+ 4	+ 8	0	+27	+33	-
1967-68	+23	+ 6	- 5	-20	+33	-
1968-69	+17	0	- 5	-33	+67	-
1969-70	+18	+ 0.8	-25	-40	+100	-
1970-71	+34	+ 3	-50	-40	+67	-

Table VI(I)

Percentage Increase and Decrease

Years	Total cropped area	Net area sown	Area under current fallows	Area not cultivated other than fallows	Area under forest	Total irrigated area
LUDHIANA						
Base 1950=100						
1951-52	- 0.3	+33	- 1.11	- 1.3	-	+14
1952-53	- 4	- 1.6	+ 4.4	-15	-	+15
1953-54	+ 2	+ 3	-25	-19	-	+21
1954-55	+ 8	+ 3	-23	-19	-	+31
1955-56	+10	+ 1.5	-24	-15	-	+23
1956-57	+12	- 3.4	-24	-15	-	+35
1957-58	+15	+ 6	-46	- 9	-	+29
1958-59	+15	+ 8	-62	-13	-	+26
1959-60	+13	+ 9	-68	-17	-	+21
Base 1960=100						
1961-62	+ 2	+ 3	-15	-15	+ 8	+ 8
1962-63	+ 3	+ 2	- 8	-19	+ 9	+ 9
1963-64	+ 9	+ 5	-38	-29	+29	+29
1964-65	+14	+ 2	- 8	-26	+38	+37
1965-66	+13	+ 3	-31	-26	-	-
1966-67	+16	+ 3	-31	-26	+55	+56
1967-68	+21	+ 6	-77	-33	+57	+57
1968-69	+26	+ 6	-92	-44	+83	+83
1969-70	+30	+ 7	-85	-52	+102	+102
1970-71	+33	- 7	-92	-52	+105	+105

Table VI(J)

Percentage Increase and Decrease

Years	Total cropped area	Net area sown	Area under current fallows	Area not cultivated other than fallows	Area under forest	Total irrigated area
BHATINDA						
Base 1950=100						
1951-52	-14	-13	+30.2	-	-	- 2
1952-53	-19	-19	+47.2	- 4.3	-	- 0.7
1953-54	+ 3	+ 2.7	-59	- 7	-	+ 5.5
1954-55	+16	+12.2	-26	- 2	-	+20
1955-56	+21	+12	-80	- 8	-	+29
1956-57	+27	+15	-78	+ 4	-	+34
1957-58	+27	+14	-72	-13	-	+26
1958-59	+23	+15	-78	-20	-	+34
1959-60	+25	+22	-67	-17	-	+44.8
Base 1960=100						
1961-62	+ 7	+ 5	-64	-16	0	+17
1962-63	+ 8	+ 4.3	-48	-66	0	+ 9
1963-64	+ 2	+ 5	-81	-66	0	- 2
1964-65	+ 9	+ 5	-76	-33	+400	+14
1965-66	+ 2	+ 4	-57	-33	+500	+21
1966-67	+ 4	+ 5	-78	-33	+700	+22
1967-68	+16	+ 6	-	-33	+700	+46
1968-69	+ 9	+ 4	-86.4	-	+700	+46
1969-70	+19	+ 6	-84	-	+700	+58
1970-71	+22	+ 7	-92	-	+700	+58

Table VI(K)

Percentage Increase and Decrease

Years	Total cropped area	Net area sown	Area under current fallows	Area not cultivated other than fallows	Area under forest	Total irrigated area
FEROZPUR						
Base 1950=100						
1951-52	- 1.16	+ 1.07	- 7.4	+ 2	-	+ 1.8
1952-53	-12.7	- 4	+26.1	- 8	-	+ 1.2
1953-54	- 4	- 3	+19.03	- 3	-	+ 8
1954-55	+ 7	+ 5.11	+ 5.16	- 7	-	+12
1955-56	+14	+2.5	-16	- 6	-	+18
1956-57	+15	+ 2.5	-16	- 5	-	+19
1957-58	+10	0	- 9	- 5	-	+18
1958-59	+15	+ 5.11	-41	-23	-	+25
1959-60	+10	+ 1.17	-38	-33	-	+15
Base 1960=100						
1961-62	+ 2.5	0	+22	-18	-	+ 2.1
1962-63	+ 3	0	+10	-18	-	+ 2.4
1963-64	+ 6	+ 3	-40	-21	-	+ 9
1964-65	+ 9	+ 4	-17	-24	-	+10
1965-66	- 0.7	- 3	+62	-24	-	-
1966-67	+16	+ 4	-16	-39	-	+21
1967-68	+84	+ 6	-25	-49	-	+27
1968-69	+ 7	+ 9	+71	-41	-	+31
1969-70	+13	+ 3	- 1.4	-49	-	+30
1970-71	+17	+ 4	- 3	-52	-	+45

Table VI(L)

Percentage Increase and Decrease

Years	Total cropped area	Net area sown	Area under current fallows	Area not cultivated other than fallows	Area under forest	Total irrigated area
SANGRUR						
Base 1950=100						
1951-52	-15	- 8	+31	- 6	0	-10.3
1952-53	+ 3	+ 5	-44	-14	-33	-15
1953-54	+ 8	+ 8	+51	-28	0	- 8
1954-55	+ 7	+ 1	+60	-32	-33	- 3
1955-56	+11	+ 3	+68	-38	-33	- 7
1956-57	+17	+11	+73	-42	-33	- 3
1957-58	+14	+ 5	+73	-46	-33	-0.6
1958-59	+16	+ 5	+76	-47	-33	0
1959-60	+13	+ 6	+77	-54	-33	+ 3
Base 1960=100						
1961-62	0	+ 0.4	+22	- 8	-	+ 1.2
1962-63	+ 3	+ 1	0	-12	-	+ 8
1963-64	- 3	+ 2	-11	-32	-	+10
1964-65	- 0.5	+ 2	0	-28	+500	+ 7
1965-66	- 2.8	+ 3	-16	-28	+500	-
1966-67	+ 5	+ 3	-28	-48	+700	+110
1967-68	+ 5.3	+ 3	-50	-44	+700	+126
1968-69	+ 5.2	+ 4	-56	-92	+300	+155
1969-70	+ 9	+ 3	-56	-64	+300	+270
1970-71	+ 7	+ 1.1	-50	-	+300	+270

Table VI(M)

Percentage Increase and Decrease

Years	Total cropped area	Net area sown	Area under current fallows	Area not cultivated other than fallows	Area under forest	Total irrigated area
PATIALA						
Base 1950=100						
1951-52	+ .06	+ 7.2	+ 2	- 1.4	-	+14
1952-53	- 4	+10	+31	- 1.4	-	+17
1953-54	+ 5	+ 9	+59	- 4.4	-	+ 4
1954-55	+39	+13	+70	- 3	-	+13
1955-56	+48	+13	+22	- 3	-	+11
1956-57	+55	+14	+38	- 5	-	+18
1957-58	+46	+10	+66	- 7	-	+31
1958-59	+50	+13	+52	- 9	-	+46
1959-60	+29.8	+14	+72	-11	-	+59
Base 1960=100						
1961-62	- 8	+ 1	-28	- 4	0	+ 5
1962-63	- 3	+ 2	-36	- 4.5	0	+ 8
1963-64	- 8	0	+24	-50	0	- 1.8
1964-65	- 4	+ 1.1	+36	-50	+28	+ 5
1965-66	- 8	+11.6	+200	-50	+28	-
1966-67	- 9	-12.7	+216	-50	+28	+27
1967-68	- 0.3	+2.4	- 4	-54	+28	+29
1968-69	- 9	+ 4	-16	-63	+57	+53
1969-70	- 0.5	+ 4	-32	-	+57	+60
1970-71	- 9	+ 5	-44	-	+42.8	+74

Table VI(N)

Percentage Increase and Decrease

Years	Total cropped area	Net area sown	Area under current fallows	Area not cultivated other than fallows	Area under forest	Total irrigated area
Districts of Haryana State						
HISSAR						
Base 1950=100						
1951-56	+31	10	-53	-10	-	20.4
Base 1960=100						
1961-62	- 3	1	- 1.3	-40	-	19
1962-63	- 2	2	- 1.3	-40	-	33
1963-64	- 6	0.9	+32	-60	-	32
1964-65	- 4	0.5	+16	-60	-	28
1965-66	-19	- 8.5	+161	-60	-	-
1966-67	- 2	- 5.8	+116	-60	-	-
1967-68	+ 9	- 0.3	+10	-80	-	-
1968-69	-	-	-	-	-	-
1969-70	-	-	-	-	-	-
1970-71	+ 1	0.94	15	-60	-	63.0

Table VI(O)

Percentage Increase and Decrease

Years	Total cropped area	Net area sown	Area under current fallows	Area not cultivated other than fallows	Area under forest	Total irrigated area
ROHTAK						
Base 1950=100						
1951-56	-22.4	+ 3	-43	7.6	0	+27
Base 1960=100						
1961-62	+ 3	- .2	+10	- 4	0	+ 8
1962-63	+ 4	+ .2	+10	- 8	0	+ 7
1963-64	+ 3	+ 0.9	13.3	-16.3	0	+14
1964-65	+12	- 1.5	53.3	-16.3	+300	+ 8
1965-66	- 1	+ 1.5	+ 3.3	+14	+300	+15
1966-67	+10	+ 3.4	-16.6	-20	+300	-
1967-68	+15	+ 4.2	-26	-20	+300	-
1968-69	-	-	-	-	-	-
1969-70	-	-	-	-	-	-
1970-71	+11	+ 7.08	-50	-88	+350	44

Table VI(P)

Percentage Increase and Decrease

Years	Total cropped area	Net area sown	Area under current fallows	Area not cultivated other than fallows	Area under forest	Total irrigated area
GURGAON						
Base 1950=100						
1951-56	+19	4.7	-34.3	-67	-	- 3
Base 1960=100						
1961-62	+ 2	4.1	-54	0	0	-13
1962-63	- 1.3	4.7	-50	- 8	0	+ 3
1963-64	- 7	2.3	-12.5	- 8	0	+ 7
1964-65	- 1.3	4.3	-46	- 1.66	1.6	+18
1965-66	- 5.8	- 1.7	+50	- 8.3	1.6	+28
1966-67	2.2	0.8	+41	- 1.6	1.6	-
1967-68	24.	4.13	-62	- 1.6	25	-
1968-69	-	-	-	-	-	-
1969-70	-	-	-	-	-	-
1970-71	9	4.13	0	- 1.6	41	148

Table VI(Q)

Percentage Increase and Decrease

Years	Total cropped area	Net area sown	Area under current fallows	Area not cultivated other than fallows	Area under forest	Total irrigated area
KARNAL						
Base 1950=100						
1951-56	40	27	-45	-27.8	-	37.4
Base 1960=100						
1961-62	1	2.5	- 2.8	- 9.4	0	10.3
1962-63	10	9	-34	-32	0	13.7
1963-64	.64	12	-57	-39	0	18.5
1964-65	7.07	11	-40	-44	100	20.3
1965-66	0.3	11	-31	-44	100	55
1966-67	6	13	-60	-49	100	-
1967-68	14.15	13	-34	-51	120	-
1968-69	-	-	-	-	-	-
1969-70	-	-	-	-	-	-
1970-71	22	16	-218	-64	120	147

Table VI(R)

Percentage Increase and Decrease

Years	Total cropped area	Net area sown	Area under current fallows	Area not cultivated other than fallows	Area under forest	Total irrigated area
AMBALA						
Base 1950=100						
1951-56	16	- 1.4	5	-15	+200	-
Base 1960=100						
1961-62	8	0.9	6.6	+ 5	+ 2.2	-
1962-63	8	0.4	6.6	+45	- 4.5	-
1963-64	6	9.04	6.6	-15	4.5	-10
1964-65	6	6.33	13	-25	4.5	6.6
1965-66	4	0.9	46	-10	4.5	10
1966-67	7	5	27	-40	2.2	10
1967-68	17	8	20	-30	2.2	63
1968-69	-	-	-	-	-	-
1969-70	-	-	-	-	-	-
1970-71	17	9.5	-20	-90	4.5	213

Table VI(S)

Percentage Increase and Decrease

Years	Total cropped area	Net area sown	Area under current fallows	Area not cultivated other than fallows	Area under forest	Total irrigated area
JIND						
Base 1950=100						
1951-56	39.1	17	-80	- 5.8	-	-
Base 1960=100						
1961-62	- 8	- 1.2	75	83.3	-	- 4.2
1962-63	4.3	- 0.8	50	83.3	-	6.6
1963-64	- 1.8	0	25	66.6	-	12
1964-65	- 0.3	0	0	16.6	-	7
1965-66	-18	- 9.6	500	0	-	9
1966-67	- 3.7	- 4.1	200	-66	-	-
1967-68	+ 8	- 5.4	275	-67	-	-
1968-69	-	-	-	-	-	-
1969-70	-	-	-	-	-	-
1970-71	+ 6	- 4.6	200	- 6.7	-	108

Table VI(T)

Percentage Increase and Decrease

Years	Total cropped area	Net area sown	Area under current fallows	Area not cultivated other than fallows	Area under forest	Total irrigated area
MOHINDERGARH						
Base 1950=100						
1951-56	48	14	-85	17	-	-23
Base 1960=100						
1961-62	-11	- 4	280	- 4.3	0	16
1962-63	-12	- 3	180	- 8.6	0	22
1963-64	-13	- 2	280	-13	100	33
1964-65	-20	- 2	0	- 4.3	200	61
1965-66	-26	- 1	0	-13	200	56
1966-67	-20	- .6	20	-13	200	-
1967-68	2.17	-28	40	-13	200	-
1968-69	-	-	-	-	-	-
1969-70	-	-	-	-	-	-
1970-71	- 4	0.6	20	-30	300	-

Chapter III

INTER-DISTRICT VARIATIONS IN PRODUCTION AND PRODUCTIVITY OF WHEAT AND RICE

The objective of this chapter is to throw light on inter-district variations in the production and productivity of the two crops. Part-III-A relates to a general narration of some of the important factors influencing production and yield of crops and some of the high yielding varieties trials made for wheat in Punjab and Haryana. Part-III-B covers variations in wheat and rice production in the districts of Punjab and Haryana. Part-III-C covers inter-district variations in wheat and rice yields.

PART III-A

By production is meant gross production measured in thousand metric tons. Productivity is measured by actual yield per hectare. Any study of the variations in acreages affecting production and variations in yields is beset with basic limitation, if it is undertaken without taking into account weather crop relationships. Such a study would help in separating out the effects of weather on production from that of developmental efforts on the same, e.g., in the U.S. Department of Agriculture, crop weather relationship has been received as a step towards efficient and dependable supply analysis and projections in the agricultural sector. The data

as used in this analysis on acreage, production and yields embodies the major influence of weather. In real life, such an analysis hampers the work of supply projections including the estimation of technical coefficients and price responses.

(Efficiency of production involves technical and economic efficiency. The former deals with physical relationship between input and output. The latter deals with cost price relationships. In this study cost price relationships have not been considered in the analysis of variations in production of wheat and rice.) Thus production is not converted into value terms for the simple reason that unless inter-district price information is available, such an analysis is not meaningful. Using the State price information and taking that as a common price for all districts would be really arbitrary. Any statistical calculation based on the common price information with different levels of production in different districts would eliminate the common price factor and ultimately imply that the analysis is done in terms of different levels of production rather than in terms of value of output.

(Another factor not considered at all is the damage caused to crops by insects and pests which reduce production.)

(Yield per hectare is a function of many factor inputs. Some of these are controlable in the sense that the quantity

of some of the factor inputs like, irrigation, availability of human labour, agricultural practices adopted and so on can be controlled by the farmer.

There are uncontrolable factors like weather which is most important. Apart from these there are other natural factors like soil conditions. Then, there are economic and institutional considerations also affecting per hectare yields. Economic consideration is that of cost price relationship. Will a better price prospect of a crop lead to greater incentive, e.g., to use high yielding varieties or fertilizers to raise the yield ?)

Institutional factor like the size of holdings will be an important factor in governing the per hectare yields. On a larger size of holding it will be economical to apply the high yielding package of inputs than on smaller holdings. To prove this, one would require information about the actual acreage possessed by a cultivator. However, the secondary data available is usually based on small samples which may not depict the reality. Moreover, even this sample data gives us an idea of the number of households possessing above and below certain acres. Thus, at best, with secondary data available based on 20 per cent sample, one can roughly compare the results already obtained as regards differing yields per hectare in different districts with the number of households possessing

say below 5 acres and below 10 acres of holdings. This may or may not tally.

(Availability of credit is another important factor that may influence yield per hectare. Here, it may be pointed out that in many parts, farmers due to pressing economic needs, may misuse the credit facility available and use it for fulfilling their urgent needs rather than for buying inputs to improve agricultural yields. Unless one can quantify this it is difficult to examine its impact on yields. A sample survey would definitely throw more light on this aspect.

Irrigation is a important consideration as irrigation or water availability through rainfall are necessary for an economic use of fertilizers and high yielding varieties.) In the case of rice, the bulk of the crop depends on rains for its water supply in India. In fact, the main cause of low yields and uncertainty of rice harvest is the dependence of the crop on the rains. Only 20 per cent of rice area has irrigation facilities to supplement rain water. Irrigation is among the more important factors in determining rice yields at least up to the point where it is required in a quantity to raise the yield to the maximum in combination with other inputs.

Fertilizers (including green manure), tractors, tubewells, high yielding varieties of seeds are other important factor

inputs. These and irrigation have been considered in the analysis of variations in productivity of wheat and rice in Punjab-Haryana region. One more factor that has been included is the State Price Index of wheat and rice which is taken as common for all districts to show whether yield has been influenced by varying price index.

The economic use of fertilizer depends upon:

1. Availability of adequate irrigation or rainfall.
2. The prices which the farmer pays to get them and prices which he gets for the product.
3. The extension of knowledge among farmers about use of fertilizers.

However, these have not been considered separately in this paper. Only fertilizer consumption per hectare has been taken into account. The number of tractors and tubewells per hectare, area of rice/wheat under irrigation as a proportion of area under rice/wheat are other independent variables in the model.

With introduction of high yielding varieties of cereal crops from 1966-67, the prospects of a break through in agriculture have brightened up in India.

In kharif 1968, the average yield for 704 harvests of high yielding varieties of paddy reported by the selected participants worked out to 39.9 quintals per hectare. The high

yielding paddy varieties were: Taichung Native I, IR-8, A.D.T. 27, Tainan 3, others and all varieties. Their average yields were, 29.50, 42.90, 37.91, 24.54, 43.44 and 39.91 quintals per hectare respectively. During this year higher yields were also due to relatively better climatic conditions and less humid conditions. The incidence of pests/diseases was also reported less.

Punjab reported highest yield preceded by Jammu and Kashmir and Mysore. Among the various high yielding varieties, the largest number of harvest were for I.R. 8 (278) followed by T.N. 1 (184) and A.D.T. 27 (128). Tainan 3, quite popular some time ago was almost replaced and one case was reported from Uttar Pradesh.

Thus, the performance of districts in high yielding varieties programme depends upon to some extent the varieties adopted. Fertilizer application also influences the yields considerably. Rice grown in the rabi season also responded favourably to HY programme in 1968.

In the case of wheat, the high yielding varieties introduced and tried are Mexian varieties, Luna, Rojo and Sonora-64. The basic element in this new technology is the dwarf nature of the exotic varieties enabling the application of a high dose of fertilizer with the consequent gain of a much

higher yield compared to the hitherto available varieties of this crop. Between rabi season of 1965-66 and 1967-68, few other varieties have been added. These include, S-227, S-308 and P.U.-18 (Mexican in origin) and K-68 indigenous higher yielder evolved in Uttar Pradesh. The release of P.U.-18, S-227 and S-308 (also Mexican in origin) for general cultivation during rabi 1967-68, somewhat eclipsed earlier varieties of wheat of Mexican origin as these had shown better performance in yields, besides their better grain quality. Then came the triple dwarf variety. All these varieties were adopted by cultivators on the states of Punjab, Rajasthan, Haryana and Uttar Pradesh.

The indigenous varieties of wheat are sown during October and early November. The dwarf varieties have a short duration and therefore delayed sowing would prove more beneficial crop. Higher yields were reported for PU-18 followed by S-227 and Leuna Rojo varieties and the least responsive was K-68. Punjab and Haryana complained about unadequate supply of seed. Problem of obtaining credit and acute shortage of labour was also reported from these states.

In Punjab and Haryana, the proportion of cultivators wanting to continue the use of HYV was 95 per cent. It is interesting to consider here the various trials made for wheat under the all India coordinated agronomic experiments scheme of the ICAR (Annual Report 1971-72). During this year, no trials were made for rice in this scheme.

Model agronomic centres chosen in Punjab-Haryana region were: Ludhiana, Sangrur, Hoshiarpur, Hissar, Rohtak and Ambala.

The physical and chemical characteristics of the soils around these model agronomic centres were as follows:

	Major Soil Group	Mechanical Composition of Soil			Texture
		Sand	Silt	Clay	
Hissar	Sierozem	65.0%	18	17	Sandy Loam
Ludhiana	Chestnut Brown	66%	18	16	Sandy Loam
Rohtak	Alluval	37%	50.8	12.2	Loam
Hishiarpur	Sierozem	65.0%	18	17	Sandy Loam
Ambala	Chestnut Brown	65%	18	16	Sandy Loam
Sangrur	Chestnut Brown	65%	18	17	Sandy Loam

Model Centres	High Yielding Varieties Programme	Dry Farming Programme
Hissar	Rohtak	Ambala
Ludhiana	Sangrur	Hoshiarpur

In the agronomic centre, different types of experiments were conducted with rice, wheat, jowar, maize and bajra during the kharif and rabi seasons of the year 1971-72.

