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# Pakistan Geographical Review

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## WHEAT CULTIVATION IN WEST PAKISTAN : ITS WATER BUDGET

M. K. ELAHI

THE paper seeks to measure the benefits of Green Revolution in terms of food situation in West Pakistan, with special reference to wheat cultivation. It enunciates the major factors contributive to the progress in wheat production, and brings into focus the problem of water supply. While an appraisal of wheat cultivation is made in the entire region of study, West Pakistan, considerations of water budget in this paper are restricted to the area of the Punjab province.

Wheat is the most important crop of West Pakistan, not only in acreage and production but also in its contribution to the national economy in general and agricultural sector in particular. It occupies 35.1 percent of the total cropped area and 62.4 percent of the total area under food grains in West Pakistan (Tables 1 and 2). It dominates the cropping pattern in *rabi* all over the country, not a single *tehsil* is an exception to it.

TABLE 1—AGRICULTURAL LAND USE—WEST PAKISTAN

| | Total cultivated as % of total reported area | Fallow as % of total cultivated area | Total cropped (m. acres) | Double cropped %of net sown area | Wheat | Rice | Total food grain as % of total cropped | Cotton | Sugarcane |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | % of total cropped | | | % of total cropped | |
| 1970-71 | | | | | | | | | |
| Baluchistan | 6.1 | 67.6 | 0.98 | 4.2 | 40.6 | 10.1 | 74.7 | ... | ... |
| N.-W. F. P. | 31.7 | 18.3 | 3.84 | 20.7 | 37.9 | 3.4 | 68.9 | 0.1 | 5.1 |
| Punjab | 64.9 | 10.9 | 28.11 | 16.1 | 37.1 | 6.4 | 54.4 | 11.5 | 4.1 |
| Sind | 43.2 | 44.4 | 9.08 | 19.9 | 22.5 | 18.2 | 54.9 | 11.5 | 2.1 |
| West Pakistan | 35.1 | 24.7 | 42.90 | 16.9 | 35.1 | 8.6 | 55.1 | 9.3 | 3.6 |
| 1964-65 | | | | | | | | | |
| Baluchistan | 10.5 | 66.4 | 1.77 | 3.3 | 24.7 | 5.8 | 40.5 | ... | ... |
| N.-W. F. P. | 31.0 | 12.3 | 3.29 | 15.7 | 46.9 | 1.2 | 78.1 | 0.2 | 5.9 |
| Punjab | 60.7 | 9.9 | 26.26 | 14.5 | 35.6 | 5.6 | 51.7 | 10.6 | 3.3 |
| Sind | 40.7 | 39.9 | 9.82 | 16.9 | 18.0 | 16.6 | 50.4 | 8.5 | 1.6 |
| West Pakistan | 34.4 | 24.4 | 40.14 | 14.7 | 32.7 | 8.3 | 54.2 | 8.7 | 3.3 |
| 1961-62 | | | | | | | | | |
| Baluchistan | 9.4 | 59.5 | 0.81 | 6.5 | 30.5 | 9.8 | 58.1 | ... | ... |
| N.-W. F. P. | 34.9 | 12.1 | 2.97 | 10.8 | 45.1 | 1.3 | 73.0 | 0.2 | 5.4 |
| Punjab | 58.9 | 10.8 | 24.24 | 9.3 | 32.8 | 5.5 | 53.6 | 9.8 | 3.1 |
| Sind | 37.0 | 37.7 | 8.46 | 14.1 | 19.7 | 18.0 | 52.8 | 12.1 | 0.80 |
| West Pakistan | 40.9 | 20.7 | 36.48 | 10.4 | 35.4 | 8.2 | 55.1 | 9.3 | 3.00 |

SOURCE: *Year Book of Agricultural Statistics*, 1971-72, Govt. of Pakistan, Islamabad.

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TABLE 2—RATIO OF AREA UNDER VARIOUS FOOD GRAINS TO AREA UNDER TOTAL FOOD GRAINS BY PROVINCES

| | Wheat area | Rice area | Maize area | Jowar area | Bajra area | Barley area |
|---|---|---|---|---|---|---|
| 1960-61—1964-65 | | | | | | |
| Baluchistan | 63.8 | 16.2 | 2.0 | 15.1 | 0.8 | 2.1 |
| N.-W. F. P. | 58.4 | 1.6 | 24.9 | 3.3 | 3.6 | 7.2 |
| Punjab | 69.1 | 10.6 | 4.5 | 4.8 | 9.0 | 2.0 |
| Sind | 36.6 | 35.1 | 0.4 | 10.1 | 17.2 | 0.4 |
| West Pakistan | 60.6 | 15.0 | 5.3 | 6.0 | 9.9 | 2.2 |
| 1965-66—1969-70 | | | | | | |
| Baluchistan | 58.8 | 13.3 | 1.6 | 23.6 | 0.8 | 1.9 |
| N.-W. F. P. | 56.3 | 4.5 | 27.9 | 2.9 | 2.9 | 5.5 |
| Punjab | 70.4 | 11.7 | 4.6 | 4.0 | 8.0 | 1.3 |
| Sind | 40.1 | 35.0 | 0.7 | 9.6 | 14.0 | 0.6 |
| West Pakistan | 67.57 | 8.1 | 6.9 | 6.31 | 9.3 | 1.9 |
| 1970-71 | | | | | | |
| Baluchistan | 54.4 | 13.5 | 1.6 | 27.4 | 1.6 | 1.5 |
| N.-W. F. P. | 55.1 | 5.1 | 29.9 | 2.3 | 2.7 | 4.9 |
| Punjab | 70.8 | 11.9 | 4.8 | 4.2 | 7.2 | 1.1 |
| Sind | 41.4 | 33.3 | 1.1 | 9.8 | 13.9 | 0.5 |
| West Pakistan | 62.4 | 15.7 | 6.7 | 5.8 | 7.9 | 1.5 |

SOURCE: As in Table 1.

The importance of wheat as a food base is established beyond doubt, as on the basis of wheat production depends the overall food situation in the country. Food grains imported in large quantities to meet the food requirements of the fast growing population of West Pakistan* on a declining land-man ratio[1] necessitated the campaign for grow more food. In 1931 there were 1.40 acres of cultivated land per capita which declined to 1.12 acres by 1951. During the two decades 1951—61 and 1961—72, the ratio has further declined from 0.91 acres to 0.72 acres** respectively. The decline occurred in spite of an appreciable increase in the cultivated area in each of the decades.

There has been an increase of 51.1 percent (about 5 m. acres) in the land occupance of wheat between 1947-48 and 1970-71, an average annual increase of about 200,000 acres. The rate of acquisition of land for wheat has been variable over the years being 182,777 acres annually during the pre-revolution period and 255,000 acres after the beginning of the green revolution. A greater rate of increase is specially noteworthy between 1966-67 and 1970-71. Some change in the overall pattern of wheat regarding the ratio of its land occupance can be seen from Table 1. Increase in the ratio of area under wheat is noticeable in Baluchistan, which however only amounts to a small increase in actual acreage, while in Punjab and Sind, smaller increase in the proportion of area under wheat after 1964-65, has meant a sizeable addition to the total wheat acreage.

*The rate of growth of population has been 2.55 percent per annum (1961—72).

**Based on population estimates of 64,800,000 for West Pakistan.

Indices of wheat acreage (base year, 1964-65) in the pre-green revolution period for West Pakistan depict the relative instability in the wheat acreage, indices ranging between 77.7 in 1953-54 and 94.3 in 1963-64 (Table 3). In the period that followed the base year, indices show a relatively stable increase, the highest index being 117.1 during 1969-70. It is interesting to note that the provincial indices of Punjab and Sind, which have large acreages under wheat, seem to govern the upward trend of West Pakistan (Fig. 1). Baluchistan and N.W.F.P. show marked fluctuations, and no appreciable rise. The upward trends in Punjab and Sind are related, among other factors, to the improvement in irrigation facilities and the adaptability of the farmer to revolutionary processes.

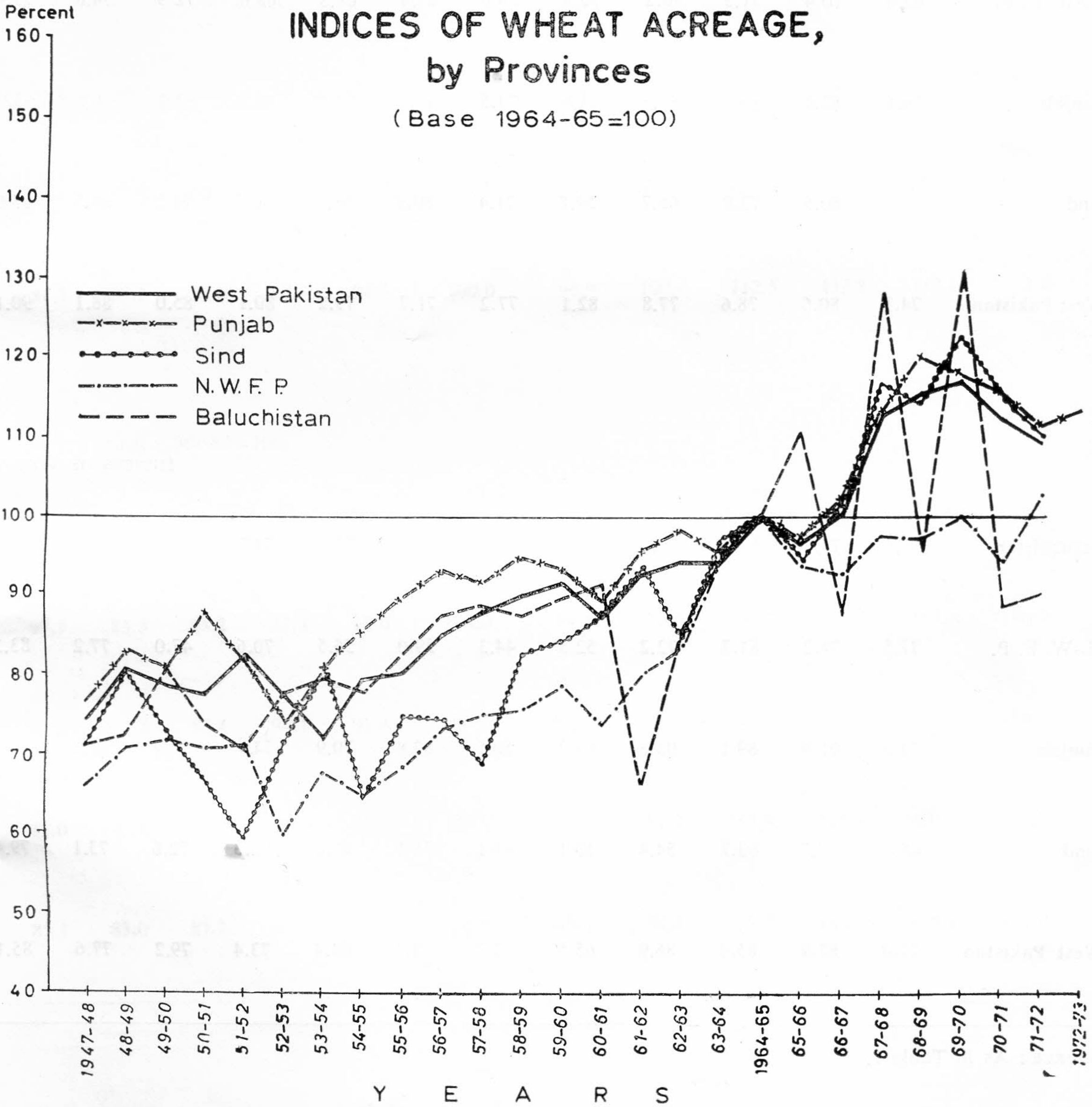



FIG. 1 (*a*)