Type-A (Wheat Irrigated)

	Variety	No. of Soil Samples	% of soil under different fertility classes								
			Organic C			Nitrogen			Phosphorous		
			Low	Medium	High	Low	Medium	High	Low	Medium	High
Rohtak	Kalyan Sona	61	75	23	2	47	51	2	2	23	75
Type-B (Irrigated Wheat)											
Rohtak	Kalyan Sona		73	25	2	51	46	3	-	22	78
Type-D (Wheat)											
Ambala	Kalyan Sona		100	-	-	79	14	7	-	40	60
Hoshiarpur	C-306										

Results on the relative performance of dwarf wheat at various levels of nitrogen and phosphorous were available for 12 centres, Hissar and Ludhiana being two of them. The experimental trials consisted of all combinations of 4 levels of notrogen (0, 80, 160, 240, Kg. N/hA) and 3 levels of phosphorous (0, 40 and 80 Kg. P_2O_5/hA) as main plot treatments and wheat varieties (4 or 5) as sub-plot treatments. Nitrogen was applied half at seeding and half at first irrigation while phosphorous was applied in full at seeding. A significant difference in the yield of different varieties was observed everywhere except Hissar. But significant responses to nitrogen was obtained even at Hissar. Response to Phosphorous was obtained at Ludhiana, only at Hissar there was significant additional response to the higher level of phosphorus. At Ludhiana, responses to phosphorous were higher with varieties H-D 1949, WL-212 and HD-1941 and they were of similar order (about 1000-1300 kg/ha) with HD-1941, there was a tendency for reduction in yield at the 80 Kg. P_2O_5/level HA. Significant interactions between nitrogen and phosphorous were observed at Ludhiana. At all the centres, response to nitrogen, particularly at higher levels increased with increasing levels of phosphorus.

Wheat is the staple diet in Punjab-Haryana region and is the premier crop of the State. Ferozpur, Amritsar, Jullundher, Ludhiana and Karnal are important wheat producing districts.

Wheat is grown everywhere except on high unirrigated lands. Wheat requires cool and moist weather during the growing period and warm and dry weather at the time of ripening. The main growing period for wheat in Punjab is the month of January and February. By March, it reaches a ripening stage and water in March will be harmful. But water supply either through irrigation or rainfall has a favourable effect on the yield of the crop in the period December, January and February.

Rice although, not a staple diet of the region, is a high value crop and has been steadily increasing in its levels of production and yield. In 1951-52, it occupied only 3.8 per cent of the cropped area in the State. Thereafter it has increased steadily. Finer varieties of rice not grown hitherto, are being taken to speedily. Most of the rice produced is exported to other states and almost the entire production constitutes the marketed surplus. The important rice growing districts in terms of average yield and area are Karnal, Amritsar, Gurdaspur, Ambala, Ferozpur and Patiala. Kapurthala although has low acreage under rice has high average yield. In terms of average production, the important districts are Karnal, Kapurthala, Amritsar, Gurdaspur, Ferozpur and Ambala.

In Punjab State as a whole, with 1950 as base year, production of wheat in 1960 increased by 58 per cent, area

increased by 32 per cent and yield increased by 20 per cent. In 1971, with 1960 as base year, the corresponding increases in production, area and yield were 195.3 per cent, 64 per cent and 80 per cent respectively. The rise is much sharper in the years after 1960. It is particularly sharp from 1967 onwards. This is clear from the tables showing percentage variations in acreage, production and yield of the two crops. Part of this can be attributed to the role ofhigh yielding varieties which came into force in the same period.

However, in the case of wheat even if one were to take the period from 1960-65 the yield increase is steeper than increase in area under cultivation. Production has increased sharply. If we take 1950-51 as base year, and take the block years 1960-65, the average increase were 36.8 per cent in acreage, 104 per cent in production and 44.2 per cent in yield respectively. But in the case of rice, for the same period there was 171 per cent increase in production, 95.8 per cent increase in acreage and 42 per cent increase in yield. Thus increase in rice production was through extensive (in terms of areas) cultivation while it was through intensive cultivation in the case of wheat. This almost establishes the basis for what came to be said a little later that green revolution touched wheat first and then rice.

In the case of rice, with 1950 as base year, in 1960, area, production and yield per acre increased by 63 per cent, 145 per cent and 51 per cent respectively. In 1971, with 1960 as base, these increased by 72 per cent, 200 per cent and 75 per cent respectively.

In these years, both wheat and rice production and yield have increased in 1971 over 1960 level, by almost the same percentage. But in the case of rice, acreage has increased slightly more (by 8 per cent) than in wheat.

In Haryana, with 1950 as base year, in 1971, area, production and yield of wheat increased by 211 per cent, 696 per cent and 155 per cent respectively. In the case of rice, these were 259 per cent, 525 per cent and 196 per cent. There rates of increase are much sharper than for Punjab. In Haryana the increases are sharper for rice in area and yield as compared to wheat. In Punjab, the two crops held almost similar positions.

Inter-District Variations

At the inter-district level in Punjab, one striking feature is that in the case of wheat, in all the districts, acreage, production and yield either remained more or less the same or increased. But these have not declined in any district. This would seem to explain the relatively stable nature of the crop and the attainment of a higher level of yield. But in the

case of rice, there are districts where both area and yields have declined leading to decline in production in certain years especially after 1966. These are Sangrur, Hoshiarpur, Ludhiana districts. In Ferozpur and Kapurthala districts yield has fallen causing production to fall in certain years before 1966. But in the last three years of our analysis, rice acreage, production and yield are on the rising trend.

In Haryana, in 1971, area, production and yield of wheat have increased in almost all districts over 1950 level. But in the case of rice in most districts, in the years after 1960, rice yield and acreage have been falling over 1950 level with the only exception of Karnal and Jind where both crops have progressed. However, in 1971, acreage, production and yield of rice have shown an increase over 1950 level in the districts of Haryana.

One possible explanation for the irregular behaviour of acreages is perhaps to be found in the fact that if farmers grow crops keeping in mind the profitability aspect, perhaps in different years, wheat portion remaining more or less the same, rice or some other crop is grown depending upon whichever is more profitable. Varying weather considerations may also be able to explain the fluctuations in acreages and yields.

Wheat is grown almost steadily at a certain rate because apart from all other reasons governing the acreage under a crop, the main factor explaining its steadiness is that it is the staple diet of the people in this region. Thus there is not only an external pressure for growing it (viz., for export to other states) but also a growing internal pressure to grow more. Whenever there is fluctuation in acreage under wheat, it may be that gram, the next important item of diet is grown.

The inter-district variations in respect of area and yields of wheat and rice in Punjab and Haryana are brought out in Maps V-A, B, VI-A, B, XI-A, B, XII-A, B, given in Chapter II and Maps IX-A, B, X-A, B, XV-A, B, and XVI-A, B in Chapter III.

III-B

Variations in Production

Variations in the production of wheat and rice have been examined for a period of eighteen years for Punjab and for nine years for Haryana. As such the period covered for Punjab is 1950-71 and for Haryana it is 1960-71. The analysis is done separately for the districts of the two regions due to the differences in data availability.

The explanatory variables chosen to explain variations in gross production (X), are, y_1 (acreage under the two crops),

y_2 (proportion of area irrigated of the crop) and y_3 (productivity index as measured in terms of yield) per hectare trends.

Due to very high multicolinearity between the explanatory variables, the fitting of a linear regression model is difficult as that would present a highly distorted picture. Nevertheless, one can say that each one of the variables taken separately does explain significantly variations in production in the districts of Punjab and Haryana.

The correlation matrix presented below gives the R^2 (explained variation) derived on the basis of the correlation coefficients of the dependent variable X (gross production) and independent variables y_1 (area under the crop), y_2 (proportion of area irrigated of the crop), y_3 (productivity index measured in terms of yield) and y_4 (time factor) taken separately.

P.T.O.

Table H

WHEAT R^2(per cent)

Districts of Punjab

	$R^2(y_1)$	$R^2(y_2)$	$R^2(y_3)$	$R^2(y_4)$
Gurdaspur	79.5	83.7	90.2	57.7
Amritsar	56.7	21.4	96.04	52.2
Kapurthala	66.4	79.9	74.1	47.1
Jullundher	72.9	67.2	59.5	56.5
Ludhiana	95.2	70.5	94.6	68.0
Hoshiarpur	10.8	67.4	57.7	46.2
Ferozpur	73.7	66.2	79.7	68.0
Bhatinda	93.5	29.5	74.3	73.6
Sangrur	81.5	13.3	90	77.7
Patiala	85.9	50	65	68.3

Districts of Haryana Table I R^2(per cent)

	$R^2(y_1)$	$R^2(y_2)$	$R^2(y_3)$	$R^2(y_4)$
Hissar	95.8	0.38	88.9	60
Rohtak	88.7	83.1	81.3	69.7
Gurgaon	96.2	11.44	87.7	77.0
Karnal	49.9	2.3	94.0	54.76
Ambala	86.1	46.9	84.8	28.5
Jind	97.8	35.6	81.1	36.7

Foot Note: 1. Except Hoshiarpur, in all other districts y_1 explains a good percentage of total variation in X. y_2 explains a significant percentage of variation in X except in Amritsar, Bhatinda and Sangrur. y_3 and y_4 explain a significant percentage of variation in X^4 in all the districts.

2. In Haryana, y_1 y_3 and y_4 explain a significant percentage of total variation in X. y_2 is explaining significantly in all except Hissar, Karnal and Jind.

Variations in Wheat Production

The table above indicates clearly the importance of each of the variables separately in explaining production of wheat in Punjab and Haryana districts between 1950-71, and between 1960-71 respectively. Area under wheat explains more than 60 per cent of the variation in production in all districts except Amritsar where it explains 56.7 per cent and in Hoshiarpur where it explains only 10.8 per cent.

y_2, (proportion of area irrigated of the crop), the proportion of wheat area irrigated explains 50 per cent and above of total variation in production except in Bhatinda and Amritsar. Yield increases over time also explain more than 60 per cent of total variation in production except in Jullundher, and Hoshiarpur.

If time period alone is taken into account, it also explains more than 60 per cent of total variation in wheat production except in Gurdaspur, Kapurthala, Amritsar, Jullundher and Hoshiarpur where it explains 50 per cent.

In Haryana districts, area under wheat explains more than 80 per cent of the variation in production except Karnal where it explains 49.9 per cent.

In Haryana however, proportion of area irrigated of wheat has not very significantly explained production of wheat

except perhaps in Ambala and Jind. But area under wheat has excersised an important influence on production, except for Karnal; it has explained more than 80 per cent of the total variation in production.

Yield per hectare of wheat has also explained more than 80 per cent of total variation in production in all districts. When only time factor is taken into account, it explains more than 50 per cent of total variation in all districts except Ambala and Jind.

One feature that emerges from the above two tables is that, in both Punjab and Haryana, increases in wheat production have more to do with increase in area under wheat, as the explained variation is high in almost all the districts, except Hoshiarpur in Punjab. Among the other three variables, yield index and time factor are also important in most districts in explaining variations in production. The effect of increase in irrigated area of wheat has varied between the two regions of Punjab and Haryana. Within each region, it has behaved irrigularly and has not very significantly explained variation in production.

While each of the independent variables separately explain a significant percentage of the variation in production, a linear regression equation would not be quite revealing because of the existence of multicolinearity as already discussed. The high

correlation that exists between the three independent variables in Punjab districts is clear from the table below:

CORRELATION MATRIX - J

WHEAT

Districts of Punjab	y_1 and y_2	y_1 and y_3	y_2 and y_3
Gurdaspur	.820	.854	.957
Amritsar	.010	.741	.420
Kapurthala	.769	.516	.787
Jullundher	.743	.926	.675
Ludhiana	.776	.952	.837
Hoshiarpur	.023	.273	.637
Ferozpur	.547	.735	.755
Bhatinda	.463	.858	.531
Sangrur	.171	.786	.522
Patiala	.611	.713	.807

CORRELATION MATRIX - K

Districts of Haryana	y_1 and y_2	y_1 and y_3	y_2 and y_3
Hissar	.630	.864	.247
Rohtak	.759	.783	.933
Gurgaon	.303	.869	.404
Karnal	.359	.698	-.023
Ambala	.600	.738	.548
Jind	-.034	.866	.144

In all districts of Punjab y_1 (area under crop) and y_2 (proportion of area irrigated of the crop); y_1 (area under crop) and y_3 (productivity index measured in terms of yield); and y_2 (proportion of area irrigated of the crop); and y_3 (productivity index measured in terms of yield) are highly correlated except, e.g. in Hoshiarpur (y_1 area under the crop, and y_2 proportion of area irrigated of the crop); and (y_1 area under the crop, and y_3 productivity index measured in terms of yield), in Sangrur (y_1 area under the crop and y_2 proportion of area irrigated of the crop), are not highly correlated In Haryana however, multicolinearity is not very high uniformly.

REGRESSION TABLE - L

R^2 (Explained variation) Derived on the basis of stepwise regression.

WHEAT

Districts of Punjab	$R^2(y_1)$	$R^2(y_2)$	$R^2(y_3)$	Total explained variation by all the three variables	t value y_1	t value y_2	t value y_3
Gurdaspur	2.5	0.00	90.2	92.7	1.171	.234	-.697
Amritsar	0.4	0.3	97.8	98.5	1.968	1.530	-12.817*
Kapurthala	.7	80.00	6.4	93.4	3.846*	-23.873*	36.963*
Jullundher	73.0	7.6	0.2	80.8	.111	-.094	-.322
Ludhiana	95.3	0.5	2.3	97.8	-3.962*	1.725	3.256*
Hoshiarpur	9.7	67.4	4.7	81.8	-.241	3.594*	1.893
Ferozpur	9.0	79.8	4.8	93.6	23.33*	3.230*	-15.414*
Bhatinda	93.5	1.2	0.0	94.7	3.178*	-.045	.465
Sangrur	85.9	5.7	0.5	92.1	8.143*	-.413	.932
Patiala	6.3	0.2	90.3	96.8	-2.556*	-.916	1.154

* Significant.

REGRESSION TABLE - M

WHEAT

Districts of Haryana	$R^2(y_1)$	$R^2(y_2)$	$R^2(y_3)$	Total explained variation by all the three variables	t value y_1	t value y_2	t value y_3
Hissar	97.9	0.3	.008	99.0	-3.46*	1.341	2.81
Rohtak	88.8	9.1	0.1	98.0	7.988	-.172	.316
Gurgaon	96.2	0.0	2.9	99.1	3.499	-.219	-.945
Karnal	1.6	1.7	94.3	97.6	1.864*	.256	-.014
Ambala	86.2	0.9	12.2	99.3	-3.219	2.632	3.995*
Jind	95.9	0.1	3.6	99.6	-1.061	1.188*	2.309*

* Significant.

Looking at regression Table L and M, the variation in production explained by all the three variables (y_1 area under the crop, y_2 proportion of area irrigated of the crop, y_3 productivity index measured in terms of yield) together is more than 90 per cent in all districts except Jullundher, where it explains 80.8 per cent and Hoshiarpur where it explains 81.8 per cent of the variation. But, explanation by individual variable as is apparent, has been significantly distorted. In Jullundher, Ludhiana, Bhatinda and Sangrur, y_1 (area under the crop) explains more of the total variation in production; in Kapurthala, Hoshiarpur, Ferozpur y_2 (proportion of area irrigated of wheat) explains more and in Gurdaspur, Amritsar and Patiala y_3 (productivity index measured in terms of yield) explains more of the total variation in gross production of wheat. When we compare Table M with Table H we find that while in Table M

y_2 (proportion of area irrigated of the crop) and y_3 (productivity index measured in terms of yield) explain only a small percentage of total variation in X (gross production), individually in Table H, explain a fairly high percent of variation.

The t values given in table for y_1 (area under the crop), y_2 (proportion of area irrigated of the crop) and y_3 (productivity index measured in terms of yield) shows that for y_1 (area under the crop), they are significant in Amritsar, Kapurthala, Ludhiana, Ferozpur, Bhatinda, Sangrur and Patiala. In Ludhiana and Patiala, area under wheat negatively explains production. In Kapurthala, y_2 (proportion of area irrigated of the crop) and y_3 (productivity index measured in terms of yield) are also significant in t values. But proportion of area irrigated explains negatively production. Thus, in Kapurthala all the three explanatory variables have significant t values.

In Ludhiana, y_3 (productivity index measured in terms of yield) and y_2 (proportion of area irrigated of the crop) have a significant t value. y_2 (proportion of area irrigated of the crop) has a insignificant t value. Ferozpur is another district where all the three variables have significant t values. But yield explains negatively wheat production. Bhatinda, Sangrur and Patiala have significant t values for only y_1 (area under the crop). In Patiala also, y_1 (area under the crop) negatively explains production of wheat.

If any inference must be based on the regression coefficients and the constant t values one can perhaps say that area under wheat is more important in explaining variations in production. In Patiala and Ludhiana, Hoshiarpur, this negatively explains changes in production. In these districts perhaps y_3 (productivity index measured in terms of yield) has more to explain changes in production. In Hoshiarpur, the t value for y_2 (proportion of area irrigated of the crop) is quite significant. In Kapurthala and Ferozpur, they are all significant in explaining variations in productions.

In Haryana districts, y_1 (area under the crop) is significant in explaining variations in production in all districts except Karnal and Jind. In Karnal however the t value is almost significant. Ambala is the only district where all the three are significant. But y_1 (area under the crop) explains negatively production. y_3 (productivity index measured in terms of yield) t value is highly significant and positive.

In Hissar also, t value for y_1 (area under the crop) is negative but positive and significant for y_3 (productivity index measured in terms of yield). In Jind district the t value for y_3 (productivity index measured in terms of yield) is significant.

Thus, we find that in few districts of Punjab and Haryana, all the three variables have significant t values. In most other districts, either y_1 (area under the crop) or y_3 (productivity index measured in terms of yield) have significant t values. This and the R^2 (explained variation) tables imply that each one of

these variables taken separately is highly relevant in explaining the variations in production of wheat. Multicolinearity has not distorted the t values too much as we are able to see from the t values that in most districts, they are significant for y_1 (area under the crop) and y_3 (productivity index measured in terms of yield). For y_2 (proportion of area irrigated of the crop), the t values are not very significant except in few districts with a sign (*); and this may be because y_1 (area under the crop) and y_2 (proportion of area irrigated of the crop) are highly correlated amongst themselves.

VARIATIONS IN RICE PRODUCTION

Table - N

Rice Production

Districts of Punjab	R^2 (Explained variation) on the basis of coefficient of correlation.			
	$R^2(y_1)$	$R^2(y2)$	$R^2(y_3)$	$R^2(y_4)$
Gurdaspur	70.2	63.6	32.4	74.4
Amritsar	88.9	56.1	51.6	82.2
Kapurthala	94.2	82.2	82.2	88.7
Jullundher	77.00	36.8	12.4	79.3
Hoshiarpur	61.7	8.9	14.9	39.1
Ludhiana	77.6	8.4	28.1	65.9
Ferozpur	76.5	15.9	30.4	60.6
Bhatinda	-	-	-	-
Sangrur	78.6	73.7	52.5	76.7
Patiala	.81	86.4	62.7	25.3

Table - O

Districts of Haryana	$R^2(y_1)$	$R^2(y_2)$	$R^2(y_3)$	$R^2(y_4)$
Hissar	70.2	23.8	0.81	0.18
Rohtak	95.6	20.7	1.2	64
Gurgaon	-	-	-	-
Karnal	83.9	60.9	86.2	58.0
Ambala	7.8	3.3	68.2	1.2
Jind	86	0.00	14.4	46.2

Foot Note: 1. y_1 (area under the crop) and y_4 (time factor) are explaining significant percentage of variation in production in all districts. But y_2 (proportion of area irrigated of the crop) is explaining in all the districts except Hoshiarpur, Ambala and y_3 (productivity index measured in terms of yield) in all except Jullundher, Hoshiarpur and Ludhiana.

2. In Haryana, y_1 (area under the crop) explains a significant percentage of variation in production except in Ambala, y_2 (proportion of area irrigated of the crop) in only Karnal, y_3 (productivity index measured in terms of yield) in only Karnal and Ambala, y_4 (time factor) in all except Hissar and Ambala. In Ambala only y_3 (productivity index measured in terms of yield) explains a significant percentage of variation.

The R^2 (explained variation) derived for each variable separately on the basis of coefficient of correlation presented in Table N and O, shows once again as in the case of wheat, that the explained variation in production of rice by y_1 (area under the crop) is uniformly high in all districts of Punjab and Haryana except Ambala where yield increases (y_3 productivity index measured in terms of yield) have a higher R^2 (explained variation). The explained variation by y_2 (proportion of area irrigated of the crop) and y_3 (productivity index measured in terms of yield) is not uniformly high in all districts of Punjab and Haryana.

Time factor taken alone, explains significantly variations in rice production in all districts except Patiala, Hissar and Ambala.

The problem of multicolinearity is not so pronounced in the case of rice as for wheat, particularly in few districts of Punjab. This is clear from the correlation matrix below:

CORRELATION MATRIX - P

Districts of Punjab	y_1 and y_2	y_1 and y_3	y_2 and y_3
Gurdaspur	.858	.513	.561
Amritsar	.826	.613	.486
Kapurthala	.905	.928	.877
Jullundher	.747	.276	.298
Ludhiana	.151	.513	-.044
Hoshiarpur	.393	.442	.329
Ferozpur	.515	.346	.181
Bhatinda	-	-	-
Sangrur	.744	.610	.641
Patiala	.921	.814	.802

CORRELATION MATRIX - Q

Districts of Haryana	y_1 and y_2	y_1 and y_3	y_2 and y_3
Hissar	-.429	-.049	.082
Rohtak	-.602	-.255	.049
Gurgaon	-	-	-
Karnal	.825	.812	.763
Ambala	.605	-.298	-.200
Jind	-.122	.053	.531

Looking at regression table R and S for rice below for Punjab and Haryana districts, the picture we get is almost a reverse of that we got for wheat.