TABLE 3—INDICES OF WHEAT

| | 47/48 | 48/49 | 49/50 | 50/51 | 51/52 | 52/53 | 53/54 | 54/55 | 55/56 | 56/57 | 57/58 | 58/59 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baluchistan | 71.0 | 72.3 | 80.4 | 73.2 | 70.3 | 77.5 | 79.7 | 77.7 | 82.6 | 87.5 | 88.8 | 87.3 |
| N.-W. F. P. | 65.6 | 70.4 | 71.3 | 70.2 | 70.8 | 59.6 | 67.4 | 64.8 | 68.0 | 72.9 | 74.8 | 75.4 |
| Punjab | 76.5 | 82.6 | 80.8 | 87.5 | 81.9 | 73.5 | 80.8 | 85.7 | 89.8 | 93.3 | 91.9 | 95.0 |
| Sind | 71.1 | 80.5 | 73.0 | 66.7 | 59.5 | 71.4 | 80.9 | 64.4 | 74.7 | 74.2 | 68.7 | 83.0 |
| West Pakistan | 74.3 | 80.6 | 78.6 | 77.8 | 82.1 | 77.2 | 71.7 | 79.2 | 80.1 | 85.0 | 88.1 | 90.1 |
| INDICES OF WHEAT | | | | | | | | | | | | |
| Baluchistan | 55.5 | 73.7 | 89.8 | 74.7 | 64.6 | 54.5 | 77.7 | 72.7 | 78.7 | 70.7 | 81.8 | 70.7 |
| N.-W. F. P. | 77.5 | 74.2 | 81.7 | 72.2 | 52.3 | 44.3 | 59.0 | 56.5 | 70.6 | 47.0 | 77.2 | 83.3 |
| Punjab | 73.8 | 91.9 | 89.1 | 93.8 | 69.3 | 50.5 | 82.8 | 70.9 | 74.3 | 80.9 | 78.2 | 86.5 |
| Sind | 68.1 | 73.7 | 63.7 | 54.4 | 50.1 | 69.1 | 71.1 | 67.6 | 68.3 | 72.6 | 73.1 | 79.4 |
| West Pakistan | 73.0 | 87.9 | 85.4 | 86.9 | 65.5 | 52.3 | 79.3 | 69.4 | 73.4 | 79.2 | 77.6 | 85.1 |

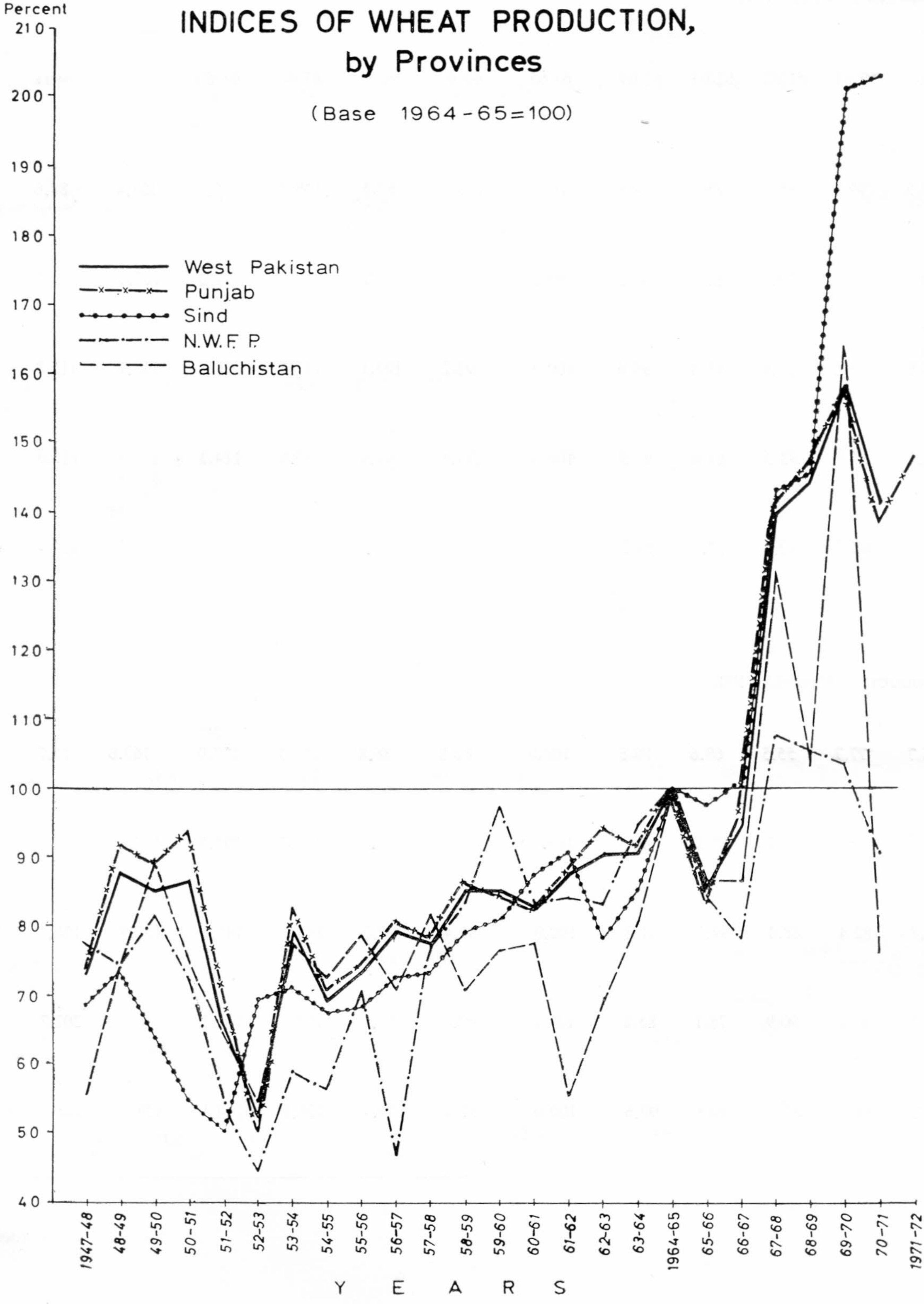
SOURCE : As in Table 1.

ACREAGE (1964-65=100)

| 59/60 | 60/61 | 61/62 | 62/63 | 63/64 | 64/65 | 65/66 | 66/67 | 67/68 | 68/69 | 69/70 | 70/71 | 71/72 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 89.5 | 91.3 | 65.7 | 85.5 | 94.6 | 100.0 | 110.9 | 87.5 | 128.2 | 95.7 | 131.4 | 88.6 | 90.2 |
| 88.4 | 73.2 | 79.7 | 83.9 | 95.5 | 100.0 | 93.7 | 92.8 | 97.9 | 97.2 | 100.1 | 94.3 | 102.7 |
| 93.8 | 89.2 | 95.8 | 98.4 | 95.6 | 100.0 | 97.2 | 102.1 | 113.2 | 120.1 | 118.1 | 115.8 | 111.6 |
| 84.1 | 87.9 | 93.3 | 84.8 | 97.5 | 100.0 | 94.5 | 101.6 | 117.0 | 114.3 | 122.9 | 115.9 | 110.2 |
| 91.7 | 87.2 | 92.5 | 94.4 | 94.3 | 100.0 | 96.9 | 100.4 | 112.5 | 115.8 | 117.1 | 112.4 | 109.6 |

PRODUCTION (1964-65=100)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 76.7 | 77.7 | 55.5 | 69.6 | 80.8 | 100.0 | 86.8 | 86.8 | 131.3 | 103.0 | 163.6 | 75.7 | ... |
| 97.7 | 83.3 | 84.2 | 83.3 | 95.0 | 100.0 | 84.2 | 78.3 | 107.7 | 105.5 | 103.8 | 90.3 | ... |
| 84.7 | 82.4 | 88.4 | 94.1 | 91.3 | 100.0 | 83.4 | 95.2 | 141.3 | 147.5 | 157.9 | 138.5 | 148.2 |
| 81.0 | 87.6 | 90.9 | 78.1 | 85.2 | 100.0 | 97.9 | 101.2 | 152.9 | 155.3 | 200.3 | 202.7 | ... |
| 85.1 | 83.0 | 87.7 | 90.8 | 90.6 | 100.0 | 85.3 | 94.4 | 139.8 | 144.1 | 158.8 | 141.0 | ... |



INDICES OF WHEAT PRODUCTION, by Provinces
(Base 1964-65=100)
Percent
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
West Pakistan
Punjab
Sind
N.W.F.P.
Baluchistan
1947-48
48-49
49-50
50-51
51-52
52-53
53-54
54-55
55-56
56-57
57-58
58-59
59-60
60-61
61-62
62-63
63-64
1964-65
65-66
66-67
67-68
68-69
69-70
70-71
1971-72
YEARS


FIG. 1 (*b*)

Production indices of wheat (base year 1964-65) show similar trends, but the range is greater. The lowest index of 52.3 for West Pakistan occurs in the year of lowest acreage, that is 1952-53. During the period after 1964-65, the upward trend reaches an index of 158.8 in West Pakistan in 1969-70, 157.9 in Punjab during 1969-70 and 202.7 in Sind during 1970-71.

A comparative study of the indices of wheat acreage and production indicates not only the general progressive trend but also an increasing tendency towards intensive wheat culture, with higher production per unit area in Punjab and Sind.

The coefficient of variability of wheat acreage and production in irrigated and unirrigated lands have been calculated for a few selected districts of Punjab (Table 4). It clearly establishes that variability coefficient for *barani* wheat acreage is high in districts with a small ratio of unirrigated acreage. It is very high in Multan and Lyallpur being 41.2 and 31.7 respectively. In districts with large *barani* wheat acreage the variability coefficient is fairly low, being only 6.7 and 4.3 in Campbellpur and Jhelum districts respectively.

TABLE 4—COEFFICIENT OF VARIABILITY OF WHEAT ACREAGE AND PRODUCTION IN SOME SELECTED DISTRICTS OF WEST PAKISTAN

| District | Acreage | | Production | |
|---|---|---|---|---|
| | *% Irrigated* | *% Unirrigated* | *% Irrigated* | *% Unirrigated* |
| Campbellpur | 20.4 | 6.7 | 20.0 | 35.5 |
| Jhelum | 12.4 | 4.3 | 16.0 | 26.4 |
| Sargodha | 7.8 | 15.6 | 24.8 | 32.1 |
| Jhang | 9.3 | 28.0 | 22.3 | 38.6 |
| Lyallpur | 6.8 | 31.7 | 19.4 | 40.4 |
| Multan | 6.8 | 41.2 | 18.4 | 37.3 |
| Sahiwal | 8.4 | 27.6 | 21.88 | 47.0 |

SOURCE: As in Table 1. Note : Co-eff of variability

$$CV = \frac{\sigma}{X} \times 100$$

Similarly in case of production, in districts with a small share in unirrigated wheat acreage, *barani* production shows high-variability, ranging from 47.0 in Sahiwal to 32.1 in Sargodha. Irrigated wheat on the whole shows relatively much less variability in production than the *barani* wheat but the absolute figures of coefficient are fairly high ranging between 16.0 to 24.8 in Jhelum and Sargodha respectively.

(Fig. 2). From the figures in Table 4 it is further indicated that *a*) the acreage under *barani* wheat is less affected by the moisture conditions in the pre-sowing and sowing period, *b*) production on the other hand seems to be more directly affected by the water supply conditions (rainfall and irrigation) during the growing season. These deductions from Table 4 are in agreement with the findings of S. K. Qureshi.[2] He has worked out correlations of wheat acreage and production with rainfall during the pre-sowing, sowing and growth periods for *barani* areas. The acreage elasticity with respect to each period is in direct proportion to the amount of rainfall. Elasticities of acreage related to the pre-sowing and sowing period rainfall are much lower than elasticities of production related to the rainfall during the growing period.[3]

About 26.3 percent of the total area under wheat in West Pakistan entirely depends on rainfall. In Baluchistan and N.-W.F.P. *barani* wheat acreage amounts to 47.8 and 60.3 percent of the total wheat area respectively. In the Punjab province most of the *barani* wheat acreage is in the Potwar region of Campbellpur, Rawalpindi and Jhelum districts, where as much as 95.2 percent of the wheat acreage is *barani*. This region of Potwar has 11.7 percent of the total wheat acreage of West Pakistan. The substantial contribution of wheat production from the *barani* sector with its high variability, therefore, needs to be stabilized through improved wheat culture.

The distribution of wheat acreage is shown in Fig. 3. It brings out that wheat is a widely distributed crop all over the cultivated land in the country. The degree of concentration, however, varies widely, depending on the environmental conditions.

Among the provinces, highest concentration is in Punjab, which shares 73.4 percent of the wheat acreage and 76.4 percent of wheat production of West Pakistan (Fig. 4, Table 5). In this province the areas of relatively higher concentration are parts of Potwar and the canal irrigated districts of central Punjab. Almost all the districts of the province show the ratio of wheat acreage to total cropped area above thirty percent. The highest concentration of acreage is in Potwar where the ratio in all the *tehsils*, except Murree, remains above forty. In Potwar highest ratio is in Campbellpur district where all the *tehsils* have more than fifty percent of the cropped area under wheat, while in Talagang *tehsil* the ratio is as high as seventy-five percent. In these areas in spite of almost no irrigation facilities and bad land topography, the ratio is high due to no competition in *rabi* with any other crop. In the canal irrigated districts of the Punjab, other *rabi* crops compete for land and water and some of the *kharif* crops like cotton and sugarcane still occupy land at the time of wheat sowings. The ratio of area under wheat, therefore, in most of the irrigated districts varies between thirty to forty percent of the total cropped area.

COEFFICIENT VARIABILITY OF WHEAT ACREAGE AND PRODUCTION, by selected districts of the Punjab

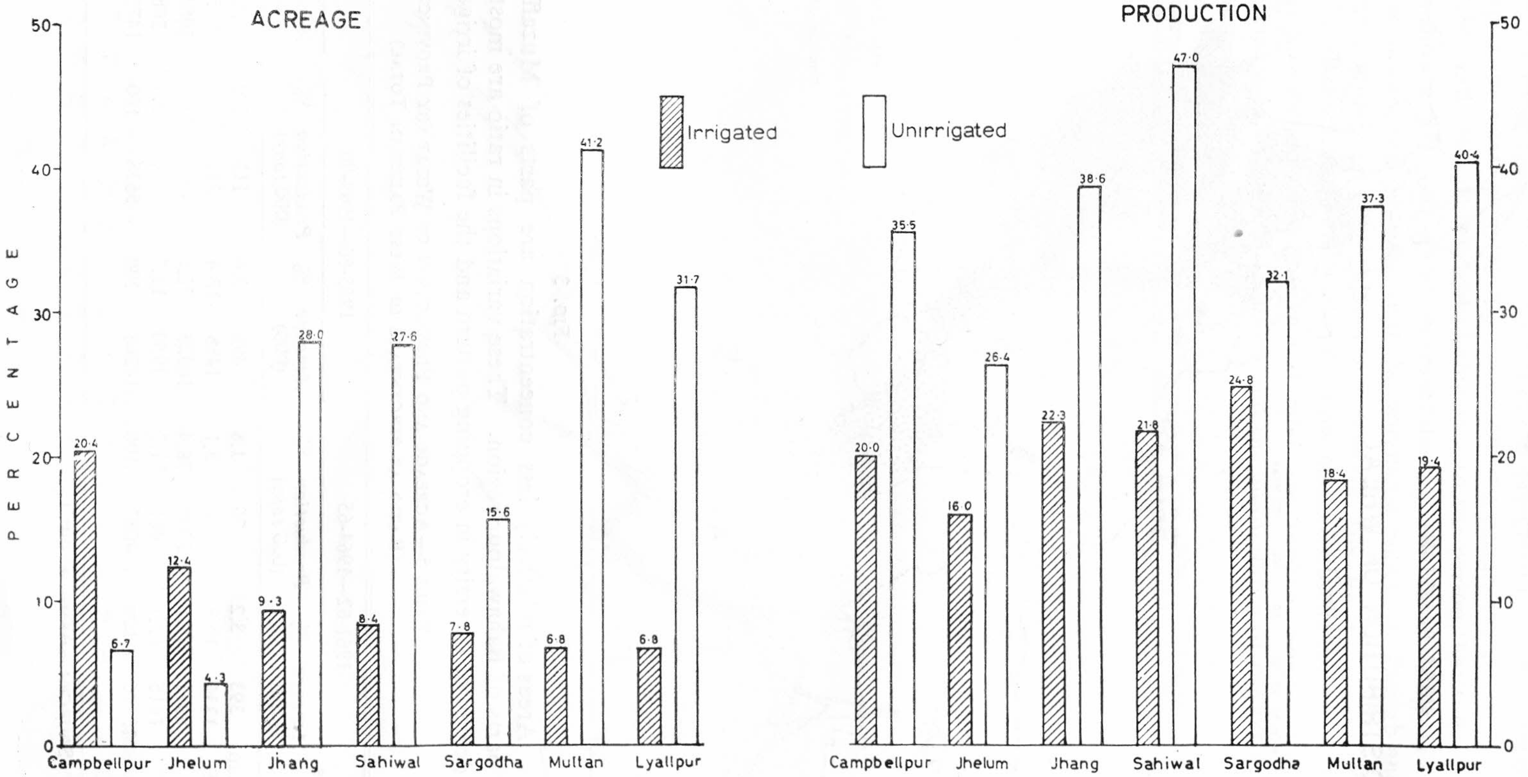



FIG. 2

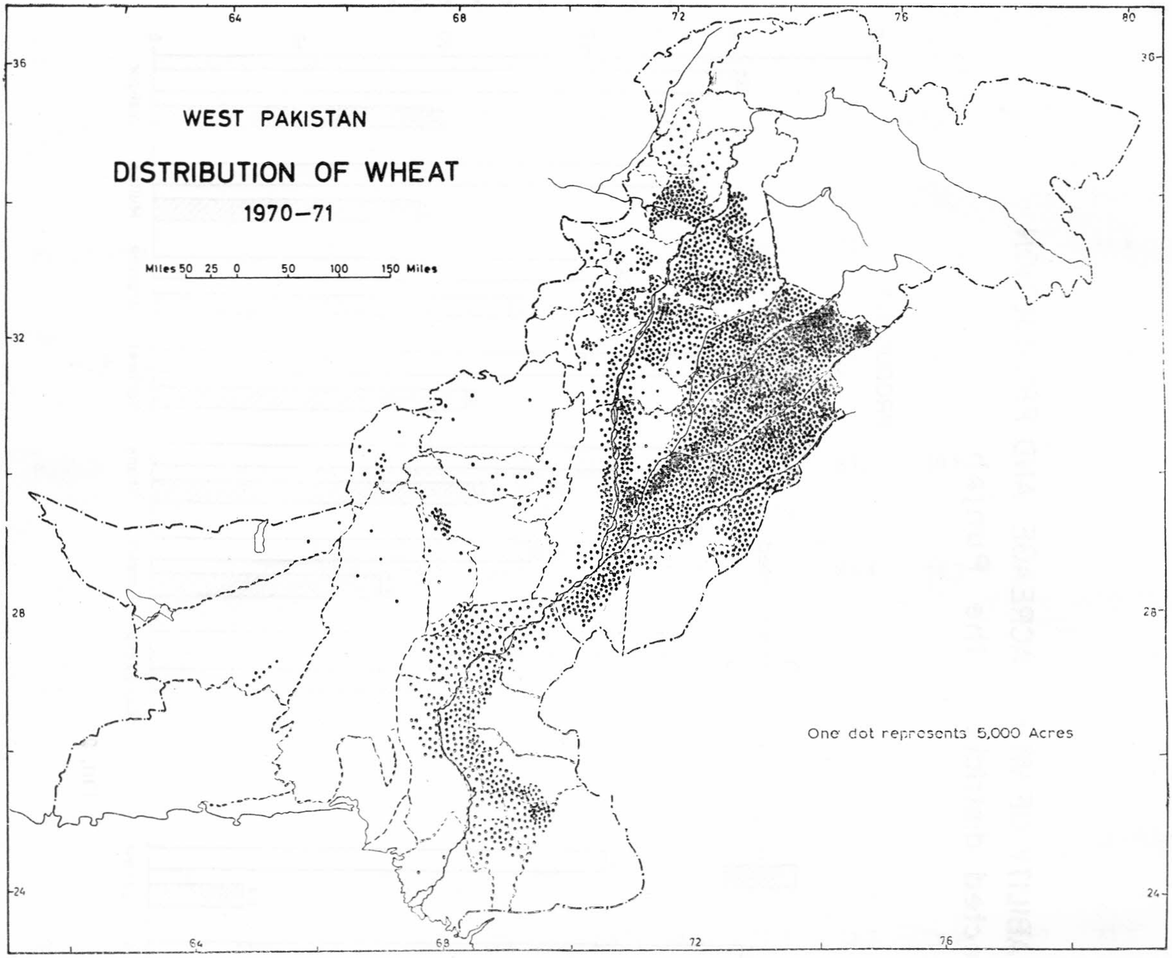



FIG. 3

Areas of relatively less concentration are parts of Muzaffargarh, Sargodha and parts of Bahawalpur region. These variations in ratio are mostly associated with the degree of diversity in cropping pattern and the facilities of irrigation water.