REGRESSION TABLE - R

Districts of Punjab	$R^2(y_1)$	$R^2(y_2)$	$R^2(y_3)$	R^2 (all of the variables)	t value y_1	t value y_2	t value y_3
Gurdaspur	70.2	1.2	2.7	74.1	-1.280	.829	2.376*
Amritsar	89.0	0.2	3.2	92.4	1.446	-.635	-2.562*
Kapurthala	94.3	0.4	0.0	94.7	.767	.008	.016
Jullundher	77.2	0.9	1.3	79.4	1.105	-.752	-2.046*
Ludhiana	77.6	2.5	1.4	81.5	-2.119*	-.846	1.013
Hoshiarpur	61.8	0.00	0.2	62	.774	-.093	-.118
Ferozpur	76.5	0.3	7.1	83.9	.661	-.1236	-.572
Bhatinda	-	-	-	-	-	-	-
Sangrur	78.7	8.9	1.8	89.4	3.307*	.050	1.572
Patiala	1.1	86.8	0.2	88.1	-.084	-8.750	.465
Districts of Haryana		REGRESSION TABLE - S					
Hissar	70.2	2.0	2.3	74.5	1.054	.035	.603
Rohtak	95.6	1.8	1.9	98.3	-2.265	-1.560	-3.281
Gurgaon	-	-	-	-	-	-	-
Karnal	7.4	0.3	87.0	94.7	-1.322	-.551	2.128*
Ambala	30.6	0.1	68.5	99.2	-.062	1.100	9.461*
Jind	86.8	0.06	11.0	98.4	1.348	-1.59	-14.59*

* Significant.

Y_2 (proportion of area irrigated of the crop) does not have a significant t value in any district. This is perhaps because, area under rice cannot be there at all, if there is no irrigation. Thus, y_1 (area under crop) and y_2 (proportion of area irrigated of the crop) are so highly correlated that, if y_1 (area under the crop) emerges as important, the other will not. This is true in districts of Punjab where except in Hoshiarpur and Ferozpur, y_1 (area under the crop) and y_2 (proportion of area irrigated of the crop) are highly correlated. In Haryana, they have a high correlation in Rohtak, Karnal and Ambala. In Hissar, Rohtak and Jind, they are negatively correlated. y_3 (productivity index measured in terms of yield) has significant t values in more districts and y_1 (area under the crop) has t values in fewer districts. In Ludhiana and Rohtak, y_1 (area under the crop) explains negatively variations in production of rice. In Amritsar, Jullundher and Rohtak and Jind, y_3 (productivity index measured in terms of yield) has a negative t values.

Thus, in the case of wheat and rice both, we find that in terms of R^2 (explained variation) drived on the basis of coefficient of correlation, y_1 (area under the crop) is more important. But when we consider t values derived by multiple regression coefficients, in the case of rice, in both Punjab and Haryana districts, y_3 (productivity index measured in terms of yield) is more significant in terms of t values, and in the case of wheat y_1(area under the crop) is significant in terms of t values in more than seven districts, whereas y_3 (productivity index measured in terms of yield) has significant t values in 7 districts. Thus,

both y_1 (area under the crop) and y_3 (productivity index measured in terms of yield) are generally significant in the case of wheat in districts and in the case of rice, y_3 (productivity index measured in terms of yield) has more significance in the districts of Punjab and Haryana.

In the case of rice, as in the case of wheat, all the variables taken together explain more than 80 per cent of the variation in rice production in most districts. But considering their respective share after multiple regression, there is a very high R^2 (explained variation) for y_1 (area under the crop) in all districts except Patiala, Karnal and Ambala. In Karnal and Ambala, y_3 (productivity index measured in terms of yield) has a high R^2 (explained variation) whereas in Patiala y_2 (proportion of area irrigated of the crop). Here again due to a high correlation between y_1 (area under the crop) and y_2 (proportion of area irrigated of the crop), wherever y_1 (area under the crop) has high R^2 (explained variation), y_2 (proportion of area irrigated of the crop) has a low R^2 (explained variation).

Taking time factor alone into account in each district, the variation in production by time factor explained is as follows:

REGRESSION TABLE - T

Districts of Punjab	Wheat		Rice	
	R^2	t value	R^2	t value
Gurdaspur	57.8	4.681*	74.5	6.841
Amritsar	52.4	4.197*	82.2	8.622*
Kapurthala	47.2	3.788*	88.7	11.231*
Jullundher	56.6	4.568*	79.4	7.855*
Ludhiana	68.1	5.844*	66.0	5.580*
Hoshiarpur	46.3	3.717*	39.2	3.216*
Ferozpur	68.1	5.849*	60.7	4.975*
Bhatinda	73.6	6.685*	-	-
Sangrur	77.8	7.496*	76.7	7.268*
Patiala	68.5	5.906*	25.4	2.334*
Districts of Haryana				
Hissar	36.8	2.020*	0.9%	-.115
Rohtak	69.8	4.029*	64.2	3.549*
Gurgaon	77.2	4.868*	-	-
Karnal	54.8	2.918*	58.1	3.116*
Ambala	28.5	1.673	1.2	.301
Jind	60.1	3.250*	46.4	2.461*

* Significant.

Production of wheat, area under the crop, proportion of area irrigated of the crop and yield per hectare are highly correlated, if any one of them is taken at one time. They all are highly correlated with respect to time. Time itself has been an important factor in bringing about the changes.

SUMMARY

A feature that emerges from the Part II of this chapter is that for both wheat and rice, our variables are highly relevant in explaining the variations in their production. They have behaved alike in most districts for each crop taken separately. On other words, inter-district or intra-regional variations are not so marked. One glaring difference is that the t values are highly significant for y_3 (productivity index measured in terms of yield) in all districts of Haryana producing rice, except Hissar. In Punjab however, the t values are significant for only three districts producing rice. The t value for y_2 (proportion of area irrigated of the crop) is significant in none. Y_1 (area under the crop) is significant in t values in only 3 districts.

In the case of wheat, y_1 (area under the crop) is significant in terms of t values in the ten districts of Punjab and Haryana and y_3 (productivity index measured in terms of yield) in nine districts of Punjab and Haryana and y_2 (proportion of area irrigated of the crop) is significant in four districts only. Thus, in wheat production both y_1 (area under the crop) and y_3 (productivity index measured in terms of yield) have significant t values.

From the tables above, it is beyond doubt that all the three variables are highly relevant and significant when taken individually. Multicolinearity has distorted the values

of only variable y_2 (proportion of area irrigated of the crop). y_1 (area under the crop) and y_3 (productivity index measured in terms of yield) still are able to explain variation in production of wheat and y_3 (productivity index measured in terms of yield) is able to explain a significant percentage of variation in production of rice in most districts of Punjab and Haryana.

Finally time factor alone is also able to explain significantly the variation in production of wheat and rice.

III-C

Inter-District Variations in Wheat and Rice Productivity

Productivity depends on several criteria. While yield per hectare is the most important single indicator of productivity, a number of factors contribute to explain variations in productivity as measured by yield per hectare of the two crops. Taking into consideration the availability of data at the district level, the following variables are chosen for the study. X is the dependent variable and denotes yield per hectare. The independent variables of the model are:

X = Yield per hectare (dependent variable).

y_1 = Proportion of area irrigated of wheat/rice to area under wheat/rice.

y_2 = Proportion of area under high yielding varieties of wheat/rice to area under wheat/rice.

y_3 = Number of tractors per hectare.

y_4 = Number of tubewells per hectare.

y_5 = Fertilizer consumption per hectare.

y_6 = Price index of wheat/rice.

Only five year data has been considered for explaining yield variations, as the information pertaining to high yielding varieties, fertilizer consumption etc., were difficult to obtain for years before this. So, in our multiple stepwise regression analysis, the years considered are, 1968-69, 1969-70, 1970-71, 1971-72 and 1972-73. The figures for 1972-73 are projected figures only.

Fertilizer consumption is not available cropwise and therefore, it is just converted into consumption per hectare of all crops. This therefore is a serious limitation.

State price index of wheat/rice is used for the districts. This has been considered to examine whether a change in price of the crop results on a change in his response to use fertilizers, high yielding varieties and therefore, whether this could be an explanation of varying yields. This is not a very satisfactory measure but for a lack of districtwise, cropwise

data on prices the State level figures are used as an interim exercise.

The number of years for which data are available is very few. Therefore, instead of analysing variations district by district, it has been done for all districts of Punjab and Haryana during each year. This can help us to compare how the variables have behaved each year how has their impact on yield of wheat/rice varied from time to time, in the Punjab-Haryana region.

Combined Regression Results for Wheat and Rice

First, we take up both crops wheat and rice and their collective behaviour. In other words, the six explanatory variables and their influence on wheat and rice yields year by year are analysed with the help of multiple stepwise regression coefficients as given below. As a first step, the explanation is offered in terms of the correlation matrix which indicates how the independent variables are themselves related and they are all related to the dependent variable. This can be compared for the five years.

CORRELATION MATRIX - A

Years	X and y_1	X and y_2	X and y_3	X and y_4	X and y_5	X and y_6
1968-69	.40671	.66477	.17676	.26057	.46030	.70530
1969-70	.32266	.57670	.13705	.41063	.64632	.76486
1970-71	.47898	.48736	.41726	.41686	.70637	.64990
1971-72	.69484	.67890	.44153	.35188	.75051	.46466
1972-73	.48574	.70774	.36179	.26666	.61582	.18349

The variables, y_2 (proportion of area under high yielding varieties of the two crops to area under the two crops), y_5 (fertilizer consumption per hectare) and y_1 (proportion of area irrigated of the two crops, to area under the two crops) have been important in explaining the combined yields of the two crops as is evident from the high correlation between them and the dependent variable X (yield per hectare of the two crops). It is not surprising for y_1 (proportion of area irrigated of the two crops, to area under the two crops) is area irrigated under the two crops, y_2 is the proportion of wheat and rice area under high yielding varieties to area under the two crops. y_3 is the fertilizer consumption per hectare. Increase in yield is generally due to the combined influence of all the three variables.

The tables below throw light on multicolinearity of independent variables, where any.

CORRELATION MATRIX - B

Years	y_1 and y_2	y_1 and y_3	y_1 and y_4	y_1 and y_5	y_1 and y_6
1968-69	.22845	.04504	.07594	.43125	.45194
1969-70	.07475	-.02553	.13288	.41098	.41344
1970-71	.30249	.28002	.02497	.41117	.433
1971-72	.54227	.26494	-.01111	.51307	.557
1972-73	.58883	.13097	.01596	.24715	.29759

CORRELATION MATRIX - C

Years	y_2 and y_3	y_2 and y_4	y_2 and y_5	y_2 and y_6
1968-69	-.01551	.35657	.56490	.61326
1969-70	-.08331	.12896	.27518	.38921
1970-71	.39081	.39612	.67259	.54992
1971-72	.35370	.27073	.52630	.18960
1972-73	.29822	.02509	.54653	.37152

CORRELATION MATRIX - D

Years	y_3 and y_4	y_3 and y_5	y_3 and y_6
1968-69	-.00741	.19852	.28439
1969-70	-.05969	.17542	.21646
1970-71	.60887	.36899	.44009
1971-72	.59123	.47500	.39890
1972-73	.52544	.45268	.31898

CORRELATION MATRIX - E

Years	y_4 and y_5	y_4 and y_6	y_5 and y_6
1968-69	.73795	.45304	.69988
1969-70	.65898	.42041	.72708
1970-71	.55199	.38387	.78723
1971-72	.53969	.2264	.69730
1972-73	.52414	.23571	.52183

REGRESSION TABLE - F

R^2 (Explained Variation)

(Per cent)

Years	y_1	y_2	y_3	y_4	y_5	y_6	R^2 of all six variables
1968-69	2.2	8.6	0.6	0.4	1.5	49.7	63
1969-70	0.1	9.1	0.1	0.1	1.9	58.5	69.8
1970-71	4.3	0.1	2	0.1	49.8	0.7	57
1971-72	13	4.6	0.0	0.7	46.3	1.4	76
1972-73	2.4	50	0.3	0.9	7.2	4.7	65.5

REGRESSION TABLE - G

t Values

Years	y_1	y_2	y_3	y_4	y_5	y_6
1968-69	.056	.231	.441	.518	-.373	.056
1969-70	.291	.203	.102	-.166	.032	-.131
1970-71	.320	-.126	.078	-.073	.082	-.123
1971-72	-1.047	.664	-.007	.043	-.507	1.374
1972-73	-.003	.632	.477	1.340	-.990	.032

It is clear from the tables above that in each year, the explanatory variables contribute to the explanation of at least more than 60 per cent of total variation in the dependent variable, except in 1970-71, when the explained variation is 57

per cent. The unexplained variation throws light on the fact that other institutional factors like, size of holdings, availability of credit, etc., are also important.[1/] The harm caused to crops due to pests may also reduce yields. What is more interesting is the relative performance of variables in their explanation of the total variation in the dependent variable. (y_6), the price index of wheat and rice together explains most of the variation when considered with the other five variables in 1968-69 and 1969-70. This variable is followed by 8.1 per cent and 9.1 per cent of explained variation by area under high yielding varieties of the two crops as a proportion to area under the two crops. This is corroborated by our correlation matrix A, where X (yield per hectare of the two crops) and y_6 (price index of the two crops) have a correlation of .70 and X (yield per hectare of the two crops) and y_2 (proportion of area under high yielding varieties of the two crops to area under the two crops) have a correlation of .66 . Both are quite high. In these two years, fertilizer consumption per hectare (y_5) explained 1.5 per cent and 1.9 per cent of the variation in yields of the two crops. The correlation between X (yield per hectare of the two crops) and y_5 (fertilizer consumption per hectare) was .460 and .646 respectively; the latter is quite high.

1/ These data are not available on a district basis.

From 1970-71 to 1971-72, the relative behaviour of explanatory variables changes. y_5 (fertiliser consumption per hectare) explains 49.8 and 56.3 per cent of the total variation in yield. y_2 (proportion of area under high yielding varieties of the two crops to area under the two crops) explains 1 per cent and 4.6 per cent respectively.

In 1972-73, once again there is a change. Area under high yielding varieties explains 50 per cent of the total variation in yield, y_5 (fertilizer consumption per hectare) explains 7.2 per cent.

Thus, it is clear that the three factors namely high yielding varieties, fertilizer consumption and area irrigated have an important bearing on the yields of rice and wheat but their behaviour is highly irregular and they do play an important role in raising or lowering yields. The importance of price has declined if we take its role in explaining variations in yields after 1969-70. Tractors and tubewells (y_3 and y_4) are important as they are required at the initial cultivation processes but they do not seem to be having an important bearing on varying yields of the two crops. However, all these conclusions should be viewed against the limitation that information pertaining to y_3 (number of tractors per hectare), y_4 (number of tubewells per hectare) and y_5 (fertilizer consumption per hectare) is not available cropwise and y_6 (price index of the two crops) is the price index for the State and is used for the district.

The R^2 (explained variation) by all the six variables together is fluctuating from year to year and this irregularity is perhaps to do, among other factors, to weather irregularity; which is an important factor influencing Indian agriculture.

Although in terms of explained variations the variables are highly relevant, yet, when t values are considered, all are insignificant (Regression Table - G). This may be due to multicolinearity between the explanatory variables which distorts the picture as more and more variables are considered. We can however at least say which of the six variables explains the maximum of total variation in the yield. The subsequent variables may add little to the already explained variation, if they are mutually highly correlated. In our correlation matrix C, we see that y_2 (high yielding varieties) and y_5 (fertilizer consumption) have a fairly high correlation for all the five years except, 1969-70. This may have perhaps lead to the situation that in the years in which y_5 (fertilizer consumption per hectare) explains more, y_2 (proportion of area under high yielding varieties of the two crops to area under the two crops) explains less and vice-versa. This is clear from Regression Table - F. (Observe columns y_2 and y_5).

(Page 75)

In the Regression Table - G negative t value indicates that the influence of fertilizer consumption on yield has remained negative except for 1969-70 and 1970-71.

However, in 1970-71, high yielding varieties had a negative influence on yield. In all other years, their influence

is positive. This is perhaps because in high yielding varieties itself, fertilizer availability in a required quantity is necessary. However, one interesting feature to note is that when the regression coefficient for y_5 (fertilizer consumption per hectare), is negative, the coefficient for area irrigated under the two crops (y_1) is also negative or very low. When y_5 (fertilizer consumption per hectare) has positive regression coefficient, y_1 (proportion of area irrigated of the two crops, to area under the two crops) also has a positive regression coefficient. y_3 (number of tractors per hectare) has a positive regression coefficient except for 1971-72 when the negative value is very low. y_4 (number of tubewells per hectare) and y_6 (price index of the two crops) have behaved alike in so far as their negative regression coefficients are concerned in 1969-70 and 1970-71.

Now let us see how the above results we have obtained, would compare with a situation in which the results are provided separately for wheat and rice. The method adopted once again is that of stepwise regression, year by year for the same set of five years.

Wheat Productivity:

Let us first consider the correlation matrix for all the variables including dependent variable.

CORRELATION MATRIX A_1

Years	X and y_1	X and y_2	X and y_3	X and y_4	X and y_5	X and y_6
1968-69	.643*	.903*	.247	.542	.816*	.822*
1969-70	.529	.389	.155	.565	.851*	.780
1970-71	.700*	.498	.480	.529	.862*	.731*
1971-72	.640*	.649*	.350	.321	.815*	.592*
1972-73	.476	.701*	.213	.212	.627*	.252

* Significant.

CORRELATION MATRIX B_1

Years	y_1 and y_2	y_1 and y_3	y_1 and y_4	y_1 and y_5	y_5 and y_6
1968-69	.538	-.081	.191	.501	.533
1969-70	.291	-.142	.214	.461	.494
1970-71	.313	.339	.203	.571	.662
1971-72	.405	.227	.016	.479	.629
1972-73	.569	.066	.109	.197	.319

CORRELATION MATRIX C_1

Years	y_2 and y_3	y_2 and y_4	y_2 and y_5	y_2 and y_6
1968-69	.253	.612	.883	.763
1969-70	-.187	.322	.449	.164
1970-71	.326	.457	.640	.255
1971-72	.353	.399	.530	.092
1972-73	.346	.272	.656	.391

CORRELATION MATRIX D_1

Years	y_3 and y_4	y_3 and y_5	y_3 and y_6
1968-69	.005	.215	.331
1969-70	-.061	.186	.247
1970-71	.601	.385	.461
1971-72	.538	.489	.456
1972-73	.526	.469	.439

CORRELATION MATRIX E_1

Years	y_4 and y_5	y_4 and y_6	y_5 and y_6
1968-69	.741	.514	.789
1969-70	.640	.439	.803
1970-71	.538	.371	.806
1971-72	.533	.253	.784
1972-73	.521	.318	.705

It is clear from Correlation Matrix A_1 that the correlation is fairly high between X (yield per hectare of the crop) and y_2 (proportion of area under high yielding varieties of the crop to area under the crop) except for 1969-70 and 1970-71 and between X (yield per hectare of the crop) and y_5 (fertilizer consumption per hectare) for all the five years. Between X (yield per hectare of the crop) and y_6 (price index of the crop) it is high for the

first three years and thereafter not so high. X (yield per hectare of the crop) and y_1 (proportion of area irrigated of the crop to area under the crop) have also a steadily high correlation except 1972-73 when it is lower than for earlier years.

From correlation matrix C_1, it appears evident that y_2 (proportion of area under high yielding varieties of the crop to area under the crop) and y_5 (fertilizer consumption per hectare) have a high correlation amongst themselves. Thus, due to this, if one of them is introduced and explains most of the variation, when the other one is introduced, its importance may be reduced.

REGRESSION TABLE - H

R^2 (Explained Variation) (Per cent)

Years	y_1	y_2	y_3	y_4	y_5	y_6	R^2 of all six variables
1968-69	2	81.6	0.1	0.0	0.2	4.3	88.8
1969-70	1.4	0.2	0.2	0.4	72.5	2.6	77.3
1970-71	6.4	2.2	1.4	0.2	74.4	0.7	85.3
1971-72	8.1	0.0	0.2	0.8	66.5	5.6	81.2
1972-73	8.9	49.2	0.2	2.5	4.9	4.8	69.6

Regression Table - H, evidently points to the fact that y_2 (proportion of area under high yielding varieties of the crop to area under the crop) and y_5 (fertilizer consumption per hectare) in different years explain most of the total variation in yield. In 1968-69, y_2 (proportion of area under high yielding varieties of the crop to area under the crop) exploring total variation in yield of wheat more than y_5 (fertilizer consumption per hectare).

From 1969-70 onwards upto 1971-72, y_5 (fertilizer consumption per hectare) explained most of the total variation in X (yield per hectare of the crop) and in 1972-73 the position reversed, and y_2 (proportion of area under high yielding varieties of the crop to area under the crop) explained most of the total variation in yield of wheat. y_3 (number of tractors per hectare) and y_4 (number of tubewells per hectare) almost maintained their respective positions in all the five years at a steady level. y_1 (proportion of area irrigated of the crop to area under the crop) contributed to a little more of the explanation after 1969-70. Thus in this case again, y_1 (proportion of area irrigated of the crop, to area under the crop) y_2 (proportion of area under high yielding varieties of the crop, to area under the crop) and y_5 (fertilizer consumption per hectare) explain most of total variation in yield of wheat as compared to the other variables. In 1972-73, the per cent of explained variation when all the six variables are considered together has fallen from 81.2 per cent in the earlier year to 69.6 per cent. In this year, other factors factors not considered here may have more to explain variations in yields of wheat.

REGRESSION TABLE - I

t Value

Years	y_1	y_2	y_3	y_4	y_5	y_6
1968-69	.361	.013	.252	.587	-.347	-.061
1969-70	-.123	.991	.236	.050	-.462	.344
1970-71	.233	.280	-.247	.274	-.332	.207
1971-72	-.112	.116	.027	.190	.011	.170
1972-73	-.064	.173	.286	.879	-.437	.160

t values are positive for all the five years, for X (yield per hectare of the crop) and y_2 (proportion of area under high yielding varieties of the crop, to area under the crop). (Table - I). Negative for all the years for X (yield per hectare of the crop) and y_5 (fertilizer consumption per hectare). In this case, as for wheat and rice crops combined, y_5 (fertilizer consumption per hectare) and y_2 (proportion of area under high yielding varieties of the two crops, to area under the two crops) have moved in the opposite directions in so far as their influence on X (yield per hectare of the two crops) is concerned. X (yield per hectare of the two crops) and y_2 (proportion of area under high yielding varieties of the two crops, to area under the two crops) have a positive regression coefficient throughout. X (yield per hectare of the two crops) and y_1 (proportion of area irrigated of the two crops, to area under the two crops) have mostly negative regression coefficient values. Here again y_1 (proportion of area irrigated of the crop, to area under the crop) and y_5 (fertilizer consumption per hectare) bear resumblance in their behaviour forwards explaining variation in yield of wheat.