TABLE 5—ACREAGE AND PRODUCTION OF WHEAT (BY PROVINCES)
(RATIO AS PERCENTAGE OF WEST PAKISTAN TOTAL)

| Provinces | 1961-62—1964-65 | | | | 1965-66—1969-70 | | | | 1970-71 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Acreage* (000) | % | *Production* (000 *tons*) | % | *Acreage* (000) | % | *Production* (000 *tons*) | % | *Acreage* (000) | % | *Production* (000 *tons*) | % |
| Baluchistan | 393 | 3.2 | 76 | 1.8 | 496 | 3.4 | 113 | 2.0 | 398 | 2.7 | 75 | 1.2 |
| N.-W.F.P. | 1336 | 10.9 | 332 | 8.1 | 1488 | 10.4 | 346 | 6.2 | 1457 | 9.8 | 326 | 5.1 |
| Punjab | 8971 | 72.8 | 3208 | 78.4 | 10323 | 72.5 | 4396 | 78.1 | 10847 | 73.4 | 4870 | 76.4 |
| Sind | 1616 | 13.1 | 481 | 11.7 | 1959 | 13.7 | 771 | 13.7 | 2069 | 14.1 | 1103 | 17.3 |
| West Pakistan | 12316 | 100 | 4087 | 100 | 14268 | 100 | 5626 | 100 | 14771 | 100 | 6374 | 100 |

SOURCE : As in Table 1.

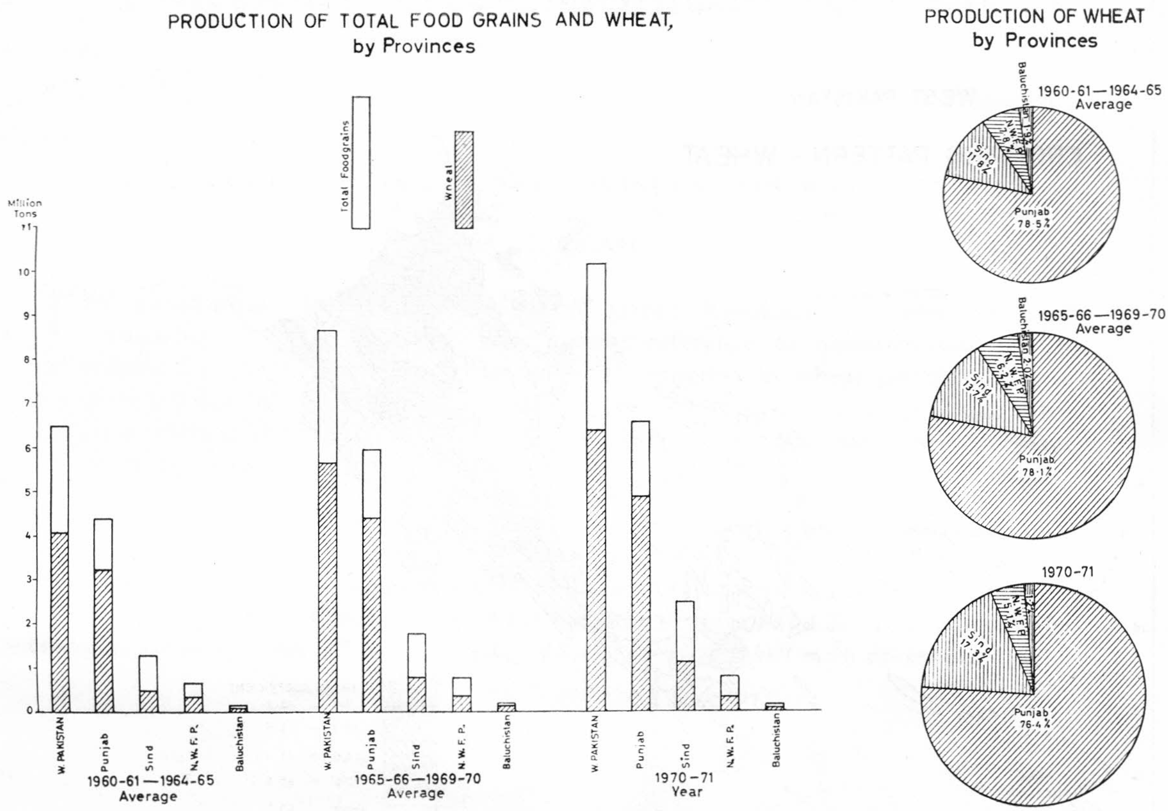
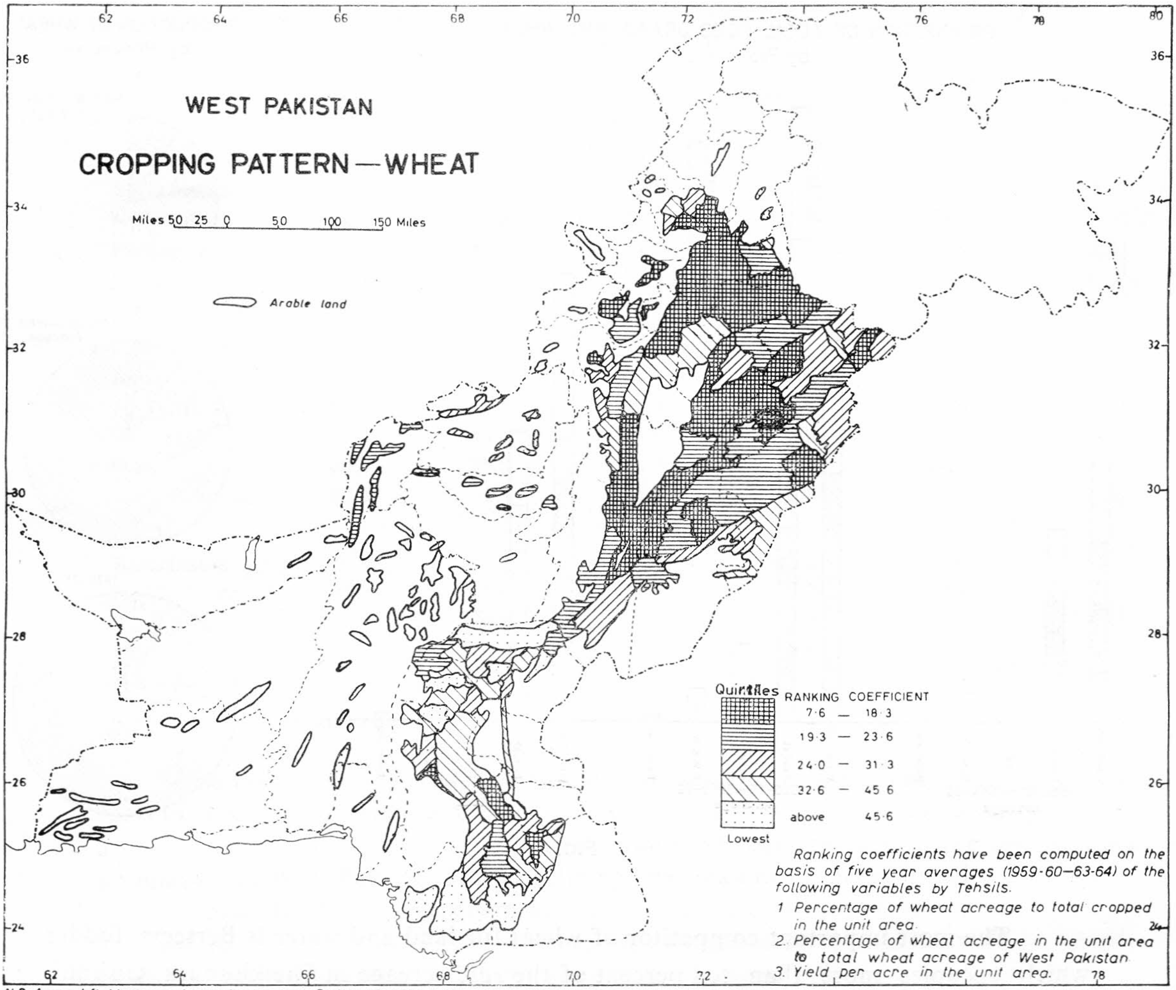



FIG. 4

The most important competitor of wheat for land and water is Berseem fodder which occupies more than ten percent of the *rabi* acreage in Sheikhupura, Gujranwala, Sialkot, Lyallpur, Lahore, Sargodha, Jhang, Sahiwal, and Multan districts.

Sind province shares 14.1 percent and 17.3 percent of the acreage and production of wheat in West Pakistan respectively. The overall distributional pattern in this province shows much less concentration of wheat acreage as compared to Punjab. The ratio of area under wheat in various districts of Sind ranges between two percent in Thatta to 33.7 percent in Hyderabad. The districts with higher ratio than twenty are Sukkur, Larkana, Nawabshah, Khairpur, Sanghar, and Hyderabad.

In N.W.F.P. relatively higher ratio of wheat acreage occurs mostly in *barani*. areas, where it is above fifty percent. Peshawar and Mardan have less than forty percent of the cropped area under wheat. These areas with better irrigation facilities have large acreage under sugarcane which remains in the ground for almost all the year and limits the land available for wheat in *rabi*.




N.B. Areas left blank represent uncultivated land. Pockets of arable land shown on the map are not shaded for want of data.

FIG. 5

Cropping pattern of wheat shown in Fig. 5 brings the relative importance of wheat on the basis of triple criteria* taking *tehsil* as unit area. It brings out two prominent areas of wheat production in West Pakistan, which principally lie in upper Indus basin in the province of Punjab :

1) Potwar and the adjacent area, including parts of Mardan and Peshawar districts.

2) Irrigated areas in Jhang, Sargodha, Multan, Lyallpur, Sahiwal, Muzaffargarh and D. G. Khan districts.

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* Criteria are :

(*a*) Ratio of area under wheat to total cropped in the unit area.

(*b*) Ratio of area under wheat to total area under wheat in West Pakistan.

(*c*) Production of wheat per acre in the unit area.

Potwar and the adjacent parts of Mardan and Peshawar districts form the top wheat producing region of the north. This submontane region, mostly a *barani* wheat area, with rainfall of about six inches during the growing period of wheat (November-April) is well suited for its cultivation.

The irrigated areas with fertile alluvial soils and well developed canal irrigation system have higher yields of wheat per acre. These areas are the most productive wheat areas of West Pakistan.

A few *teshils* of Nawabshah, Tharparker and Hyderabad districts of Sind fall in the first and second grade wheat areas.

The above widespread distributional pattern of wheat indicates that the problem is not so much of areal extent as of increasing the intensity of cultivation, through adequate manuring and water supply.

Output of wheat per unit area in West Pakistan shows slight fluctuations, with no marked improvement during the pre-green revolution period. The range of yield had been between 10.2 maunds per acre in 1948-49 to 6.9 in 1952-53. The green revolution with the introduction of new improved varieties of wheat has led to a rise in per acre yields by about 2.4 maunds in West Pakistan. Yields of improved varieties, which occupied forty-two percent of the wheat acreage in 1969-70, range between 20—25 maunds per acre.

The indices of wheat yields on the basis of 1964-65 yields as one hundred for West Pakistan and some selected districts are shown in Table 6. The difference in yields of wheat between the irrigated and unirrigated are well marked. The districts of Jhelum and Campbellpur show fluctuating low indices. The canal irrigated districts of Sargodha, Lyallpur, Sahiwal and Multan representatives of best wheat lands of West Pakistan, show a marked upward trend in indices (Fig. 6). In Sind, the most marked rise has been portrayed by the districts of Nawabshah, Hyderabad and Tharparker, where indices of yields have reached between 180—197.5 during 1969-70 and 1970-71. In spite of the greater rise in indices in these districts of Sind, average yields of wheat are somewhat lower than the best products of Punjab, Sahiwal and Multan.

The average yields of wheat in West Pakistan are lower than the yields in some extensive wheat producing countries of the world.[5] The assessment of progress in terms of production per unit area is an important aspect of green revolution. But the overall progress in area and production becomes more meaningful when judged from the point of view of per capita availability of food grains in general and wheat in particular.

TABLE 6—INDICES OF WHEAT YIELDS PER ACRE (IN MAUNDS) 1964-65 TO 1970-71

Base Year 1964-65 = 100

| Selected districts | 1964-65 | 1965-66 | | 1966-67 | | 1967-68 | | 1968-69 | | 1969-70 | | 1970-71 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Yield per acre | Yield per acre | % age deviation | Yield per acre | % age deviation | Yield per acre | % age deviation | Yield per acre | % age deviation | Yield per acre | % age deviation | Yield per acre | % age deviation |
| Mardan ... | 8.0 | 6.1 | 76.2 | 6.1 | 76.2 | 8.1 | 101.2 | 9.6 | 120.0 | 8.5 | 106.2 | 6.9 | 86.2 |
| Campbellpur ... | 5.2 | 3.1 | 59.6 | 2.2 | 42.3 | 6.3 | 121.1 | 4.4 | 84.6 | 4.7 | 90.3 | 3.9 | 75.0 |
| Jhelum ... | 5.5 | 3.3 | 60.0 | 3.3 | 60.0 | 6.3 | 124.5 | 5.8 | 106.4 | 5,0 | 90.9 | 4.4 | 80.0 |
| Sargodha ... | 10.4 | 9.1 | 87.5 | 9.2 | 88.4 | 14.8 | 142.3 | 14.5 | 139.4 | 15.9 | 152.8 | 12.3 | 118.2 |
| Lyallpur ... | 15.2 | 12.6 | 82.8 | 14.8 | 97.4 | 18.3 | 120.3 | 18.9 | 124.3 | 20.3 | 133.5 | 15.9 | 104.6 |
| Sahiwal ... | 13.7 | 11.8 | 86.1 | 14.5 | 105.8 | 18.3 | 133.5 | 18.3 | 133.5 | 19.7 | 143.7 | 18.9 | 137.9 |
| Multan ... | 13.7 | 12 3 | 89.7 | 15.1 | 110.2 | 18.6 | 135.7 | 17.8 | 129.9 | 18.9 | 137.9 | 17.5 | 127.7 |
| Nawabshah ... | 8.8 | 7.7 | 87.5 | 7.7 | 87.5 | 11.8 | 134.0 | 13.4 | 152.2 | 15.9 | 180.6 | 16.7 | 189.7 |
| Hyderabad ... | 8.2 | 8.2 | 100 0 | 8.9 | 108.5 | 11.8 | 143.9 | 13.2 | 160.9 | 15.3 | 186.5 | 14.8 | 180.4 |
| Tharparkar ... | 8.2 | 8.8 | 107.3 | 5.0 | 60.9 | 12.3 | 150.0 | 10.4 | 126.8 | 14.8 | 180.4 | 16.2 | 197,5 |

SOURCE: *Season and Crop Report of West Pakistan*, 1965-66 to 1967-68, and *Year Books of Agricultural Statistics*, 1969 and 1971-72, Government of Pakistan, Islamabad.

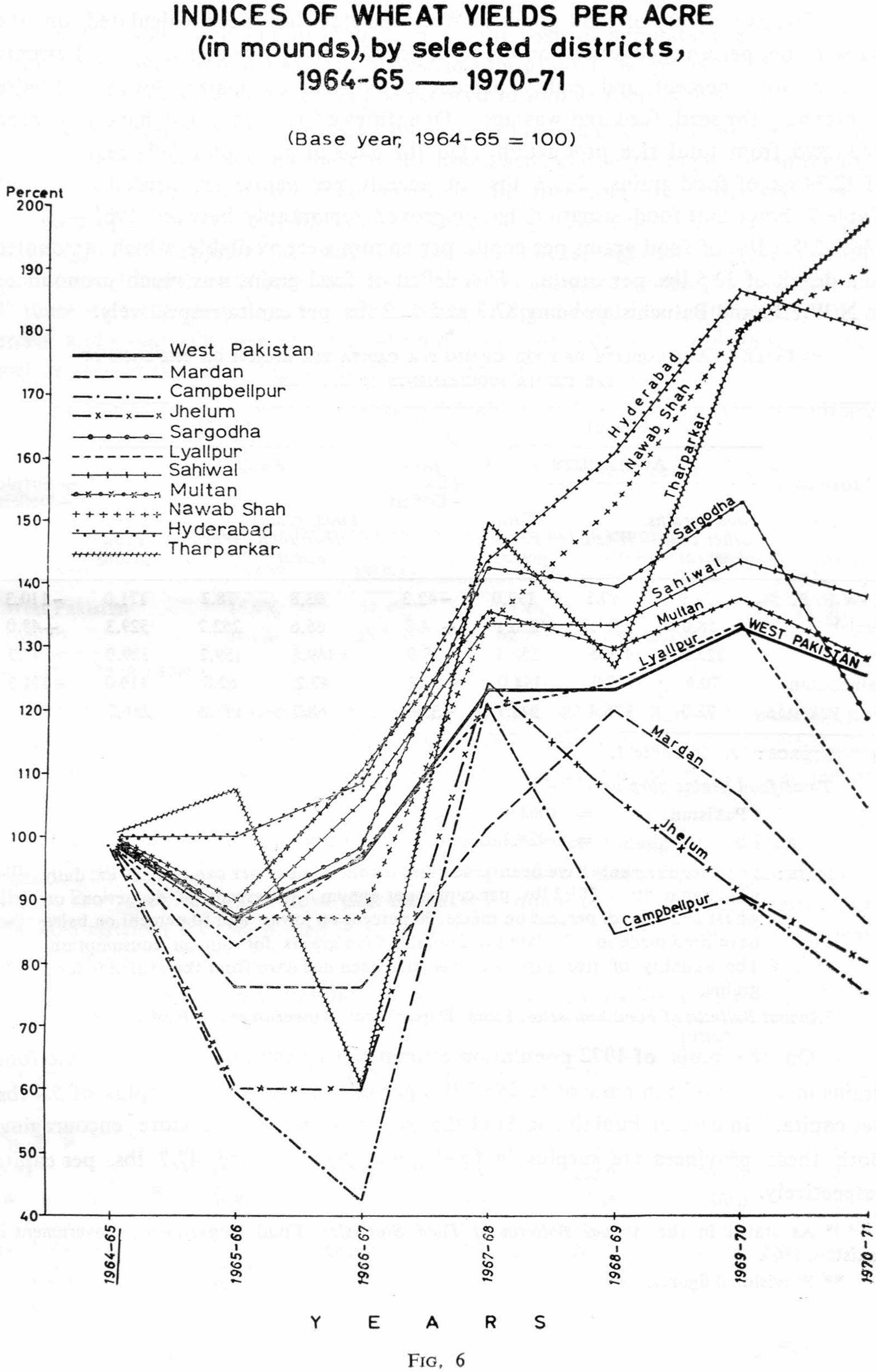
INDICES OF WHEAT YIELDS PER ACRE
(in mounds), by selected districts,
1964-65 — 1970-71
(Base year, 1964-65 = 100)
Percent
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
West Pakistan
Mardan
Campbellpur
Jhelum
Sargodha
Lyallpur
Sahiwal
Multan
Nawab Shah
Hyderabad
Tharparkar
Hyderabad
Nawab Shah
Tharparkar
Sargodha
Sahiwal
Multan
WEST PAKISTAN
Lyallpur
Mardan
Jhelum
Campbellpur
1964-65
1965-66
1966-67
1967-68
1968-69
1969-70
1970-71
YEARS

FIG. 6

The availability of food grains in West Pakistan has been calculated on the basis of ten percent deductions on the total production of rice and wheat and twenty percent, fifty percent and eighty percent deductions on maize, jowar and bajra respectively for seed, feed and wastage. Quantities of rice exported have also been deducted from total rice production. On the basis of per capita daily requirements of 12.34 oz. of food grains, 281.3 lbs. of cereals per capita are needed annually.* Table 7 shows that food situation has improved remarkably between 1961—72. In 1961, 248.7 lbs. of food grains per capita per annum were available which amounted to a deficit of 32.6 lbs. per capita. This deficit of food grains was much pronounced in N.W.F.P. and Baluchistan being 87.3 and 42.3 lbs. per capita respectively.