Rice Productivity

CORRELATION MATRIX A-II

Years	X and y_1	X and y_2	X and y_3	X and y_4	X and y_5	X and y_6
1969-70	.306	.366	.240	.408	.796	.639
1970-71	.587	.629	.483	.357	.702	.610
1971-72	.794	.706	.560	.400	.758	.771
1972-73	.603	.764	.552	.348	.705	.740

CORRELATION MATRIX B-II

Years	y_1 and y_2	y_1 and y_3	y_1 and y_4	y_1 and y_5	y_1 and y_6
1969-70	.132	.095	.049	.352	.443
1970-71	.426	.222	-.156	.246	.282
1971-72	.646	.298	-.036	.545	.406
1972-73	.630	.189	-.137	.293	.333

CORRELATION MATRIX C-II

Years	y_2 and y_3	y_2 and y_4	y_2 and y_5	y_2 and y_6
1969-70	-.052	.088	.438	.395
1970-71	.476	.406	.782	.736
1971-72	.367	.183	.545	.406
1972-73	.284	-.127	.509	.592

CORRELATION MATRIX D-II

Years	y_3 and y_4	y_3 and y_5	y_3 and y_6
1969-70	-.058	.163	.225
1970-71	.616	.350	.428
1971-72	.594	.458	.419
1972-73	.524	.433	.398

CORRELATION MATRIX E-II

Years	y_4 and y_5	y_4 and y_6	y_5 and y_6
1969-70	.679	.478	.783
1970-71	.567	.400	.786
1971-72	.546	.257	.762
1972-73	.527	.313	.670

REGRESSION TABLE - J

R^2 (Explained variation (Per cent)

Years	y_1	y_2	y_3	y_4	y_5	y_6	R^2 for all six variables
1969-70	0.1	0.0	0.6	3.3	63.4	0.0	67.4
1970-71	18.3	1.2	3.7	0.0	49.3	0.0	72.5
1971-72	63.1	2.5	0.1	18.5	0.3	5.5	90
1972-73	3.6	58.4	0.8	20.3	0.1	2.7	85.9

REGRESSION TABLE - K

t Values

Years	y_1	y_2	y_3	y_4	y_5	y_6
1969-70	.006	.121	.016	-.167	.024	.012
1970-71	.369	-.330	.068	0.000	.159	.001
1971-72	-.103	-.276	.248	-.570	.815	-.370
1972-73	.022	-.015	.117	-.144	.278	-.321

In the case of rice, as for wheat, the correlation between yield of rice and fertilizer consumption and between yield of rice and high yielding varieties is fairly high. But for this crop, it is high between yield of rice and price index of rice also. There is not a steadily very high multicolinearity of the explanatory variables except for y_2 (proportion of area under high yielding varieties of the crop, to area under the crop) and y_5 (fertilizer consumption per hectare) and y_2 (proportion of area under high yielding varieties of the crop to area under the crop) and y_6 (price index of the crop) in 1970-71. y_5 (fertilizer

consumption per hectare) and y_6 (price index of the crop) also have a fairly high correlation for all the years. y_1 (proportion of area irrigated of the crop, to area under the crop) and y_2 (proportion of area under high yielding varieties of the crop to area under the crop) have a high correlation for 1971-72 and 1972-73.

Thus, as for wheat, similarly for rice, area under high yielding varieties and fertilizer consumption, area under irrigation of rice are correlated amongst themselves and therefore, the relative importance of the variables may be presented in a distorted manner. However, the extent to which the most significant of all the variables is taken in the first step of regression, we can at least say, which of the six explains most of the total variation in yield. But the other variables which may be quite important, may add little to this explained variation due to multicolinearity between independent variables.

In the case of rice, fertilizer consumption and price index of the crop, are also highly correlated unlike for wheat. This is a significant point of difference to note.

All the six variables together explain 67 per cent of the total yield variation in 1969-70 and 72.5 per cent in 1970-71 and 90 per cent and 85 per cent respectively in 1971-72 and 1972-73. Thus, our explanatory variables do explain the

variations in yield of rice to a great extent. The t values however, are insignificant and this may be due to the high correlation between some of the independent variables as mentioned above.

Fertilizer consumption per hectare explains 63.4 per cent and 49.3 per cent of total variation in yield of rice in 1969-70 and 1970-71. In 1971-72, surprisingly enough, y_1 (proportion of area irrigated of the crop to area under the crop) and y_4 (number of tubewells per hectare) explain most of the variation compared to other variables. In this year, the relative importance of y_5 (fertilizer consumption per hectare) is reduced. In 1972-73, y_2 (proportion of area under high yielding varieties of the crop, to area under the crop) explains 58.4 per cent out of 85.9 per cent of explained variation by all the six variables taken together. This is followed by y_4 (number of tubewells per hectare).

The difference between wheat and rice in the percentage of variation as explained by our six variables lies in the following. Firstly, in the case of the latter, y_1 (proportion of area irrigated of the two crops, to area under the two crops) and y_4 (number of tubewells per hectare) are equally important as y_2 (proportion of area under high yielding varieties of the two crops to area under the two crops) and y_5 (fertilizer consumption per hectare) in certain years in explaining yield variations. In the case of the former, it was mainly y_2 (proportion

of area under high yielding varieties of the two crops to area under the two crops) and y_5 (fertilizer consumption per hectare) which reversed their positions but explained most of the variation in yield.

Secondly, the explained variation by all the six variables together is greater than for wheat, in all the years. Due to a lesser degree of multicolinearity between the explanatory variables themselves in the case of rice all the variables have added to the explained variation in different years. Only variable y_3 (number of tractors per hectare) has remained almost steady. This is not a very influential factor on yields in these five years as compared to the other five variables either for wheat or for rice.

SUMMARY

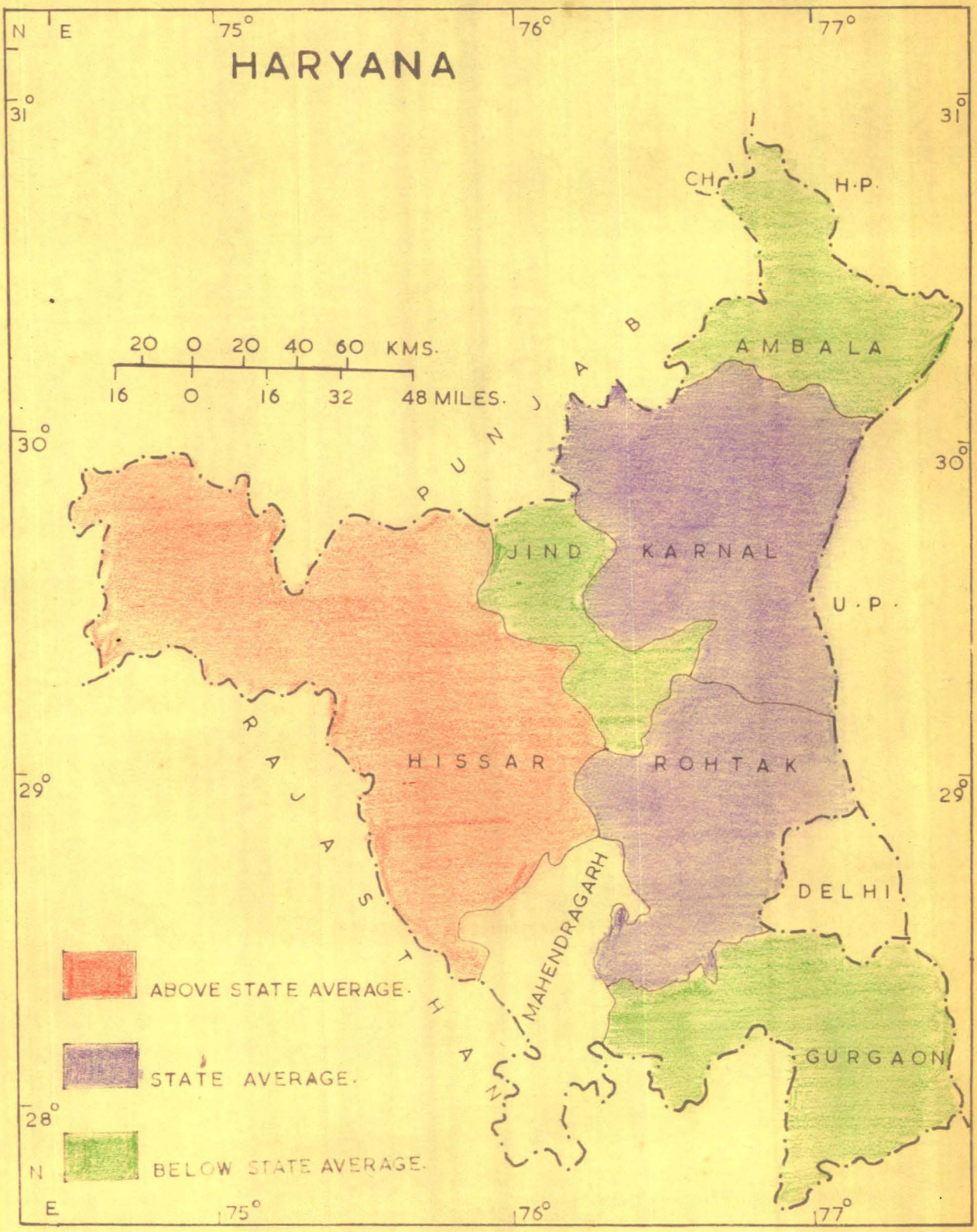
From the above analysis, we can roughly conclude that in Punjab-Haryana region between 1968-73, the most important factors influencing variations in yield have been y_2 (proportion of area under high yielding varieties of the two crops, to area under the two crops) and y_5 (fertilizer consumption per hectare) for wheat. For rice these two have been important but not consistently so, for in certain years, they are overtaken by other variables already mentioned, as is clear from Regression Table - J.

In the case of wheat, t values were mostly negative for all the years for X (yield per hectare of the two crops) why ? and y_5 (fertilizer consumption per hectare), but not for rice. The t values are all positive. Again, for wheat t values were all positive for X (yield per hectare of the two crops) and y_2 (proportion of area under high yielding varieties of the two crops, to area under the two crops), but for rice, they are mostly negative. The behaviour of variables in both these cases is exactly the reverse.

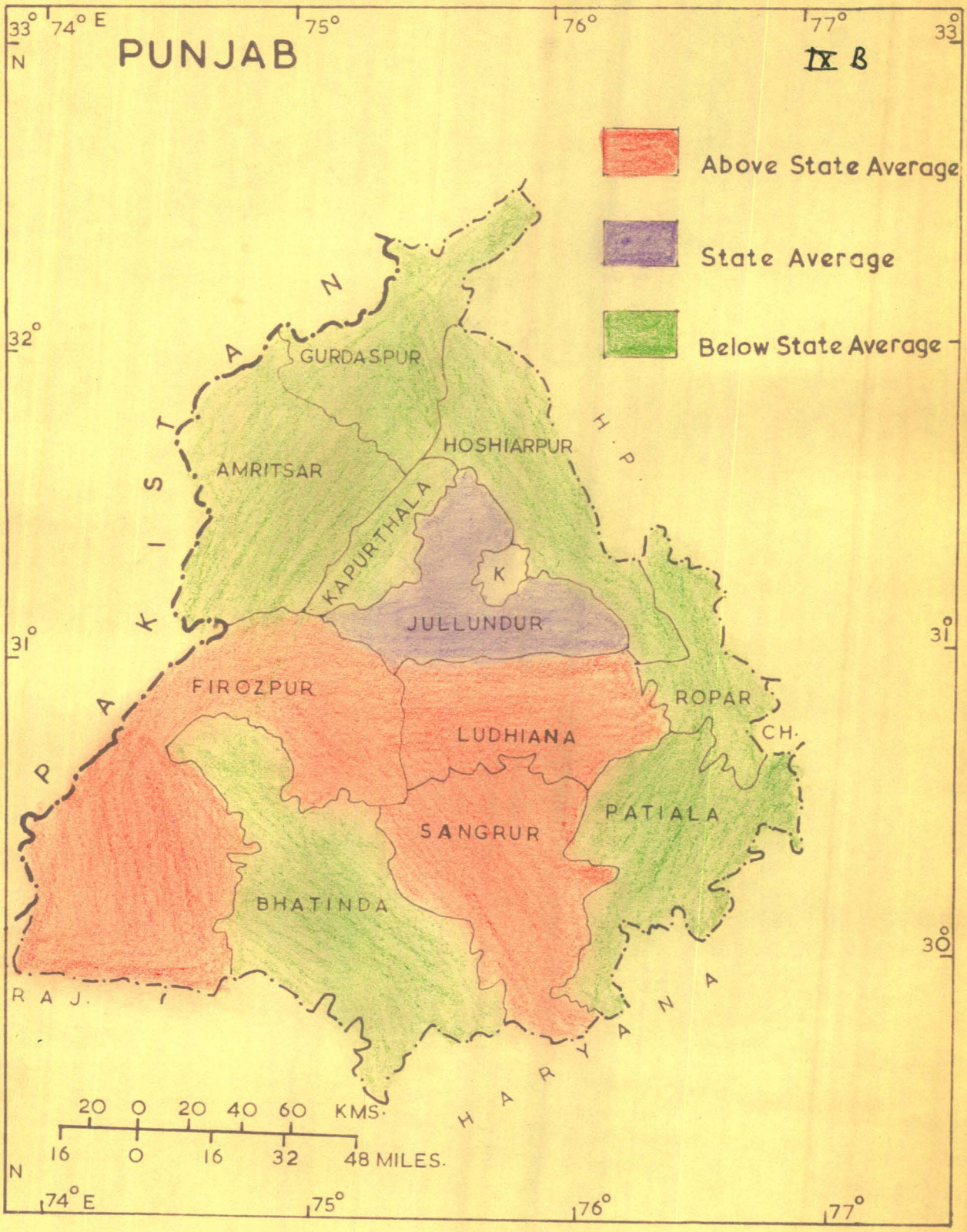
This leads to one conclusion however, tentative, viz., in the case of rice yields, high yielding varieties perhaps explain less of the variations than fertilizer consumption per hectare. The t values do not bring about the importance of price index and this may be due to the high correlation between y_5 (fertilizer consumption per hectare) and y_6 (price index of the two crops) in the case of rice. But the correlation matrix A-II (Page 84), does point to the high correlation between rice yield and price index of rice. This is not surprising for, rice is grown in the region on a smaller area than wheat and almost the entire production of finer varieties of rice grown is marketed out of the region. Without price incentive, such a sutiation would not obtain.

Unfortunately, due to the limited data available, it was not possible to present the districtwise picture. Nevertheless,

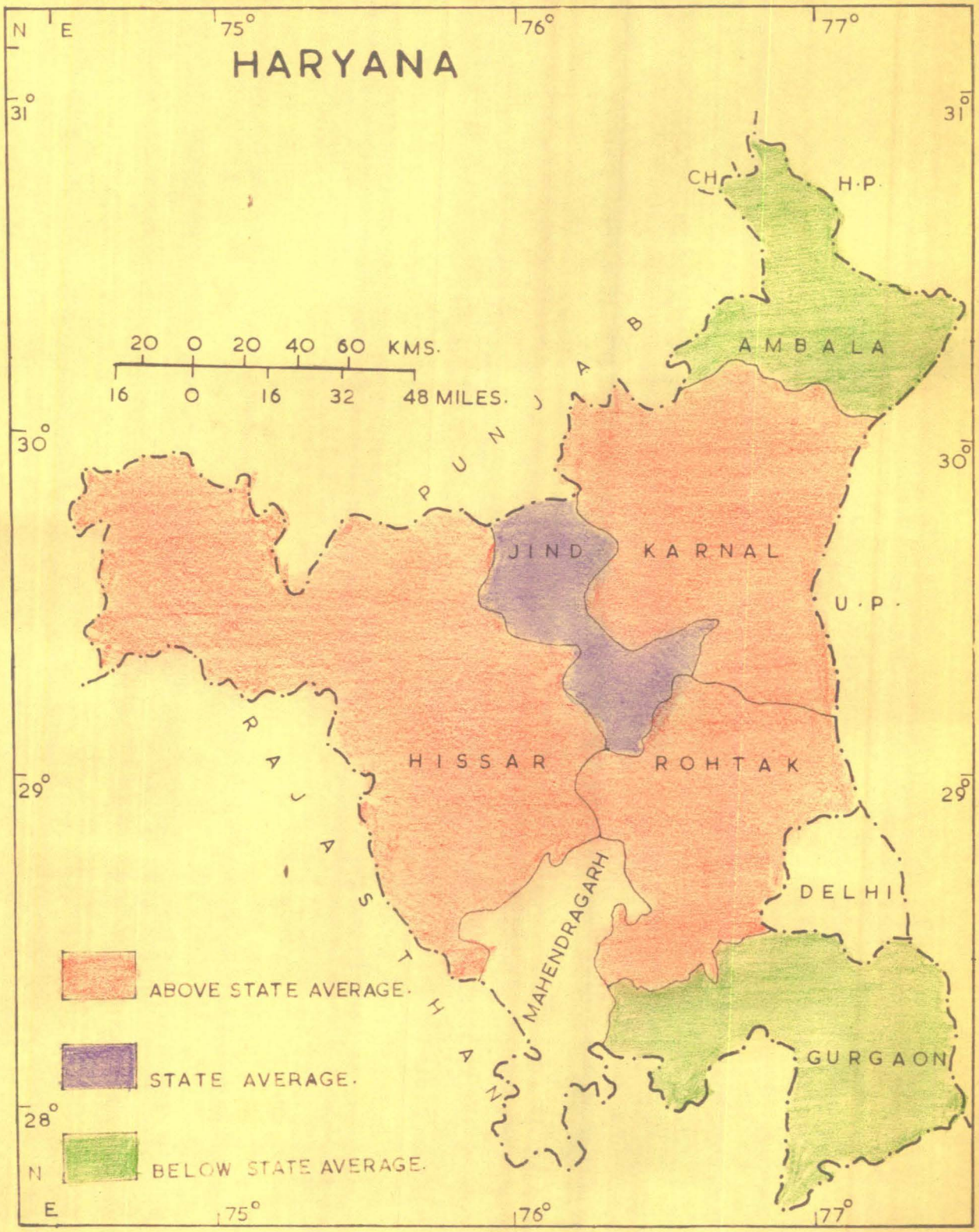
DISTRICT WHEAT YIELD AS A PROPORTION OF STATE WHEAT YIELD 1961 IX (A)



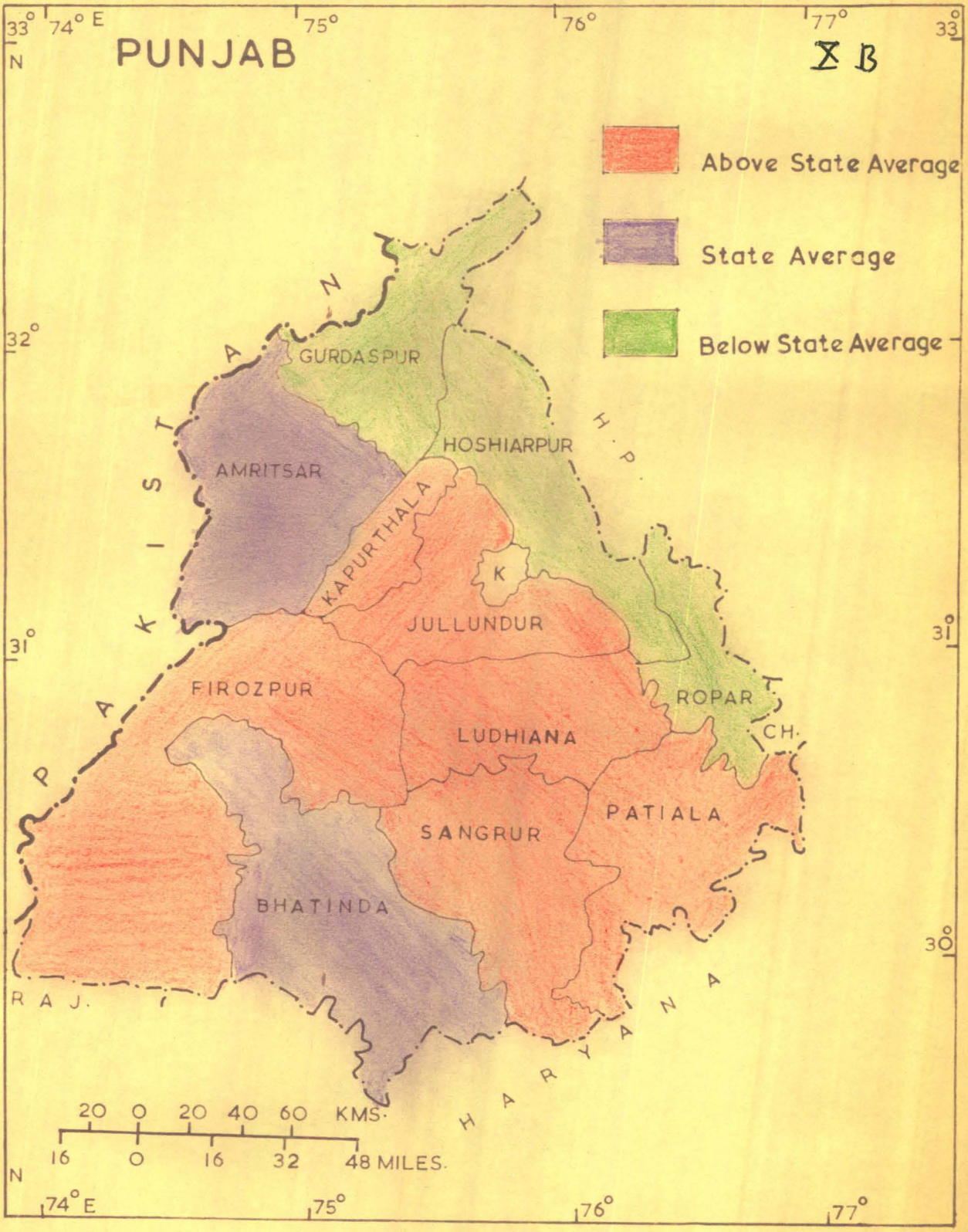
PROPORTION OF DIST. WHEAT YIELD TO STATE WHEAT YIELD 1961



DISTRICT WHEAT YIELD AS A PROPORTION OF STATE WHEAT YIELD 1971 X (A)