TABLE 7—AVAILABILITY OF FOOD GRAINS PER CAPITA PER ANNUM ON THE BASIS OF PER CAPITA REQUIREMENTS OF 281.3 LBS.

| Province | 1960-61 Availability | | | +Surplus -Deficit | 1971-72 Availability | | | + Surplus -Deficit |
|---|---|---|---|---|---|---|---|---|
| | *Food grains other than wheat* | *Wheat* | *Total Food grains* | | *Food grains other than wheat* | *Wheat* | *Total Food grains* | |
| N.-W.F. P. | 58 9 | 80.1 | 139.0 | -42.3 | 93.8 | 78.2 | 171.0 | -110.3 |
| Punjab | 58.0 | 228.1 | 286.1 | + 4.8 | 66.6 | 262.7 | 329.3 | +48.0 |
| Sind | 125.9 | 126.5 | 252.4 | -28.9 | 169.8 | 159.2 | 329.0 | +47.7 |
| Baluchistan | 70.1 | 123.9 | 194.0 | -87.3 | 47.2 | 62.8 | 110.0 | -171.3 |
| West Pakistan | 72.0 | 176.4 | 248.7 | -32.6 | 88.7 | 198.0 | 286.7 | +5.4 |

SOURCE: As in Table 1.

*Total food grains surplus* 1970-71

West Pakistan = 1008.9 th. tons

Punjab = 926.2 th. tons

NOTE: Food requirements have been calculated on the basis of per capita 12.34 oz. daily which amounts to 281.3 lbs. per capita per annum,* 10 percent of deductions on wheat and rice, 20 percent on maize, 50 percent on jowar and 80 percent on bajra have been made to calculate the available food grains for human consumption. The quantity of rice exported has also been deducted from the available food grains.

**Annual Bulletin of Food Statistics*, Food Department, Government of Pakistan, 1966.

On the basis of 1972 population estimates (64.8 million)** the available food grains in West Pakistan amount to 286.7 lbs. per capita, leaving a surplus of 5.4 lbs. per capita. In case of Punjab and Sind the situation is all the more encouraging. Both these provinces are surplus in food grains by 48.0 and 47.7 lbs. per capita respectively.

* As stated in the *Annual Bulletin of Food Statistics*, Food Department, Government of Pakistan, 1966.

** Provisional figures.

The overall surplus in all food grains on the basis of population estimates for 1972 (64.8 million) amounts to 157.2 thousand tons of all food grains. On the basis of the above results, there appears to be no need to import food grains.[6]

As has been seen from the preceding quantitative analysis, the progress in the production level of wheat has been well marked after the beginning of green revolution, but still better results could be achieved. Improvements in agriculture are a continuous process in terms of inputs and outputs. The efficiency of land, labour, manuring, water supply, new varieties and techniques, agricultural research and organisational and institutional changes all contribute towards higher production level. Of these factors, manuring and water supply respectively contribute about fifteen percent and twenty-five percent of total production per unit area and thus are the most important factors in the production process, after labour.[7]

Improved wheat varieties Maxi, Chenab 70, SA 42 and Chenab Barani are much too sensitive to the input factors of manuring and water supply for optimum returns. The ratio of acreage under improved varieties has been increasing fast in recent years :

TABLE 8—RATIO OF MAXI TO TOTAL WHEAT ACREAGE

| Area | 1967-68 | 1968-69 | 1969-70 | 1970-71 | 1971-72 |
|---|---|---|---|---|---|
| West Pakistan | 15.9% | 38.4% | 43 4% | N. A. | N. A. |
| Punjab | 27.1% | 56.5% | 62.9% | 68.0% | 71.5% |

SOURCE : As in Table 1.

The latest new varieties of Chenab 70, SA 42 and Barani 70 have shown encouraging results. The new varieties when given suitable dosage of fertilizers give optimum results only in accompaniment with proper quantities of water, supplied at proper timings.

The use of fertilizers in West Pakistan has increased during the last five years from 2.3 nutrient lbs. to fifteen nutrient lbs. per acre for all crops (Tables 9 (a) & 9 (b) ). Provincewise figures show that the largest quantities of fertilizers per unit area, 20.3 nutrient lbs., were used in Sind in 1970-71. Punjab used only 14.9 nutrient lbs. per acre.

TABLE 9(*a*)—CONSUMPTION OF CHEMICAL FERTILIZERS (NUTRIENT LBS/ACRES) WEST PAKISTAN

| Provinces | 1965-66 | | | 1970-71 | | |
|---|---|---|---|---|---|---|
| | Total (000 tons) | Total cropped area (000 acres) | Lbs/acre | Total (000 tons) | Total cropped area (000 acres) | Lbs/acre |
| N.-W. F. P. | 4.2 | 3170 | 2.9 | 18.9 | 3840 | 11.0 |
| Punjab | 52.9 | 25330 | 4.6 | 187.0 | 28110 | 14.9 |
| Sind | 14.2 | 8400 | 3.7 | 82.5 | 9080 | 20.3 |
| Baluchistan | 0.2 | 1760 | 0.2 | 0.7 | 980 | 1.6 |
| West Pakistan | 71.5 | 68200 | 2.3 | 289.1 | 42900 | 15.0 |

SOURCE: As in Table 1.

TABLE 9(*b*)—CONSUMPTION OF NUTRIENTS IN SOME SELECTED COUNTRIES OF THE WORLD

| Country | Lbs/acres |
|---|---|
| Netherland | 556 |
| Japan | 361 |
| China | 270 |
| France | 182 |
| U. A. R. | 102 |
| U. S. A. | 70 |
| Turkey | 31 |
| India | 9 |
| Iran | 6 |
| Pakistan | 15* |

**Year Book of Agricultural Statistics, 1971-72*, Government of Pakistan, Islamabad.

SOURCE : *F. A. O. Production Year Book*, 1970.

Experiments of application of various chemical fertilizers to wheat at various agricultural experimental stations are being carried out. Some of the results show that the best response to the nitrogenous fertilizers was in combination with phosphates. The benefit-cost ratio in cases of application of 90-60-0 to 150-90-0 (N.P.K.) nutrient lbs. per acre was above three.[8] The average increase of yields over the normal (20 maunds per acre) was between fifteen to twenty-five maunds.

The timing of the application of fertilizers is also important. Application of fertilizers half at the time of sowing and half with the first irrigation have shown satisfactory results. However no strictly fixed doses could be recommended for all areas. For the economic use of fertilizers, optimum economic dose has to be worked out for every region.

Field studies of land use carried out from time to time have often revealed that the failures of crops is more often due to deficiencies of water supply than any other factor. West Pakistan with a large portion of its area in arid and semi-arid regions, shows moisture deficiencies all over the country. The region of maximum deficiency lies in Sibi, Jacobabad, Sukkur and Khairpur areas.[9] Irrigation water has compensated for the moisture deficiencies to some extent. Increased, regular and timely water supply is one of the most important problems facing agriculture in West Pakistan.

To solve the problem of water supply for wheat crop the consumptive use of water for the crop during its growing period has been calculated for twenty representative stations in Punjab. These values of water requirements are calculated on the basis of Blaney and Criddle formula.

The Blaney and Criddle formula mathematically expressed as :

$$U = KF$$

Where U = consumptive use of crop in inches for a given time period

F = sum of the monthly consumptive use factor for the period

K = empirical co-efficient of the irrigation season on growing season.

For monthly calculations lower case letters are frequently used for clarity as follows :

$f$ = monthly consumptive use factors $= \frac{t \times p}{100}$

$k$ = monthly co-efficient $= \frac{u}{f}$

$u$ = kf monthly consumptive use

The mean monthly temperature (t) values have been obtained from the Central Meteorological Department, Karachi. Normals of temperature used herein are for the three previous decades (1931—60).

P denotes the daylight hours of the month expressed as percentage of the total daylight hours of the year. As the daylight hours are characteristic of a particular latitude, they have been taken from the standard tables.[10]

Co-efficient $k$ values for the different crops developed by Blaney and Criddle from the results of the Pecos[11] river investigation are redeveloped, taking into consideration the climatic condition and the growing season of various crops in this region. Co-efficient $k$ values for different crops are worked out by the method given by Blaney and Ewing[12] as $\frac{u}{f} = k$

$u$ = monthly consumptive water requirements data *in inches of depth* for each crop is obtained from the results achieved by the Directorate of Land Reclamation,[13] West Pakistan, at Lahore from the lysimeter experiments and the researches undertaken at Lyallpur by the Agronomy Department of Punjab Agriculture College from 1909—1959.[14]

The monthly consumptive use factor $f$ is computed from the local climatological data. The monthly crop co-efficient values $k$ are determined by dividing the observed consumptive use $u$ for the given month by the corresponding value of $f$.

$$k = \frac{\text{observed consumptive use for the given month}}{\text{consumptive use factor of the same month}} = \text{co-efficient.}$$

The values arrived at in Table 10 differ from the earlier works done in Pakistan in following respects :

*a*) Mean annual temperature figures utilised are the latest normals for the period (1931—60);

*b*) Only effective precipitation is used instead of total precipitation;

*c*) Monthly water requirements for wheat are calculated and then added to obtain the results for the whole growing period;

*d*) Consumptive use of water is calculated for the improved varieties of wheat.