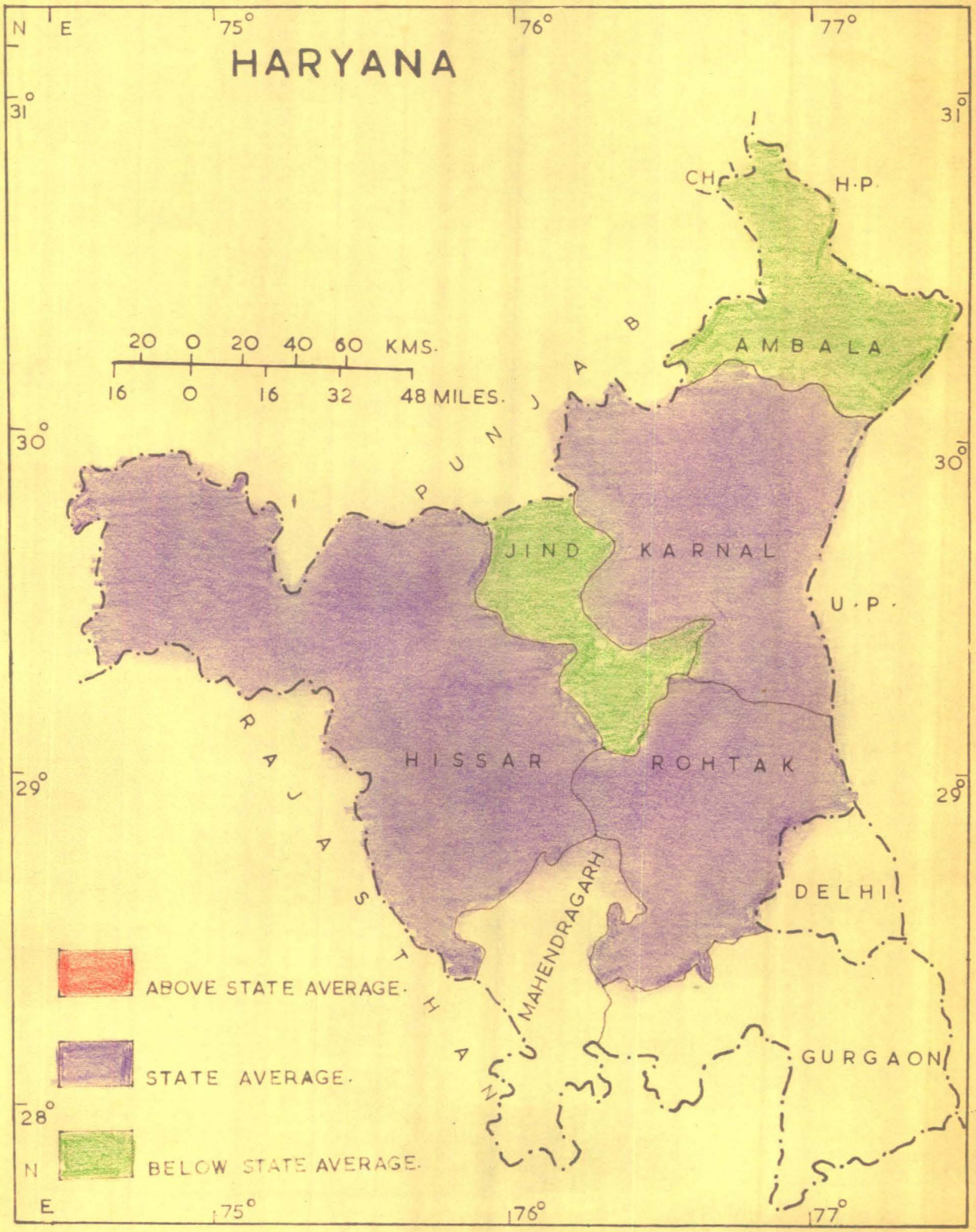


PROPORTION OF DIST. WHEAT YIELD TO STATE WHEAT YIELD 1971

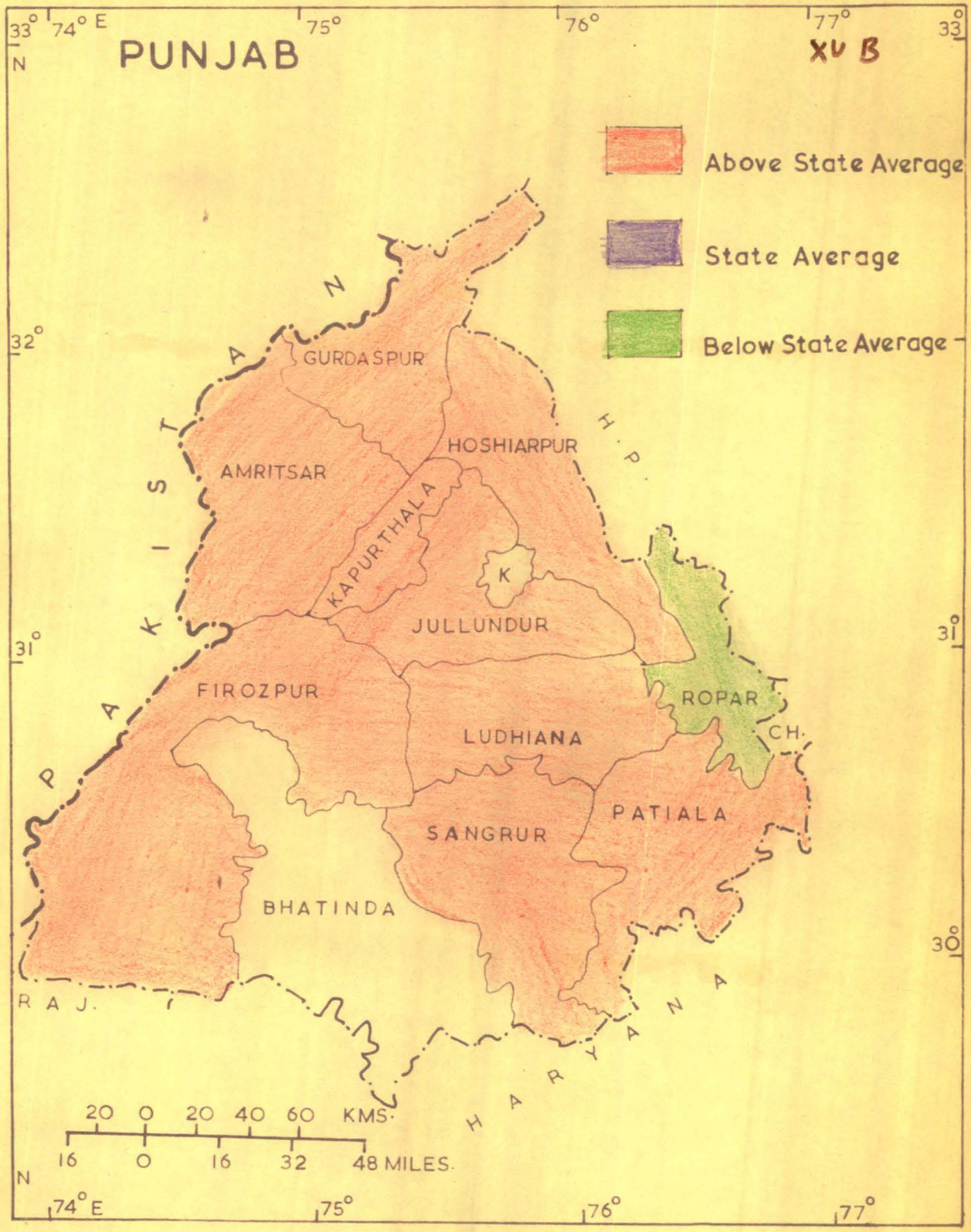


DISTRICT RICE YIELD AS A PROPORTION OF STATE RICE YIELD 1961.

XV (A)

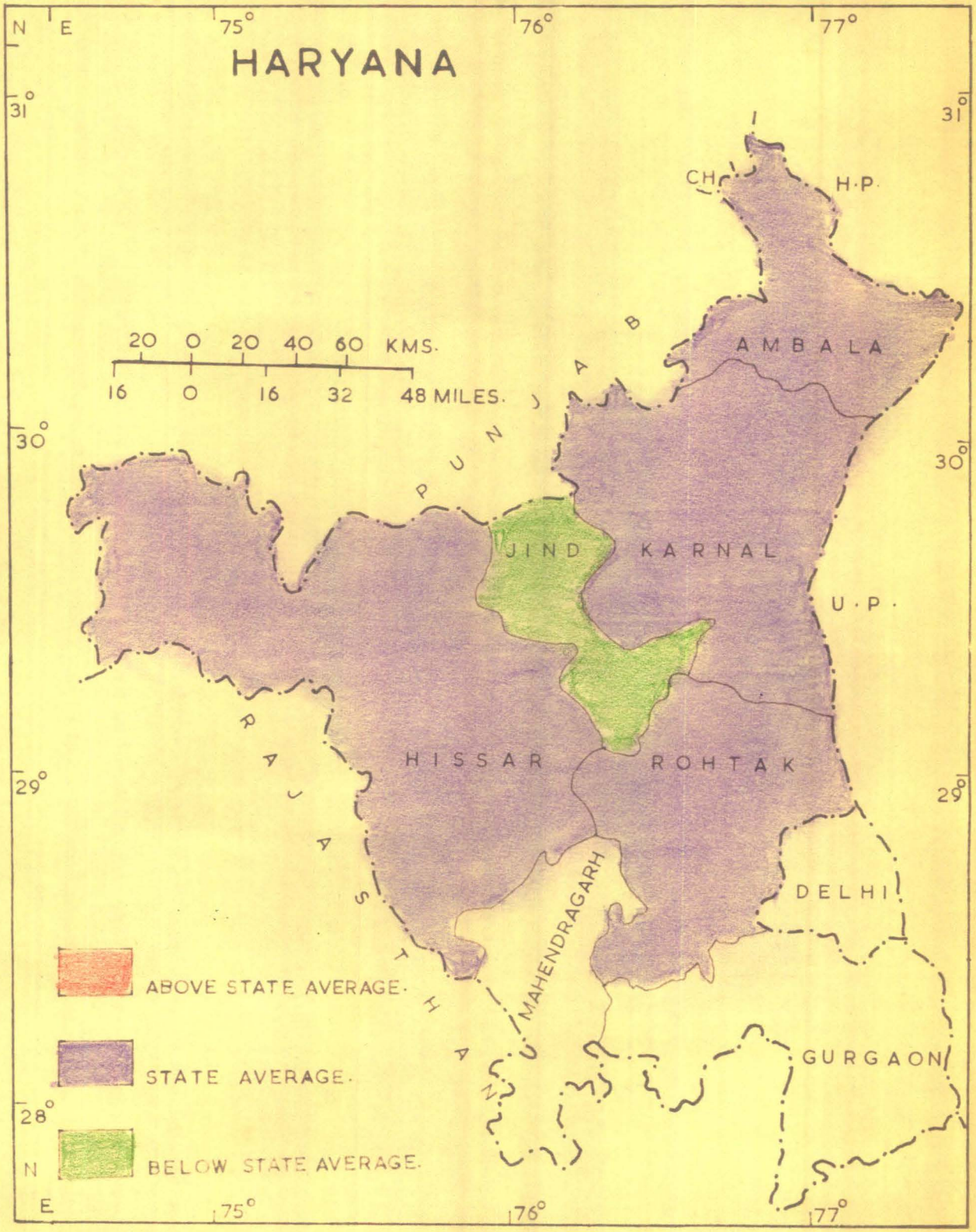


PROPORTION OF DIST. RICE YIELD TO STATE RICE YIELD 1961.

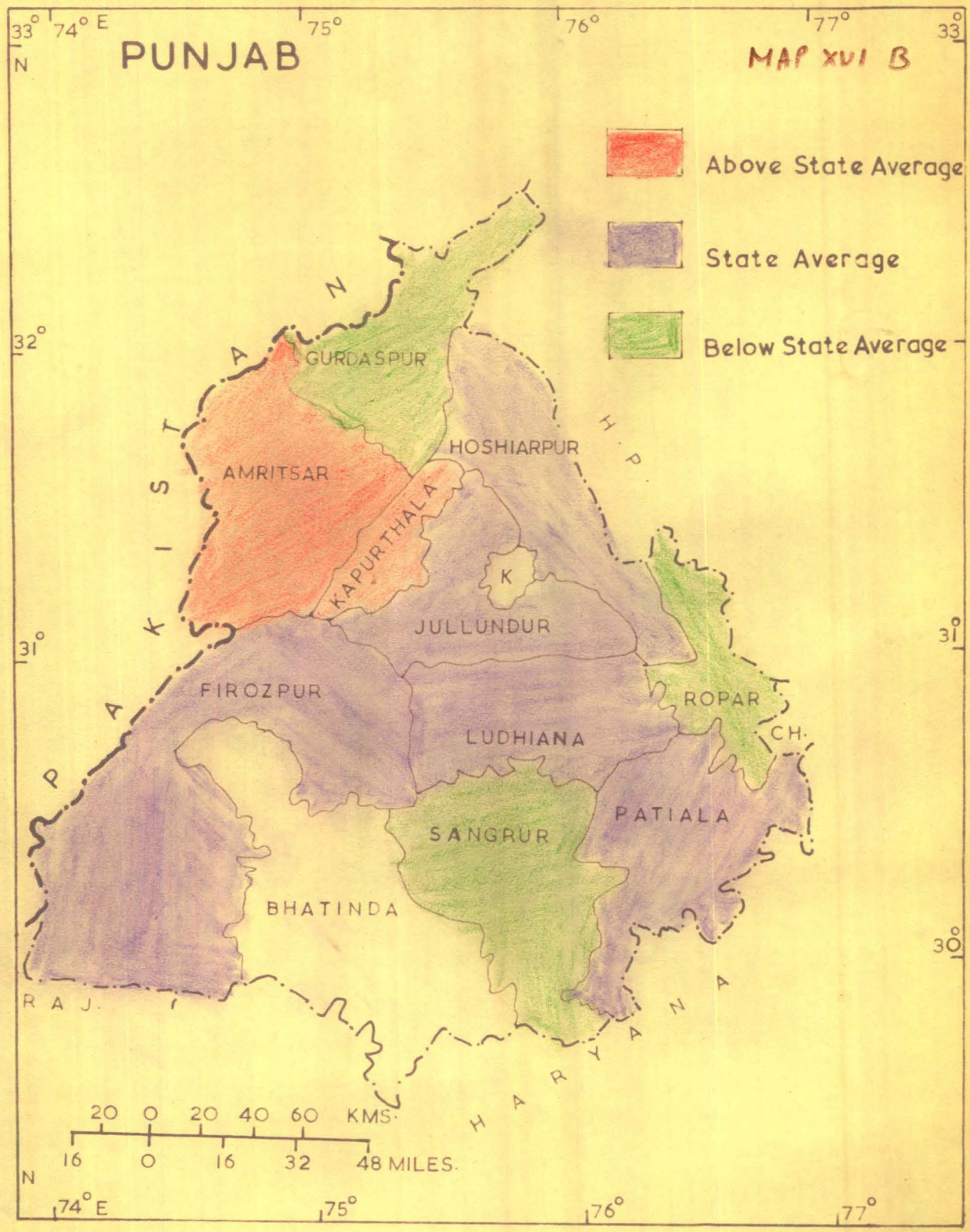


DISTRICT RICE YIELD AS A PROPORTION OF STATE RICE YIELD 1971

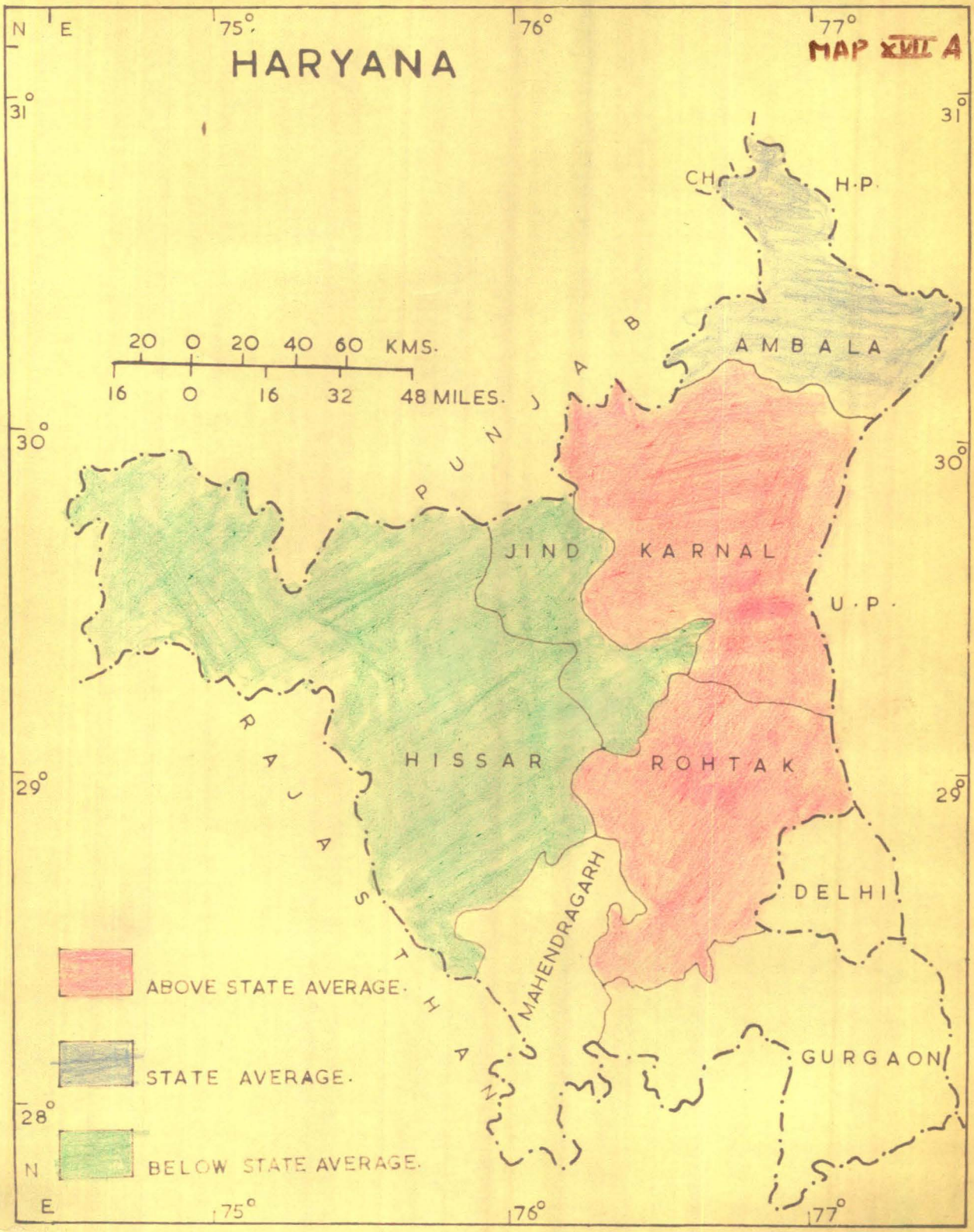
XVI (A)



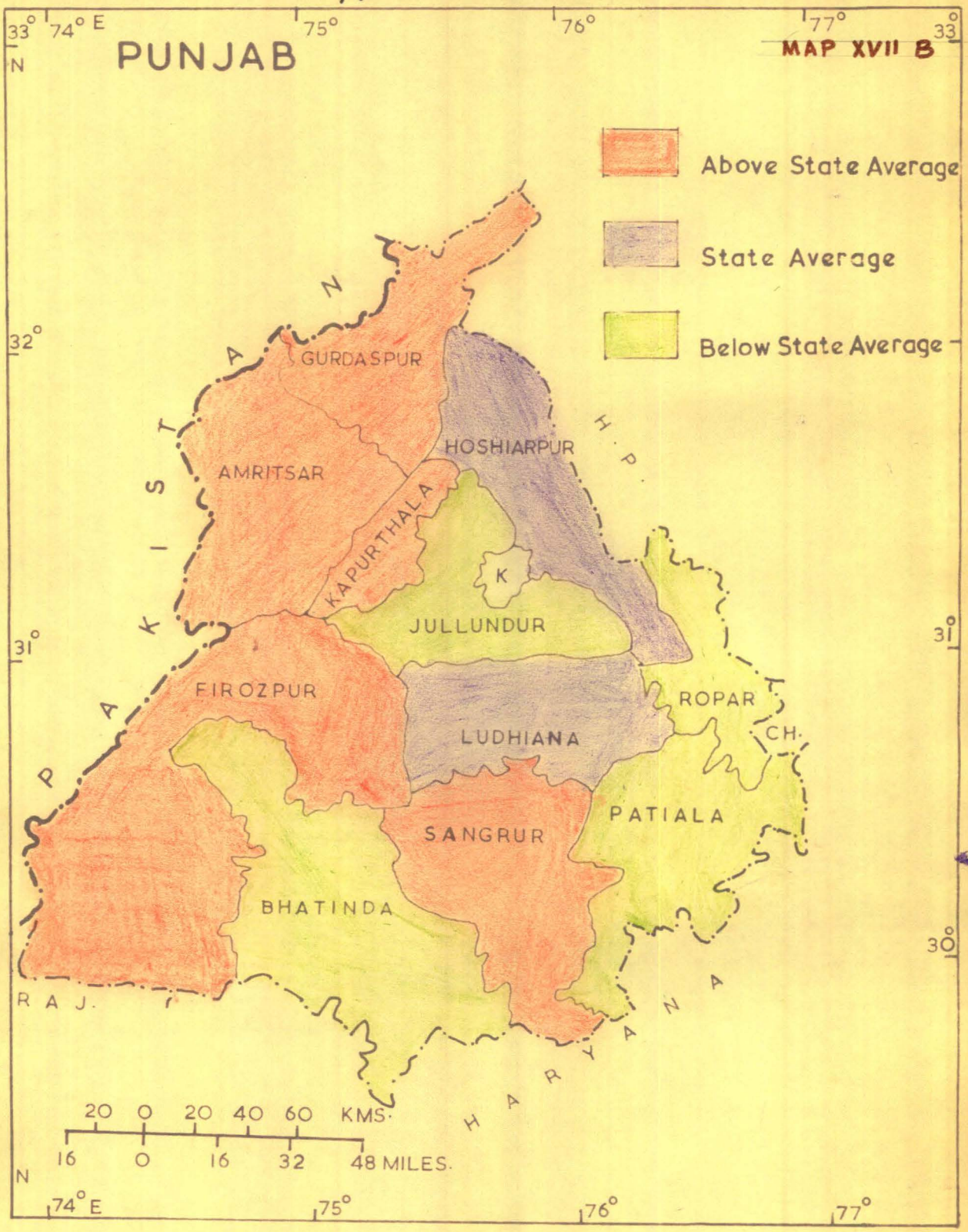
PROPORTION OF DISTRICT RICE YIELD TO STATE RICE YIELD 1971.