TABLE 10—WATER SUPPLY IN CANAL

| Name of Canal | Representative station | 1965-66 | | | 1966-67 | | | 1967-68 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | W. S. | W.R.W. | D/E | W. S. | W.R.W. | D/E | W. S. | W.R.W. | D/E |
| 1. U. C. C. ... | Gujranwala Sheikhupura* | 20.45 | 16.80 | +3.65 | 18.33 | 16.80 | +1.53 | 14.55 | 16.80 | −2.25 |
| 2. C.B. D. C. ... | Lahore ... | 18.28 | 16.86 | +1.42 | 11.56 | 16.86 | −5.30 | 16.68 | 16.86 | −0.18 |
| 3. Dipalpur C ... | Dipalpur* ... | 9.37 | 16.86 | −7.49 | 8.11 | 16.86 | −8.75 | 7.95 | 16.86 | −8.91 |
| 4. L. J. C. ... | Sargodha ... | 14.26 | 16.49 | −2.23 | 15.81 | 16.49 | −0.68 | 16.53 | 16.49 | +0.4 |
| 5. U. J. C. ... | Jhelum ... | 15.76 | 16.40 | −0.64 | 15.99 | 16.40 | −0.41 | 15.91 | 16.40 | −0.49 |
| 6. L. C. C. ... | Lyallpur ... | 15.72 | 16.86 | −1.14 | 12.86 | 16.86 | −4.00 | 13.7 | 16.86 | −3.16 |
| 7. L. B. D. L. ... | Sahiwal ... | 12.69 | 17.16 | −4.47 | 16.13 | 17.16 | −1.03 | 17.98 | 17.16 | +0.85 |
| 8. Haveli Sidhnai | Multan ... | 9.75 | 17.63 | −7.88 | 9.75 | 17.63 | −7.88 | 15.88 | 17.63 | −1.95 |
| 9. Rangpur C ... | Ahmadpur Syal* | 8.40 | 17.50 | −9.10 | 9.93 | 17.50 | −7.57 | 18.87 | 17.50 | +1.37 |
| 10. Thal C ... | Leiah ... | 19.40 | 17.20 | +2.20 | 24.21 | 17.20 | +7.01 | 19.67 | 17.20 | +2.49 |
| 11. D. G. Khan C | D. G. Khan ... | 13.75 | 17.70 | −3.95 | 10.63 | 17.70 | −7.00 | 20.98 | 17.70 | +3.28 |
| 12. Muzaffargarh C | Muzaffargarh | 10.33 | 17.70 | −7.37 | 15.93 | 17.70 | −1.77 | 18.82 | 17.70 | +1.12 |
| 13. Pakpattan C ... | Pakpattan* ... | 11.43 | 17.16 | −5.73 | 9.13 | 17.16 | −8.03 | 17.65 | 17.16 | +0.49 |
| 14. E. Sadiq ... | Fort Abbas ... | 11.88 | 17.70 | −5.82 | 13.26 | 17.70 | −4.44 | 9.91 | 17.70 | −7.79 |
| 15. Qaim C ... | Qaimpur* ... | 1.50 | 17.50 | −16.00 | 7.76 | 17.50 | −9.74 | 12.57 | 17.50 | −4.99 |
| | | No supply of C. W. | | | | | | | | |
| 16. Fordwah C ... | Bahawalnagar | 3.70 | 17.50 | −13.80 | 5.13 | 17.50 | −12.37 | 10.31 | 17.50 | −7.19 |
| 17. Mailsi C ... | Mailsi* ... | 2.52 | 17.63 | −15.11 | 6.73 | 17.63 | −10.90 | 18.27 | 17.63 | +0.64 |
| 18. Bahawal C ... | Bahawalpur ... | 3.23 | 17.60 | −14.37 | 9.29 | 17.60 | −8.31 | 20.13 | 17.60 | +2.53 |
| 19. Panjnad C ... | Rahimyar Khan | 7.73 | 18.10 | −10.37 | 12.00 | 18.10 | −6.10 | 16.29 | 18.10 | −1.81 |
| 20. Abbasia C ... | Khanpur ... | 4.01 | 18.00 | −13.99 | 15.35 | 18.00 | −2.65 | 17.61 | 18.00 | −1.39 |

SOURCE : *Canal Water Supply (Delta in Rabi) Statistical Data*, Irrigation and Power Department, Government of the Punjab, August, 1970.

COMMANDED AREAS—PUNJAB

| 1968-69 | | | 1969-70 | | | Average of five years | | |
|---|---|---|---|---|---|---|---|---|
| W. S. | W. R. W. | D/E | W. S. | W. R. W. | D/E | W. S. | W. R. W. | D/E. |
| 19.34 | 16.80 | +2.54 | 15.48 | 16.80 | -1.32 | 18.28 | 16.80 | +1.48 |
| 14.75 | 16.86 | -2.11 | 5.58 | 16.88 | -11.28 | 12.97 | 16.86 | -3.89 |
| 12.31 | 16.86 | -4.55 | 8.28 | 16.86 | -8.58 | 9.21 | 16.86 | -7.65 |
| 15.35 | 16.49 | -1.14 | 16.61 | 16.49 | +0.12 | 15.77 | 16.49 | -0.72 |
| 18.36 | 16.40 | +1.96 | 22.80 | 16.40 | - 6.40 | 17.67 | 16.40 | +1.27 |
| 14.04 | 16.86 | -2.77 | 13.87 | 16.86 | -2.99 | 14.04 | 16.86 | -2.82 |
| 16.13 | 17.16 | -1.03 | 22.94 | 17.16 | +5.78 | 17.14 | 17.16 | -0.02 |
| 10.75 | 17.63 | -6.88 | 12.27 | 17.63 | -5.36 | 11.68 | 17.63 | -5.95 |
| 7.59 | 17.50 | -9.91 | 10.71 | 17.50 | -6.79 | 8.05 | 17.50 | -9.45 |
| 20.29 | 17.20 | +3.09 | 18.11 | 17.20 | +0.91 | 21.45 | 17.20 | +4.25 |
| 20.07 | 17.70 | +2.37 | 12.11 | 17.70 | -5.59 | 15.54 | 17.70 | -2.16 |
| 7.59 | 17.70 | -10.11 | 6.81 | 17.70 | -10.89 | 11.88 | 17.70 | -5.82 |
| 14.63 | 17.16 | -2.53 | 13.95 | 17.16 | -3.21 | 13.96 | 17.16 | -3.70 |
| 16.54 | 17.70 | -1.16 | 19.50 | 17.70 | +1.80 | 14.94 | 17.70 | -2.76 |
| 6.96 | 17.50 | -10.54 | 4.69 | 17.50 | -12.81 | 6.72 | 17.50 | -10.78 |
| 12.65 | 17.50 | -4.85 | 8.01 | 17.50 | -9.49 | 8.36 | 17.50 | -9.14 |
| 5.25 | 17.63 | -0.38 | 5.95 | 17.63 | -11.68 | 7.49 | 17.63 | -10.14 |
| 11.71 | 17.60 | -5.89 | 5.70 | 17.60 | -11.90 | 10.38 | 17.60 | -7.22 |
| 8.49 | 18.10 | -9.61 | 9.50 | 18.10 | -8.60 | 10.75 | 18.10 | -7.35 |
| 13.56 | 18.00 | -4.44 | 13.09 | 18.00 | -4.91 | 14.18 | 18.00 | -2.72 |

*Note.*—Stations marked with asterisk bear interpolated figures.

All statistics are in inches depth of water. (*Over the area under the crop*).

W.S. =Water Supply (Canal Water Supply+effective precipitation).

W. R. W.= Water Requirements for Wheat.

D/E = Deficiency/Excess.

Field efficiency as 65% for Bahawalpur and Thal areas, and 70% for all other areas.

(Calculations of water requirements for wheat have been made by Mr Ahmad Nawaz Khan, Research Assistant, Department of Geography, University of the Punjab).

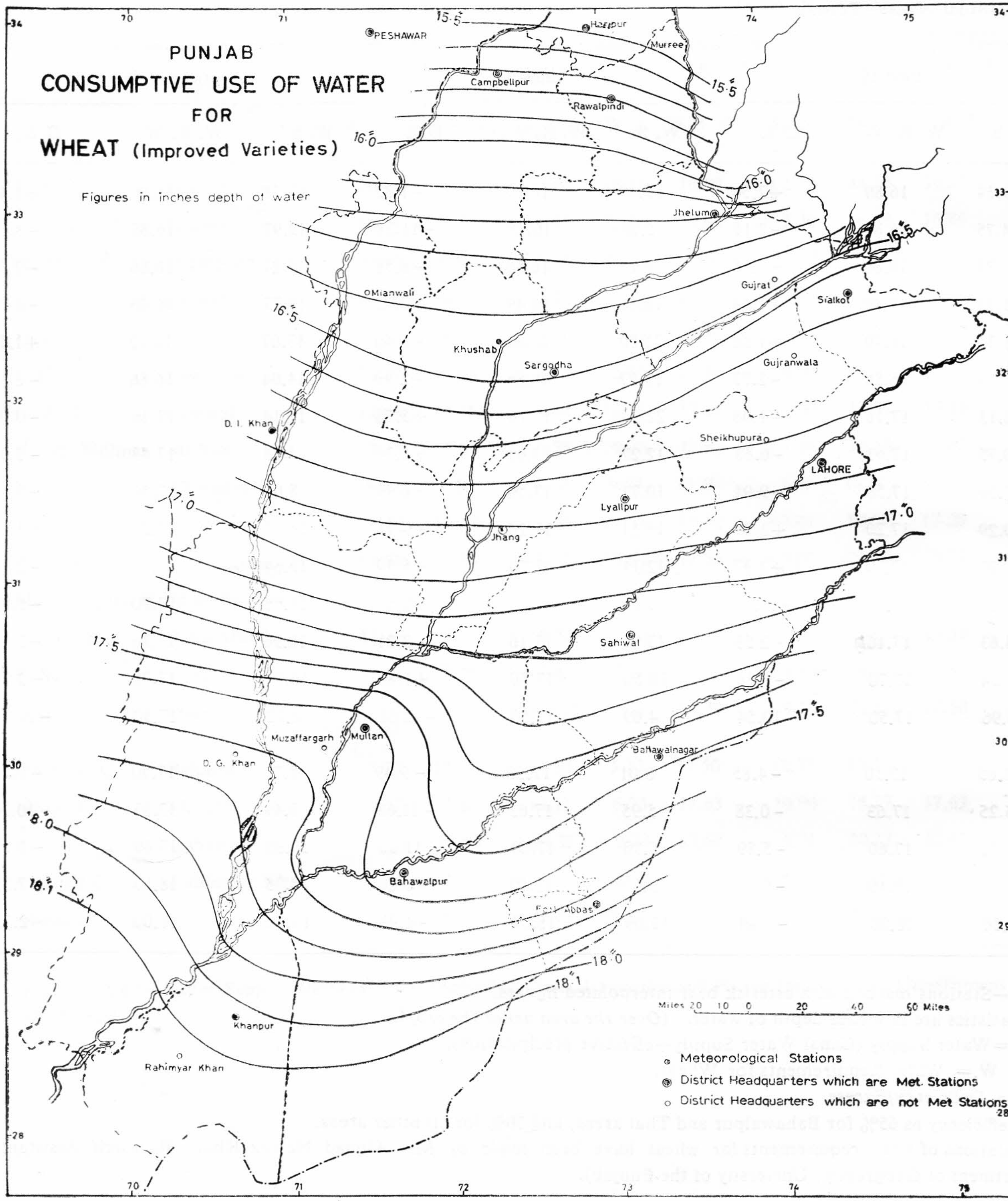
PUNJAB
CONSUMPTIVE USE OF WATER
FOR
WHEAT (Improved Varieties)
Figures in inches depth of water
PESHAWAR
Haripur
Murree
Campbellpur
Rawalpindi
Jhelum
Gujrat
Sialkot
Mianwali
Khushab
Sargodha
Gujranwala
D. I. Khan
Sheikhupura
LAHORE
Lyallpur
Jhang
Sahiwal
Muzaffargarh
Multan
D. G. Khan
Bahawalnagar
Bahawalpur
Fort Abbas
Khanpur
Rahimyar Khan
15.5"
16.0"
16.5"
17.0"
17.5"
18.0"
18.1"
Miles 20 10 0 20 40 60 Miles
Meteorological Stations
District Headquarters which are Met. Stations
District Headquarters which are not Met Stations

FIG. 7

Fig. 7 shows the consumptive use of water for wheat based on the data in Table 10. The isopleths are drawn at an interval of 0.1 inch. The isopleths show an east-west trend in general with a southerly loop in the Bahawalpur region. The values of consumptive use of water for wheat range between 15.5 to 18.10 inches from Jhelum to Rahimyar Khan.