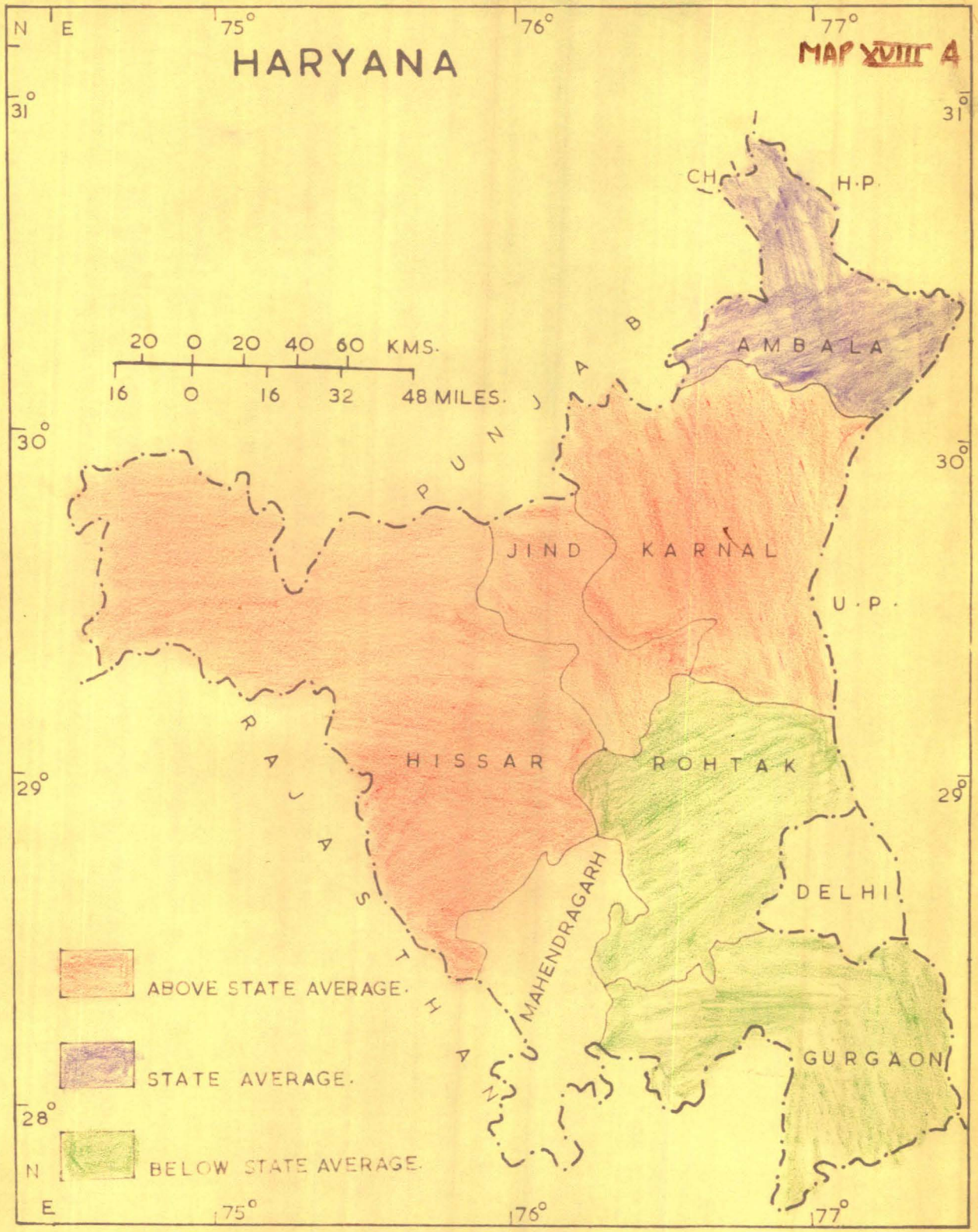
RICE AREA UNDER HIGH YIELDING VARIETIES AS A PROPORTION OF AREA UNDER THE CROP 1968-73



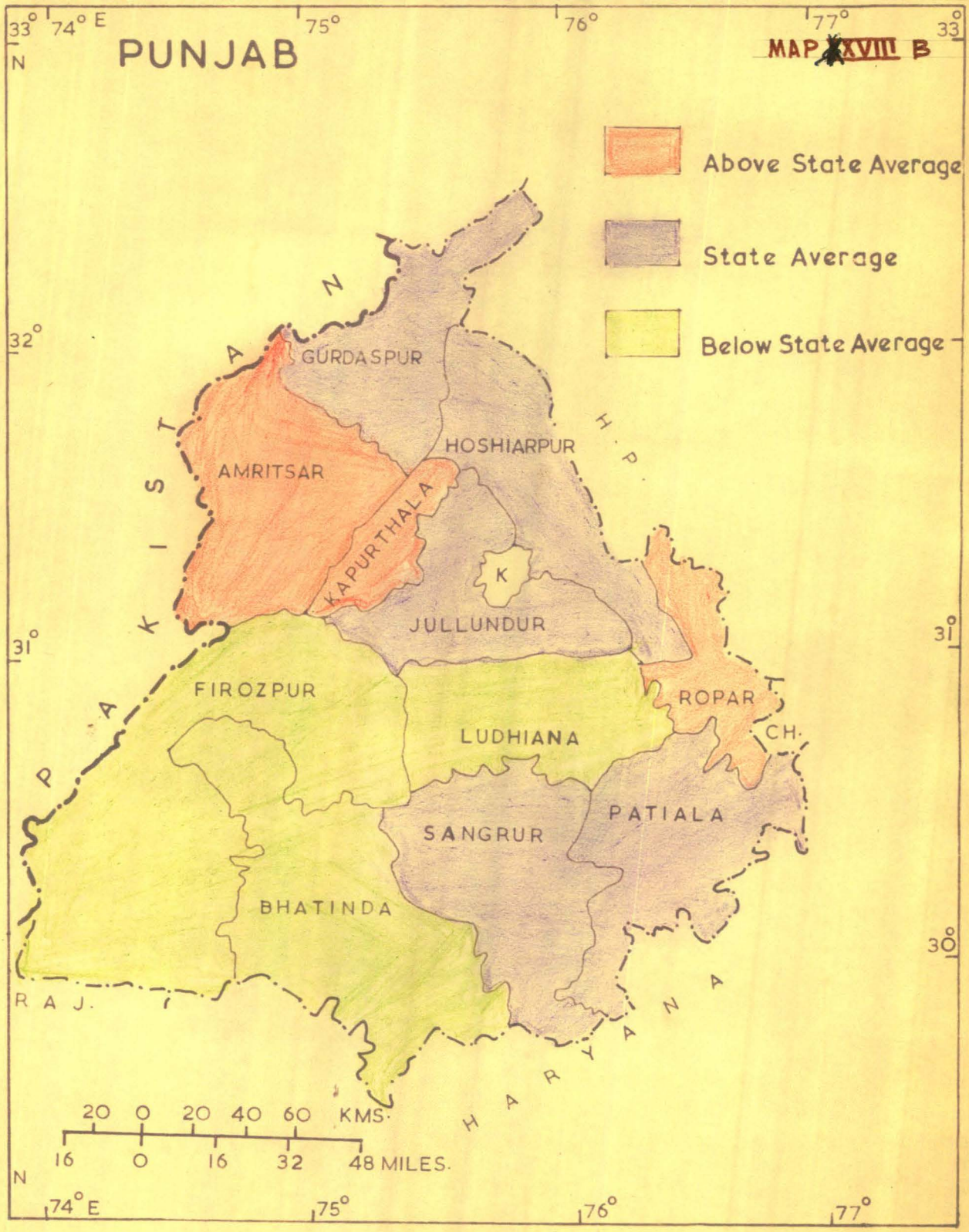
PROPORTION OF AREA UNDER HIGH YIELDING VARIETIES OF RICE TO AREA UNDER THE CROP 1968-73



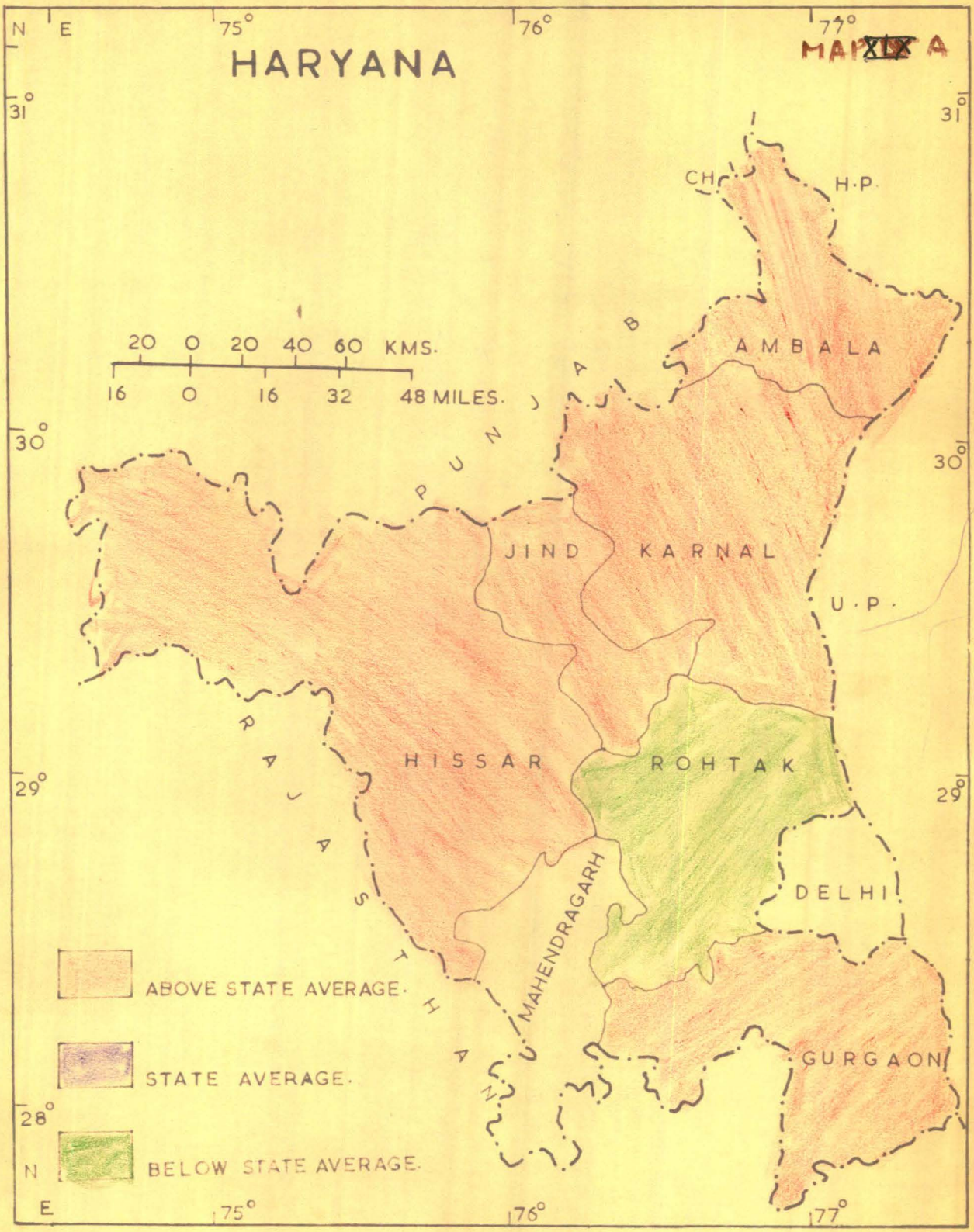
WHEAT AREA UNDER HIGH YIELDING VARIETIES AS A PROPORTION OF AREA UNDER THE CROP 1968-73



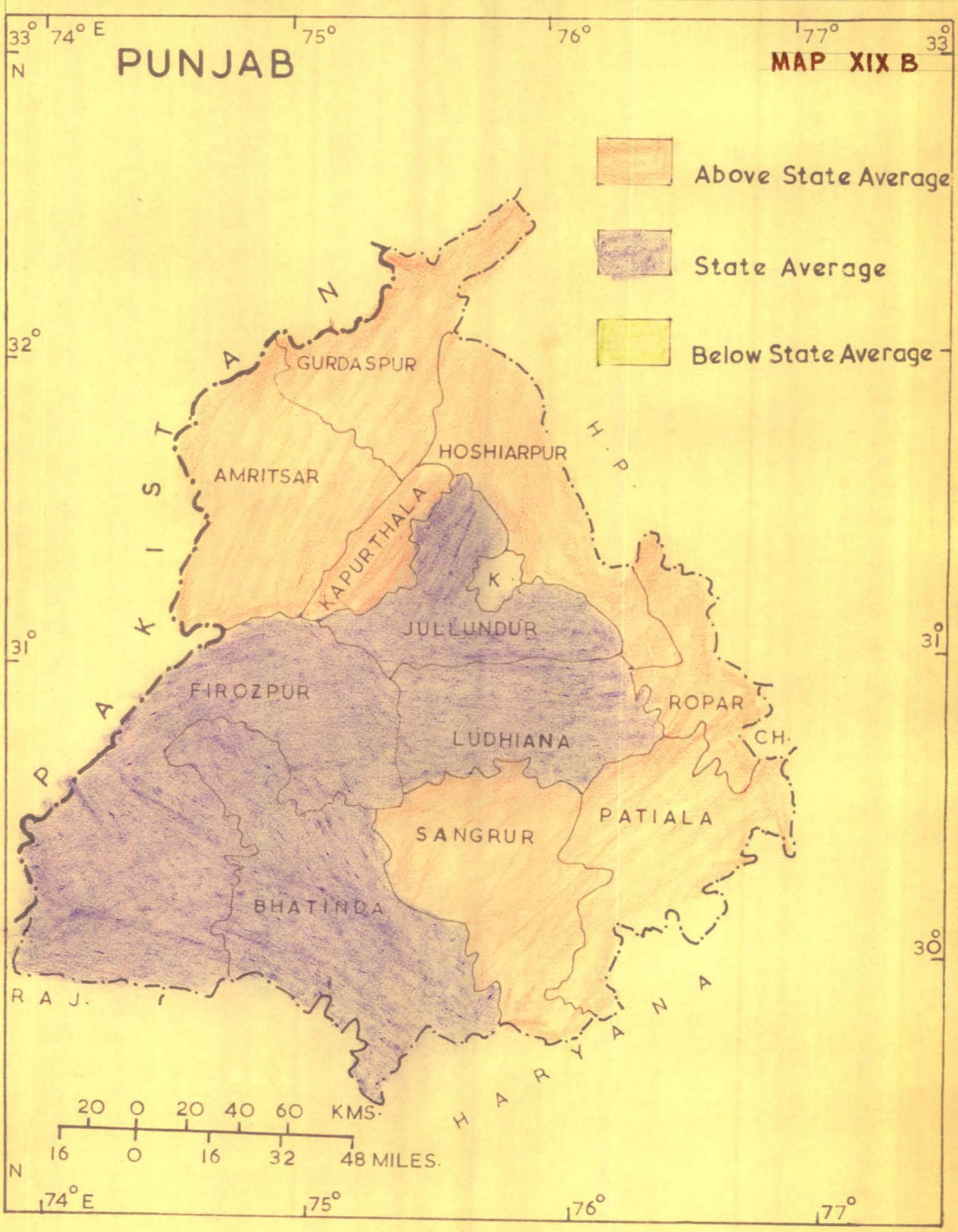
PROPORTION OF AREA UNDER HIGH YIELDING VARIETIES OF WHEAT TO AREA UNDER THE CROP 1968-73



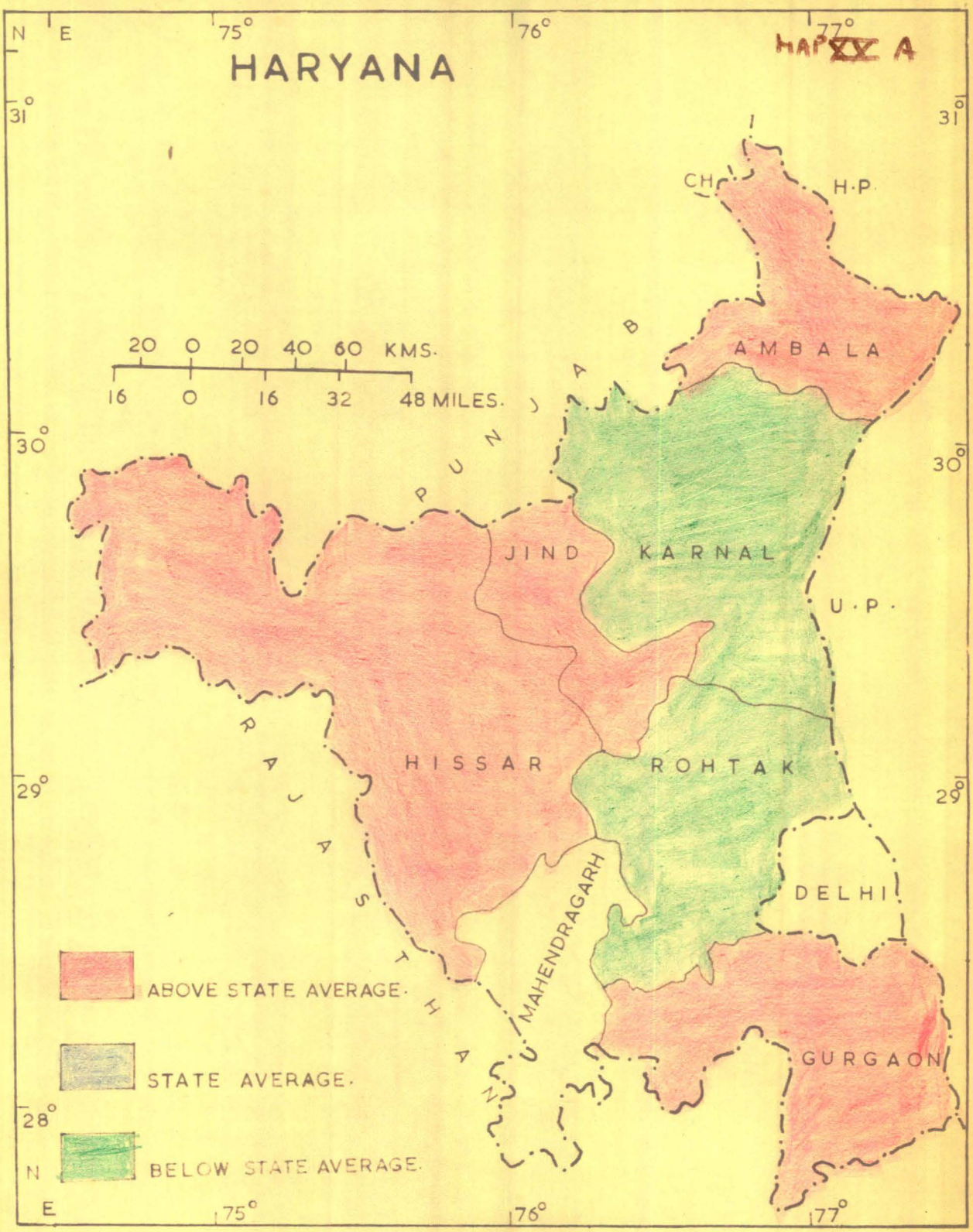
FERTILIZER CONSUMPTION PER HECTARE OF CULTIVATED AREA 1968-73



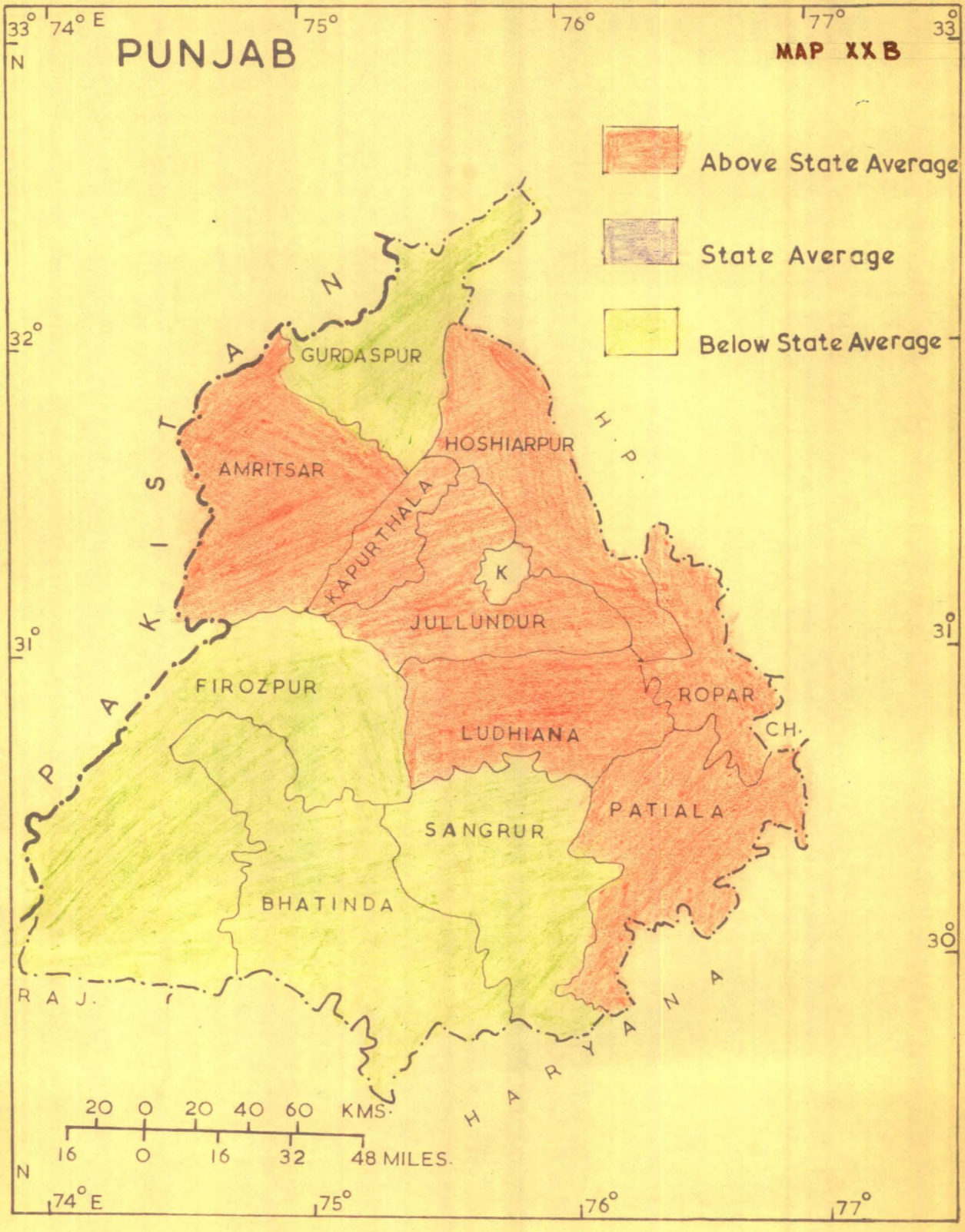
FERTILIZER CONSUMPTION PER HECTARE OF CULTIVATED AREA.



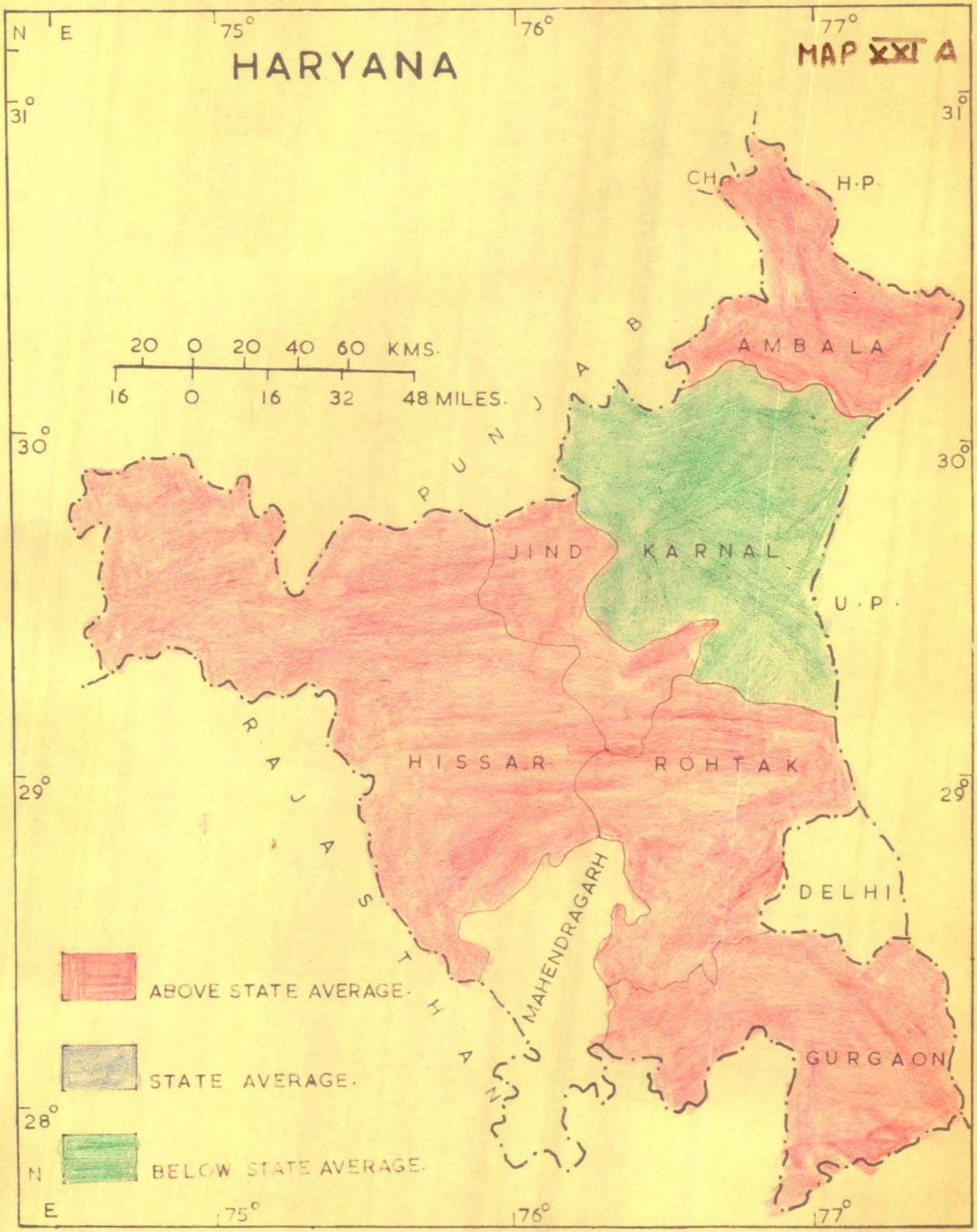
NUMBER OF TRACTORS PER HECTARE OF CULTIVATED AREA 1968-73.



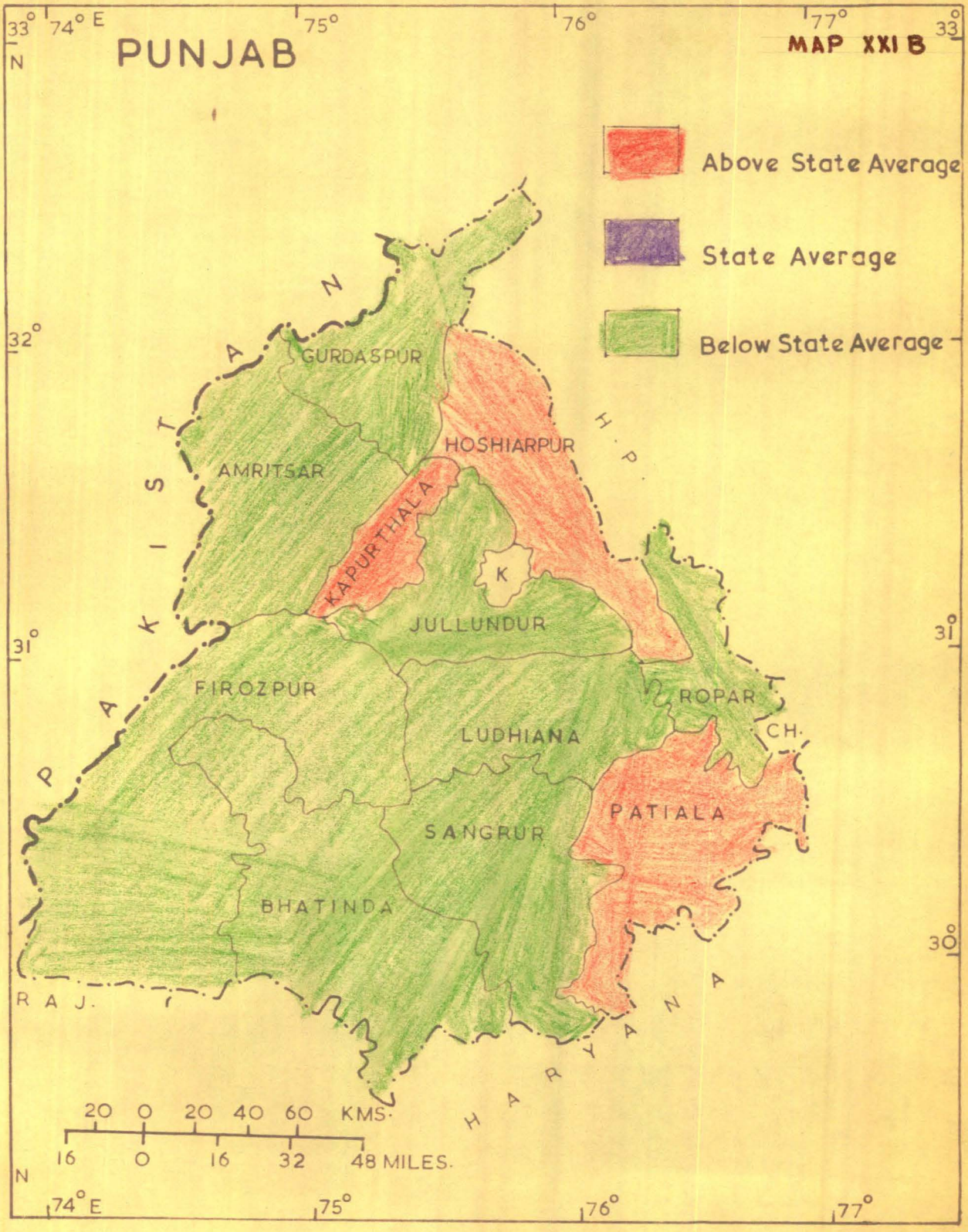
TRACTORS PER HECTARE OF CULTIVATED AREA 1968-73



TUBEWELLS PER HECTARE OF CULTIVATED AREA 1968-73



TRACTORS PER HECTARE OF CULTIVATED AREA 1968-73



even the relative behaviour of explanatory variables and changes in them year by year does explain the variations in yield in the region and does bring out some of important difference between wheat and rice. To explain inter-district variations maps are presented in the previous few pages. (Refer to Maps IX-A, B, X-A, B, XV-A, B, XVI-A, B, XVII-A, B, XVIII-A, B, XIX-A, B, XX-A, B, and XXI-A, B. All facing page 91).

Chapter IV

CONSLUSIONS

The summary given at the end of each chapter brings out the salient points of the respective chapters.

To recapitulate some of the highlighting features, the conclusions emerging from the various chapters may be set out as follows:

1. For Punjab-Haryana region as a whole, there has been an increase in gross cropped area and net area sown. In some districts like Karnal, increase in net area sown over time is comparatively higher.

2. The total area irrigated has increased very sharply particularly after 1960-65. This has reduced the percentage of area under current fallows and other land previously abandoned due to lack of water.

3. Crop intensity has been on the increase in all the districts. This is to be expected with increase in irrigation.

4. Wheat and rice acreage as a proportion to area under all crops has increased steadily over time. More area is under wheat than under rice, obviously as wheat comprises the major diet of the region; and the natural conditions may also be

favourable to cultivation of wheat than of rice. But acreage under wheat seems to have fluctuated more over time, than rice acreage. Wheat being a rabi crop, it is highly likely that in certain years, when the wheat acreage has fallen, gram may have taken its place. The area under irrigation of rice and wheat has also increased over time, particularly after 1960-65. Fluctuations in area under rice can perhaps be traced more to change in price incentive as it is a high value crop and is grown mainly on a commercial basis.

5. Production and yield of the two crops have increased over time. But there are minor differences in the behaviour of the two crops with respect to acreage, production and yield which are brought out in Chapter - II.

From the regression results, (a) it is clear that variations in production over time in Punjab and Haryana are explained more by area than by yield. Area under the crop explains most of the variation. Area under the crop and area irrigated of the crop are highly correlated and naturally the regression coefficients, t values are bound to be distorted when all of them are taken together. They are all highly significant with respect to time. (b) In explaining the increase in yields, in the case of wheat, fertilizer consumption per hectare and proportion of high

yielding varieties are more important. In the case of rice, the relative importance has varied with respect to proportion of rice area irrigated, fertilizer consumption, high yielding varieties and price index. Yield is highly correlated with all these as is clear from the correlation matrix. Fertilizer consumption and price index are highly correlated. But due to multicolinearity variation that is explained by Price Index, is distorted.

The analysis of intra-regional variations based on the district-wise data brings out the fact that not very significant differences are likely to be seen as the region itself is rather small. Also, Punjab and Haryana are afterall contiguous regions and their separation is more on political considerations. Naturally, they are likely to be governed by almost similar conditions otherwise. For the same reason our maps do not bring out any distinct intra-regional differences although, the districts have been placed into only three categories of above, below and around state average. But after their separation, districts like Hissar, has made improvements. Karnal has emerged as a fairly important, rice growing district in Haryana.

Unless, the institutional factors can be quantified by conducting sample surveys, even to some rough extent, our conclusions cannot be tested meaningfully. These factors relate

to the size of land on which the crop is grown, availability of credit etc. Equally important is to know the extent of damage caused by pests and insects to crops, resulting in their lower yields. The total neglect of these factors will reduce the significance of our conclusions.

State price index of the crops have been used to explain farmers' response to use fertilizers and high yielding varieties through price incentives. This does throw some light. But it districtwise crop price information could be obtained, the picture would be far more realistic. For the same reason, the value of crops has not been considered at all.

However, an analysis of variations in production and yield of the two crops, does throw light on the relative importance of two crops in the region and how their output and yields have behaved over time. As is clear from our regression results, all the variables taken together explain more than 70 per cent of variation in the dependent variable. Any one of them taken separately also explains most of the variation. Only due to multicolinearity, the results we got by fitting a linear regression model are distorted. The variables chosen are however, highly relevant.

For a region like Punjab-Haryana, where the necessary human factor for progress is not lacking, the government should concentrate on providing the necessary infrastructure particularly

irrigation. Steps are already being taken in this direction. The natural and institutional barriers such as soil erosion, water logging, wherever they interfere with the growing of a particular crop should be removed by afforestation and better drainage. Also, disincentives associated with share cropping tenancy should be removed, which is beyond the means of common farmers.

Although, for India as a whole, generalizations such as "Agricultural Production Depends on Vagaries of Nature" are made, for Punjab and Haryana region, this does not apply in the strict sense. The farmers are aware of the various ways by which to overcome this dependence. Irrigation by canals and tubewells as available to a large extent. The dynamism and adaptability of farmers in this region to modern agricultural practices is well known. Therefore, to obtain maximum benefits from the use of the scarce inputs like fertilizers, it is advisable to employ them on areas which are relatively free from natural constraints and where the yield response is likely to be higher. In districts where proportion of irrigated area is higher, are better suited districts for intensive agricultural development. It is necessary to encourage the use of fertilizers, pesticides etc., on Batai holdings by ensuring in practice, bearing of at least half the cost.

The schemes already completed do not cover more than 30 per cent of the area which are ripe for agricultural innovations. However, a long term strategy has to be formulated in which agricultural development could be phased in such a manner as to fulfil the regional goals of specialization in agriculture and national requirements of selected items of agriculture. These will have to be long term projects involving high cost and organizational effort, but they are necessary to fulfil the nation's pressing need for food, in particular.

Table VII(A)

Percentage Increase and Decrease

(PUNJAB STATE)

Years	Area irrigated of wheat	Area irrigated of rice	WHEAT			RICE		
			Area	Production	Yield	Area	Production	Yield
1950-51	Base	Base	Base	Base	Base	Base	Base	Base
1951-52	-	-	+ 2.2	+14.4	+11.9	- 5.3	+ 4.9	+10.51
1952-53			- 2.08	+24.8	+27.4	+ 1.2	+38.6	+36.9
1953-54	+ .81	+18.1	+ 1.4	+25.3	+23.6	+ 7.4	+46.9	+36.9
1954-55	+ 5.11	+20.0	+ 9.7	+40.3	+30.2	+10.3	+42.5	+30.86
1955-56	+ 5.5	+19.3	+20.44	+31.5	+ 8.6	+14.10	+20.44	+27.30
1956-57	+ 4.0	+31.2	+22.9	+47.7	+20.1	+25.7	+59.66	+28.30
1957-58	+ 1.9	+52.5	+21.6	+42.8	+17.2	+34.8	+73.48	+30.32
1958-59	+ 3.5	+67.5	+32.4	+67.7	+25	+51.4	+101.10	+35.98
1959-60	+11.6	+79.3	+31.79	+57.5	+19.6	+62.7	+144.75	+50.5
1960-61	Base	Base	Base	Base	Base	Base	Base	Base
1961-62	+ 4.7	- 4.3	+ 2.5	+ 1.3	- 1.12	+ 0.4	+ 0.43	0
1962-63	+ 9.3	+ 7.5	+ 8.2	+100	- 6.5	+ 8.8	+13.97	+ 4.75
1963-64	+17.2	+14.5	+ 7.9	+ 8.7	+ 0.8	+13.2	+20.08	+ 6.04
1964-65	+22.8	+26.3	+12.7	+35.8	+20.4	+26.4	+53.27	+21.2
1965-66	+32.0	+36.02	+10.7	+ 9.9	- 0.6	+28.6	+27.5	- 0.8
1966-67	+44.8	+31.1	+14.8	+40.7	+22.5	+25.5	+47.5	+17.44
1967-68	+57.7	+38.1	+27.8	+91.4	+49.7	+38.3	+81.22	+31.02
1968-69	+107.6	+61.8	+47.3	+157.8	+75	+51.98	+105.24	+35.18
1969-70	+125.2	+74.19	+54.7	+179.2	+80.4	+58.14	+133.62	+47.6
1970-71	+142.0	+92.47	+64.2	+195.3	+79.9	+71.8	+200.43	+74.9

Table VII(B)

Percentage Increase and Decrease

(HARYANA STATE)

Years	Area irrigated of wheat	Area irrigated of rice	WHEAT			RICE		
			Area	Production	Yield	Area	Production	Yield
1950-51	Base	Base	Base	Base	Base	Base	Base	Base
1951-56	-	-	+150	+110.5	+40	+ 4	+39.5	+34
1960-61	Base	Base	+73.4	+176	+59	+106.6	+306	+97
1961-62	+ 5.6	+ 4.1	+79	+195	+65	+117.3	+379.	+126
1962-63	+14.7	+16.66	+85	+173	+47	+120	+258	+62
1963-64	+21.07	+ 9.3	+90	+183	+49	+110	+411	+82
1964-65	+30.4	+13.5	+99	+213	+57	+146.6	+518	+151
1965-66	+43.8	+40.6	+87	+195	+57	+156	+374	+85
1966-67	+71.2	+43.7	+105	+260	+75	+156	+418	+102
1967-68	+71.2	+68.7	+132	+389	+99	+189	+567	+130
1968-69	+122.7	+84.3	+148	+420	+109	+205	+532	+106
1969-70	+157.8	+114.5	+180	+630	+159	+221	+460	+169
1970-71	+166.4	+144.7	+211	+696	+155	+258.6	+525	+196

Table VII(C)

Percentage Increase and Decrease

Years	Area irrigated of wheat	Area irrigated of rice	WHEAT			RICE		
			Area	Production	Yield	Area	Production	Yield
Districts of Punjab State								
AMRITSAR								
1950-51	Base	Base	Base	Base	Base	Base	Base	Base
1951-52	-	-	+ 6	-13	+ 6	+ 3	-26	-28
1952-53	-	-	- 3	- 3	- 0.2	+ 7	+40	+31
1953-54	-	-	- 4	-12	- 8	+ 3	+ 7	+20
1954-55	-	-	0	+ 7	+ 7	+ 7	+29	+22
1955-56	-	-	+ 6	- 5	-10	+13	- 2	-13
1956-57	-	-	+ 9	-15	-21	+17	+21	+ 6
1957-58	-	-	+12	+18	+ 5	+26	+37	+13
1958-59	-	-	+10	+ 6	- 3	+32	-	-
1959-60	-	-	-	-	-	-	-	-
1960-61	Base	Base	Base	Base	Base	Base	Base	Base
1961-62	+ 6	+ 1	+ 8	+21	+11	+14	+ 1	- 6
1962-63	+ 8	+55	+12	+41	+21	+59	+21	-20
1963-64	+21	+54	+16	+29	+11	+58	+46	- 9
1964-65	-	-	+16	+87	+61	+69	+43	- 6
1965-66	-	-	-	-	-	-	-	-
1966-67	+28	+59	+19	+91	+76	+61	+32	-
1967-68	-	-	-	-	-	-	-	-
1968-69	+73	+76	+53	+250	+53	+79	+69	+ 5
1969-70	+84	+96	+60	+316	+189	+95	+98	+12
1970-71	+103	+118	+73	+294	+151	+117	+151	+32

Table VII(D)

Percentage Increase and Decrease

Years	Area irrigated of wheat	Area irrigated of rice	WHEAT			RICE		
			Area	Production	Yield	Area	Production	Yield
GURDASPUR								
1950-51	Base	Base	Base	Base	Base	Base	Base	Base
1951-52	-	-	- 5	- 1	+ 4	+ 3	-45	-47
1952-53	-	-	+ 5	- 6	+26	+ 5	+19	+14
1953-54	-	-	+16	+ 9	+ 8	+ 7	+10	+ 4
1954-55	-	-	+13	+24	+10	+18	+ 2	-14
1955-56	-	-	-12	-22	-15	+22	- 7	-24
1956-57	-	-	- 9	-30	-23	+20	+24	+ 7
1957-58	-	-	- 7	-25	-20	+ 9	+ 2	- 3
1958-59	-	-	+18.99	0	-16	+12	0	-
1959-60	-	-	-	-	-	-	-	-
1960-61	Base	Base	Base	Base	Base	Base	Base	Base
1961-62	+ 2	-29	+ 3.4	+ 3	- 0.2	- 5	-16	-11
1962-63	0	- 5.3	+15	+30	+14	+ 0.8	- 3	- 3
1963-64	0	+ 3.1	- 6	+ 1	+ 8	+ 8	+29	- 4
1964-65	-	-	+ 4	+37	+33	+24	+97	-20
1965-66	-	-	-	-	-	-	-	-
1966-67	+59	+35	+18	+83	+71	+34	+102	-
1967-68	-	-	-	-	-	-	-	-
1968-69	+69	+59	+19	+166	+147	+62	+100	-
1969-70	+138	+64	+54	+245	+197	+54	+200	- 2.2
1970-71	+114	+73.11	+132	+217	+164	+65	+275	+15

Table VII(E)

Percentage Increase and Decrease

Years	Area irrigated of wheat	Area irrigated of rice	WHEAT			RICE		
			Area	Production	Yield	Area	Production	Yield
HOSHIARPUR								
1950-51	Base	Base	Base	Base	Base	Base	Base	Base
1951-52	-	-	+ 7	+14	+ 4	0	-45	-45
1952-53	-	-	+ 8	- 7	-14	+ 3	+30	+27
1953-54	-	-	+ 5	+35	+29	+ 5	+20	+14
1954-55	-	-	+ 5	+20	+15	+21	+15	- 3
1955-56	-	-	+10	- 5	-13	+21	+20	+ 0.7
1956-57	-	-	+12	+ 7	- 4	+ 5	+25	+23
1957-58	-	-	+ 9	0	- 8	+61	+65	+ 3
1958-59	-	-	+ 9	+13	+ 2	+79	0	0
1959-60	-	-	-	-	-	-	-	-
1960-61	Base	Base	Base	Base	Base	Base	Base	Base
1961-62	+14	- 5	- 4	+16	+26	+ 5	+29	+12
1962-63	-40	+ 5	+12	+15	+ 3.1	- 1	+12	-11
1963-64	-29	+ 8	+12	+ 1	-10.2	- 3	+ 5	- 5
1964-65	-	-	-	-	-	-	-	-
1965-66	-	-	-	-	-	-	-	-
1966-67	-31	+ 5	+10	+ 4.3	+16	-22	+45	- 8
1967-68	-	-	-	-	-	-	-	-
1968-69	+40	+23	+ 9	+104	+105	- 8	+92	- 6
1969-70	+71	+35	+12	+78	+73	- 5	+140	+13
1970-71	+91	+47	+17	+10	+98	- 3	+188	+30

Table VII(F)

Percentage Increase and Decrease

Years	Area irrigated of wheat	Area irrigated of rice	WHEAT			RICE		
			Area	Production	Yield	Area	Production	Yield
RUPAR								
1950-51	-	-	-	-	-	-	-	-
1951-52	-	-	-	-	-	-	-	-
1952-53	-	-	-	-	-	-	-	-
1953-54	-	-	-	-	-	-	-	-
1954-55	-	-	-	-	-	-	-	-
1955-56	-	-	-	-	-	-	-	-
1956-57	-	-	-	-	-	-	-	-
1957-58	-	-	-	-	-	-	-	-
1958-59	-	-	-	-	-	-	-	-
1959-60	-	-	-	-	-	-	-	-
1960-61	-	-	-	-	-	-	-	-
1961-62	-	-	-	-	-	-	-	-
1962-63	-	-	-	-	-	-	-	-
1963-64	-	-	-	-	-	-	-	-
1964-65	-	-	-	-	-	-	-	-
1965-66	-	-	-	-	-	-	-	-
1966-67	Base	Base	Base	Base	Base	Base	Base	Base
1967-68	+ 7	-	-	-	-	-	-	-
1968-69	+31	+100	+47	+115	+48	-	-	-
1969-70	+54	+100	+53	+141	+59	-	-	-
1970-71	+131	+400	+69	+170	+62	-	-	-

Table VII(G)

Percentage Increase and Decrease

Years	Area irrigated of wheat	Area irrigated of rice	WHEAT			RICE		
			Area	Production	Yield	Area	Production	Yield
LUDHIANA								
1950-51	Base	Base	Base	Base	Base	Base	Base	Base
1951-52	-	-	+ 6	+ 8	+ 3	0	-	-
1952-53	-	-	- 2	+11	+14	+100	0	-
1953-54	-	-	+ 8	+ 6	- 0.6	0	0	-
1954-55	-	-	+13	+42	+27	+100	0	-
1955-56	-	-	+19	+ 6	-10	+100	0	-
1956-57	-	-	+22	+36	+12	+100	0	-
1957-58	-	-	+23	+17	- 4	+200	0	-
1958-59	-	-	+33	+11	-16	+100	-	-
1959-60	-	-	-	-	-	-	-	-
1960-61	Base	Base	Base	Base	Base	Base	Base	Base
1961-62	+ 5	0	+ 2	+ 6	+ 3	-20	0	+25
1962-63	+ 6	-33	+12	+12	+13	-40	-66	-25
1963-64	+38	+33	+ 8	+60	+32	+20	0	-10
1964-65	-	-	+155	+101	-13	-40	+33	- 9
1965-66	-	-	-	-	-	-	-	-
1966-67	+86	+100	+44	+144	+86	+67	0	-27
1967-68	-	-	-	-	-	-	-	-
1968-69	+175	+66	+89	+245	+101	+67	+33	- 2
1969-70	+206	+166	+104	+287	+129	+233	+100	+10
1970-71	+127	+266	+110	+372	+147	+300	+200	+32

Table VII(H)

Percentage Increase and Decrease

Years	Area irrigated of wheat	Area irrigated of rice	WHEAT			RICE		
			Area	Production	Yield	Area	Production	Yield
FEROZPUR								
1950-51	Base	Base	Base	Base	Base	Base	Base	Base
1951-52	-	-	- 1.4	- 5	- 3	-15	-21	-28
1952-53	-	-	-15	+ 1	+18	+14	+49	+34
1953-54	-	-	- 6	- 2	+ 5	+14	+38	+21
1954-55	-	-	+10	+19	+ 8	+20	+64	+39
1955-56	-	-	+23	+ 7	-13	+16	+ 6	- 8
1956-57	-	-	+28	+28	- 0.6	+ 3	+62	+31
1957-58	-	-	+12	+26	- 3.1	+43	+71	+23
1958-59	-	-	+31	+39	+ 6	+39	+71	+23
1959-60	-	-	-	-	-	-	-	-
1960-61	Base	Base	Base	Base	Base	Base	Base	Base
1961-62	+ 4	-18	- 1	- 4	- 3	+ 3	-10	+ 9
1962-63	+ 0.4	- 2	+ 6	-21	-25	+ 2	+28	+47
1963-64	+15	+ 6	+10	+ 3	- 6	+ 6	+ 5	- 0.5
1964-65	-	-	+ 9	+14	-	-13	-17	-19
1965-66	-	-	-	-	-	-	-	-
1966-67	+29	+11	+13	+24	+22	+11	0	+ 7
1967-68	-	-	-	-	-	-	-	-
1968-69	+29	+11	+32	+104	+69	+45	+17	-12
1969-70	+76	+43	+32	+111	+75	+56	+52	+ 5
1970-71	+100	+69	+43	+142	+84	+70	+103	+143

Table VII(I)

Percentage Increase and Decrease

Years	Area irrigated of wheat	Area irrigated of rice	WHEAT			RICE		
			Area	Production	Yield	Area	Production	Yield
BHATINDA								
1950-51	-	-	-	-	-	-	-	-
1951-52	-	-	-	-	-	-	-	-
1952-53	-	-	-	-	-	-	-	-
1953-54	-	-	-	-	-	-	-	-
1954-55	-	-	-	-	-	-	-	-
1955-56	-	-	-	-	-	-	-	-
1956-57	-	-	-	-	-	-	-	-
1957-58	-	-	-	-	-	-	-	-
1958-59	-	-	-	-	-	-	-	-
1959-60	-	-	-	-	-	-	-	-
1960-61	Base	Base	Base	Base	Base	Base	Base	Base
1961-62	+13	0	+13	+53	+ 4	-	-	-
1962-63	+38	0	+33	+22	+ 4	-	-	-
1963-64	+11	0	+11	+ 8	+ 4	-	-	-
1964-65	-	-	+277	+66	+30	-	-	-
1965-66	-	-	-	-	-	-	-	-
1966-67	+38	+72	+16	+20	+19	-	-	-
1967-68	-	-	-	-	-	-	-	-
1968-69	+110	+ 2	+81	+209	+87	-	-	-
1969-70	+306	+247	+95	+234	+88	-	-	-
1970-71	+143	+400	+98	+215	+75	-	-	-

Table VII(J)

Percentage Increase and Decrease

Years	Area irrigated of wheat	Area irrigated of rice	WHEAT			RICE		
			Area	Production	Yield	Area	Production	Yield
SANGRUR								
1950-51	Base	Base	Base	Base	Base	Base	Base	Base
1951-52	-	-	- 6	+26	+31	0	0	0
1952-53	-	-	+ 6	+28	+34	0	0	0
1953-54	-	-	+10	+48	+43	+100	+150	+24
1954-55	-	-	+11	+46	+33	+50	+50	0
1955-56	-	-	+26	+28	+12	+33	+250	+ 6
1956-57	-	-	+43	+119	+54	+100	+350	+80
1957-58	-	-	+36	+67	+22	+183	+450	-
1958-59	-	-	+46	+60	+68	+183	-	-
1959-60	-	-	-	-	-	-	-	-
1960-61	Base	Base	Base	Base	Base	Base	Base	Base
1961-62	+ 5	0	+ 1	0	+ 1	0	+24	+20
1962-63	+11	-32	+10	- 7	-13	-58	- 6	+58
1963-64	+22	-25	+ 8	- 4	-10	-27	-12	+15
1964-65	-	-	+17	+16	+30	-50	- 6	+14
1965-66	-	-	-	-	-	-	-	-
1966-67	+18	-46	-10	-14	+ 4	-80	-64	-14
1967-68	-	-	-	-	-	-	-	-
1968-69	+82	-11	+18	+101	+76	-63	-35.2	-22
1969-70	+94	0	+25	+153	+87	-63	0	-22
1970-71	+98	0	+37	+110	+76	-63	-12	+ 6

Table VII(K)

Percentage Increase and Decrease

Years	Area irrigated of wheat	Area irrigated of rice	WHEAT			RICE		
			Area	Production	Yield	Area	Production	Yield
PATIALA								
1950-51	Base	Base	Base	Base	Base	Base	Base	Base
1951-52	-	-	-102	+43	+45	+33	+20	-10
1952-53	-	-	0	+44	+44	+57	0	-36
1953-54	-	-	+ 0.4	+30	+30	+62	+80	+11
1954-55	-	-	- 4	+30	+38	+38	+80	+30
1955-56	-	-	- 7	+27	+38	+71	+60	+65
1956-57	-	-	-34	+10	+71	+95	+380	+153
1957-58	-	-	-15	+46	+75	+66	+220	+100
1958-59	-	-	+ 7	+74	+67	+200	-	-
1959-60	-	-	-	-	-	-	-	-
1960-61	Base	Base	Base	Base	Base	Base	Base	Base
1961-62	+24	+10	- 5	-21	-16	- 4	+ 4	+ 9
1962-63	+22	-13	+ 0	-23	-23	-11	+ 4	+16
1963-64	+16	-10	+10	-20	- 9	- 8	+ 6	+36
1964-65	-	-	+10	-15	- 3	-51	- 6	+ 8
1965-66	-	-	-	-	-	-	-	-
1966-67	+54	+34	-16	-14	+12	+20	-10	-
1967-68	-	-	-	-	-	-	-	-
1968-69	+143	+74	+18	+95	+82	+52	+48	+ 8
1969-70	+161	+105	+26	+94	+70	+70	+60	+ 4
1970-71	+203	+125	+57	+108	+47	+79	+114	+33

Table VII(L)

Percentage Increase and Decrease

Years	Area irrigated of wheat	Area irrigated of rice	WHEAT			RICE		
			Area	Production	Yield	Area	Production	Yield
KAPURTHALA								
1950-51	Base	Base	Base	Base	Base	Base	Base	Base
1951-52	-	-	+ 5	+14	+ 8	0	-50	-50
1952-53	-	-	+ 8	+45	+35	0	+50	+50
1953-54	-	-	+ 3	+24	+20	-	+50	+50
1954-55	-	-	+ 2	+28	+25	+25	+50	+19
1955-56	-	-	+16	- 8	-21	+50	+50	+ 6
1956-57	-	-	+17	+24	+ 6	+100	+150	+30
1957-58	-	-	+15	+38	+20	+140	+300	..
1958-59	-	-	+12	+30	+27	+75	..	..
1959-60	-	-	-	-	-	-	-	-
1960-61	Base	Base	Base	Base	Base	Base	Base	Base
1961-62	- 3	-21	+ 2	- 4	- 5	-13	- 7	+ 2
1962-63	+ 7	-16	+12	+ 8	- 3	- 4	+42	+38
1963-64	+10	-11	+ 8	+12	+ 5	-13	-21	- 6
1964-65	-	-	+15	+35	+17	-13	0	- 3
1965-66	-	-	-	-	-	-	-	-
1966-67	+29	-11	+19	+40	+96	-13	0	+ .2
1967-68	-	-	-	-	-	-	-	-
1968-69	+88	+32	+46	+40	+94	+30	+21	0
1969-70	+97	+42	+50	+168	+97	+30	+43	+19
1970-71	+112	+84	+59	+197	+107	+52	+85	+36

Table VII(M)

Percentage Increase and Decrease

Years	Area irrigated of wheat	Area irrigated of rice	WHEAT			RICE		
			Area	Production	Yield	Area	Production	Yield
JULLUNDHER								
1950-51	Base	Base	Base	Base	Base	Base	Base	Base
1951-52	-	-	+43	+108	+101	+10	-25	-31
1952-53	-	-	+ 5	+80	+71	+20	0	-16.6
1953-54	-	-	+11	+196	+167	+40	+25	-11
1954-55	-	-	+11	+108	+87	+70	0	-41
1955-56	-	-	+16	+64	+41	+100	-	-
1956-57	-	-	+18	+32	+12	+130	+250	+50
1957-58	-	-	+25	+64	+60	+210	+325	+43
1958-59	-	-	+20	+108	+40	+280	..	..
1959-60	-	-	-	-	-	-	-	-
1960-61	Base	Base	Base	Base	Base	Base	Base	Base
1961-62	+ 4	+15	+10	- 7	-17	+34	+30	- 6
1962-63	+20	+19	+11	- 4	-16	+41	+50	+ 8
1963-64	+26	+33	+17	+29	+16	+38	+35	+ 2
1964-65	-	-	+19	+43	+31	+45	+30	+ 3
1965-66	-	-	-	-	-	-	-	-
1966-67	+45	+61	+19	+14	+122	+59	+30	-
1967-68	-	-	-	-	-	-	-	-
1968-69	+94	+127	+29	+211	+161	+103	+90	+ 4
1969-70	+120	+127	+44	+231	+135	+103	+105	+14
1970-71	+120	+165	+42	+275	+187	+138	+175	+30

Table VII(N)

Percentage Increase and Decrease

Years	Area irrigated of wheat	Area irrigated of rice	WHEAT			RICE		
			Area	Production	Yield	Area	Production	Yield
Districts of Haryana State								
HISSAR								
1950-51	Base	Base	Base	Base	Base	Base	Base	Base
1951-56	-	-	+39	197	45	125	133	28
1960-100 Base								
1961-62	+ 2	- 6	- 2	-15	-87	- 6	+26	35
1962-63	11	44	- 7	-26	-22	35	68	24
1963-64	22	19	- 1	-19	-18	17	110	32
1964-65	27	-13	+ 1	-16	-17	-18	- 5	16
1965-66	24	-19	-13	-36	-28	-24	-21	17
1966-67	40	-25	- 1	- 9.6	- 8	-29	0	40
1967-68	-	-	16	32	13	-21	11	33
1968-69	-	-	-	-	-	-	-	-
1969-70	-	-	-	-	-	-	-	-
1970-71	123	19	+54	102	31	18	68	100

Table VII(O)

Percentage Increase and Decrease

Years	Area irrigated of wheat	Area irrigated of rice	WHEAT			RICE		
			Area	Production	Yield	Area	Production	Yield
ROHTAK								
1950-51	Base	Base	Base	Base	Base	Base	Base	Base
1951-56	-	-	+32	+82	+38	-33	0	+73
1960-61	Base	Base	Base	Base	Base	Base	Base	Base
1961-62	+ 3	0	- 6	- 1.1	+ 5	0	+40	+16
1962-63	+ 6	0	- 8	+ 8	+18	+20	+40	+11
1963-64	+17	+50	+ 6	+11	+ 5	-20	0	+29
1964-65	+18	0	+ 9	+ 7	- 2	+40	+100	+31
1965-66	+29	+75	+16	+35	+15	+190	+40	- 8.17
1966-67	-	-	+22	+38	+13	+40	+60	+ 6
1967-68	+48	+50	+29	+66	+44	400	260	11
1968-69	-	-	-	-	-	-	-	-
1969-70	-	-	-	-	-	-	-	-
1970-71	+112	+225	+50	+148	+65	366	280	18

Table VII(P)

Percentage Increase and Decrease

Years	Area irrigated of wheat	Area irrigated of rice	WHEAT			RICE		
			Area	Production	Yield	Area	Production	Yield
GURGAON								
1950-51	Base	Base	Base	Base	Base	Base	Base	Base
1951-56	-	-	+41	+193	73	-	-	-
1960-61	Base	Base	Base	Base	Base	Base	Base	Base
1961-62	- 9	-	+15	+35	4.6	-	-	-
1962-63	+19	-	+14	+32	13	-	-	-
1963-64	+ 3	-	+17	+21	3	-	-	-
1964-65	+29	-	+41	+46	4	-	-	-
1965-66	+58	-	+24	+41	14	-	-	-
1966-67	+106	-	+39	86	34	-	-	-
1967-68	-	-	+80	165	27	-	-	-
1968-69	-	-	-	-	-	-	-	-
1969-70	-	-	-	-	-	-	-	-
1970-71	+264	-	+118	207	42	-	-	-

Table VII(Q)

Percentage Increase and Decrease

Years	Area irrigated of wheat	Area irrigated of rice	WHEAT			RICE		
			Area	Production	Yield	Area	Production	Yield
KARNAL								
1950-51	Base	Base	Base	Base	Base	Base	Base	Base
1951-56	-	-	59	139	31	5	75	62
1960-61	Base	Base	Base	Base	Base	Base	Base	Base
1961-62	14.7	6	10	17	8	10	15	6
1962-63	21	12	18	- 4	-20	13	-22	31
1963-64	18	14	19	4	-12.5	3.2	15	15
1964-65	35	19	23	29	5	25	73	37
1965-66	-	-	22	20	0	36	17	0
1966-67	85	48	26	49	19	35	43	7
1967-68	120	52	42	92	40	48	85	26
1968-69	-	-	-	-	-	-	-	-
1969-70	-	-	-	-	-	-	-	-
1970-71	354	150	104	289	88	92	223	69

Table VII(R)

Percentage Increase and Decrease

Years	Area irrigated of wheat	Area irrigated of rice	WHEAT			RICE		
			Area	Production	Yield	Area	Production	Yield
AMBALA								
1950-51	Base	Base	Base	Base	Base	Base	Base	Base
1951-56	-	-	35	41	6	12	-11.1	4.17
1960-61	Base	Base	Base	Base	Base	Base	Base	Base
1961-62	-	-	23	65	35	0	10	12
1962-63	0	0	47	61	10	-25	-35	-13
1963-64	100	0	19.2	45	22	- 8	+ 2.5	+22.6
1964-65	200	80	18	80	22	11	15	3
1965-66	150	25	- 5.2	4.77	14	14	-50	-57
1966-67	500	125	14.0	- 4	-15	+16.6	- 7.5	-21
1967-68	700	165	28	100	56	16.6	+ 2.5	-12.2
1968-69	-	-	-	-	-	-	-	-
1969-70	-	-	-	-	-	-	-	-
1970-71	900	375	88	236	78	22.5	22.5	- 1.25

Table VII(S)

Percentage Increase and Decrease

Years	Area irrigated of wheat	Area irrigated of rice	WHEAT			RICE		
			Area	Production	Yield	Area	Production	Yield
JIND								
1950-51	Base	Base	Base	Base	Base	Base	Base	Base
1951-56	-	-	90	94	0.5	0	0	6.4
1960-61	Base	Base	Base	Base	Base	Base	Base	Base
1961-62	9	33	-17	-16	+ 1.3	0	25	22
1962-63	21	33	-12	-25	-14	0	50	61
1963-64	9	33	0	- 9.3	-10.5	25	25	17
1964-65	14	33	0	1.5	0.87	25	50	16
1965-66	6	33	- 6	-12	- 6	0	-25	0.8
1966-67	-	-	12.7	20.3	- 6.7	25	50	26
1967-68	35	66	21.2	63	33	75	100	20
1968-69	-	-	-	-	-	-	-	-
1969-70	-	-	-	-	-	-	-	-
1970-71	108	267	62	126	38	125	175	19

Table VII(T)

Percentage Increase and Decrease

Years	Area irrigated of wheat	Area irrigated of rice	WHEAT			RICE		
			Area	Production	Yield	Area	Production	Yield
MOHINDERGARH								
1950-51	Base	Base	Base	Base	Base	Base	Base	Base
1951-56	-	-	66	66	10	-	-	-
1960-61	Base	Base	Base	Base	Base	Base	Base	Base
1961-62	-	-	-13	11	21	-	-	-
1962-63	-	-	0	33	30	-	-	-
1963-64	-	-	-13	0	8.4	-	-	-
1964-65	-	-	13	56	35	-	-	-
1965-66	-	-	-13	11.1	17	-	-	-
1966-67	-	-	13	56	56	-	-	-
1967-68	-	-	38	100	42	-	-	-
1968-69	-	-	-	-	-	-	-	-
1969-70	-	-	-	-	-	-	-	-
1970-71	-	-	287	333	53.4	-	-	-

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