There is an almost constant increase in the water requirements for wheat from the submontane areas of Jhelum and Sialkot towards south and south-west in the more arid regions of Multan, D. G. Khan and Bahawalpur.

In the submontane area of potwar and Sialkot the water requirements are lower than in the Punjab plains. The values in this region range between 15.5 to 16.67 inches. This trend of lower values here, is associated with the higher amount of precipitation and lower temperatures during the growing period of wheat as compared to the Punjab plains.

In middle belt of the Punjab plain the water requirements range between 16.9 to 17.2 inches. Maximum requirements of water for wheat are found in the south-western parts where the range is between 17.3 to 18.1 inches.

This tendency is obviously associated with the increasing aridity and higher temperatures in these areas as compared to the northern parts of the plain.

It is interesting to note that Bahawalpur, as is exhibited from the southerly loop of the isopleths on Fig. 7, shows lower consumptive use of water for wheat than Multan, although the former has a more southerly location. This is due to the lower values of mean temperature for the growing period of wheat, November to April.

Of the various sources of water supply in West Pakistan, canals constitute the most important source accounting for about 72.8 percent of the total irrigated areas. The ratio of canal irrigated area varies among the provinces. It is highest in Sind being 90.2 percent and least in Baluchistan, 49.4 percent. In Punjab canals irrigate 66.9 percent of the total irrigated area. A comparison of area irrigated by different sources in 1961-62 and 1970-71 shows a significant rise in the area irrigated by tube-wells from 2.4 percent to 17.6 percent. Greater change, however, has been in Punjab where tubewells irrigate 24.9 percent of the total irrigated area (Table 11).

TABLE 11—RATIO OF AREA IRRIGATED BY DIFFERENT SOURCES : WEST PAKISTAN AS PERCENTAGE TO TOTAL IRRIGATED

| Area | 1961-62 | | | | | 1970-71 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Canals | Tanks | Wells | Tube-wells | Others | Canals | Tanks | Wells | Tube-wells | Others |
| Baluchistan | 47.3 | ... | 0.3 | ... | 52.2 | 49.4 | ... | 1.1 | 29.9 | 46.6 |
| N.-W. F. P. | 89.8 | 0.1 | 6.4 | 1.5 | 2.1 | 83.9 | 0.1 | 4.4 | 5.4 | 6.2 |
| Punjab | 82.6 | 0.09 | 12.4 | 3.4 | 1.5 | 66.9 | 0.07 | 7.1 | 24.9 | 0.9 |
| Sind | 88.2 | 0.2 | 0.4 | 0.4 | 10.8 | 90.2 | ... | 0.9 | 0.8 | 8.1 |
| West Pakistan | 84.1 | 1.2 | 8.6 | 2.4 | 4.7 | 72.8 | 0.05 | 5.2 | 17.5 | 4.5 |

SOURCE : As in Table 1.

Availability of water for wheat has been calculated on the basis of canal water supplies and effective rainfall during the *rabi* season, for five consecutive years 1965-66—1969-70. Field efficiency of seventy percent has been accepted for all areas, except in Thal and Bahawalpur regions where the efficiency is sixty-five percent.

The values of consumptive use of water for wheat and water supply during *rabi* in each canal commanded area have been plotted in Fig. 8.

A study of the quantities of water supply in each of the commanded area over the period of five years (1965-66—1969-70) reveals :

*a*) In general there is slight improvement in overall water supplies in most of the areas.

*b*) The quantity of water supply varies widely in each of the commanded areas from year to year. The variation ranges from 1:2, 1:3, 1:4, 1:5, and 1:6 in some of the canal commanded areas.

*c*) The variations of water supply over the five years are far greater in the Pakpattan, Muzaffargarh, E. Sadiqia, Fordwah, Mailsi, Bahawal, Abbasi and Panjnad canal commanded areas, being 1:2, 1:2, 1:2, 1:3, 1:6, 1:5, 1:2 and 1:4 respectively.

*d*) Water supplies vary less in the Upper Chenab canal, Upper Jhelum canal, Lower Bari Doab canal, Dera Ghazi Khan canal and Haveli canal areas.

*e*) The least variations of water supplies are in Lower Jhelum canal, Lower Chenab canal and Thal canal areas.

*f*) The overall water supplies in a greater number of cases (12 areas) have been more during 1967-68, while there was a general deficiency during 1965-66.

*g*) The five year average quantities of water supply show that the areas of water supply more than fifteen inches during *rabi* are fed from Chenab, Jhelum, and Indus rivers, namely Upper Chenab canal, Lower Jhelum canal, Upper Jhelum canal, Lower Bari Doab canal (fed by link canals) and Thal canal, areas.

*h*) Areas of very low supplies below ten inches are Dipalpur, Rangpur, Qaim, Fordwah, Mailsi, Bahawal and Panjnad canal areas.

The values of consumptive use of water for wheat and the water supplies during *rabi* have been plotted in Fig. 8.

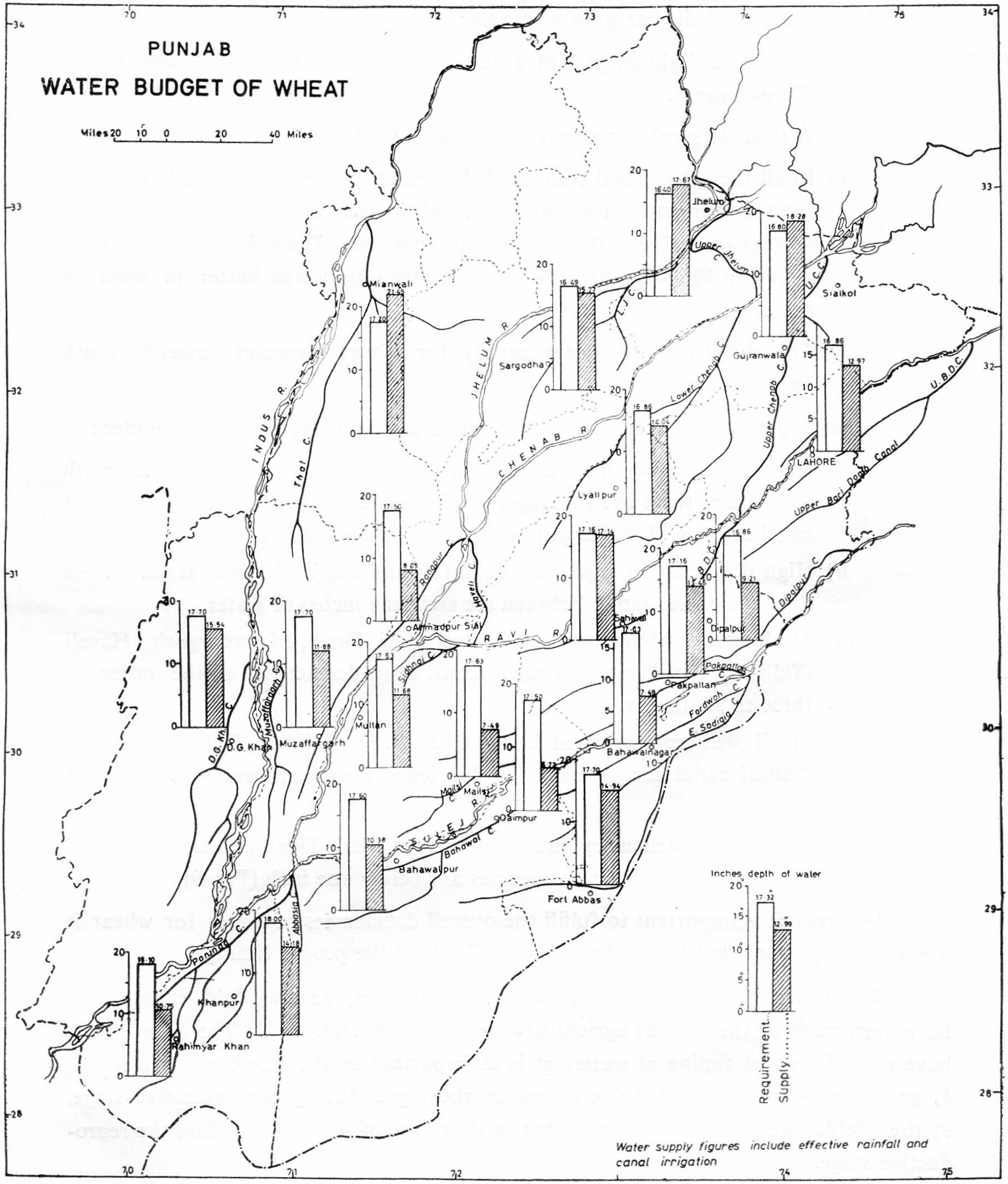
PUNJAB
WATER BUDGET OF WHEAT
Miles 20 10 0 20 40 Miles
Inches depth of water
Requirement.......
Supply.........
Water supply figures include effective rainfall and canal irrigation
Mianwali
Jhelum
Sialkot
Sargodha
Gujranwala
LAHORE
Lyallpur
Ahmadpur Sial
Sahiwal
Dipalpur
Multan
D.G. Khan
Muzaffargarh
Mailsi
Pakpattan
Bahawalnagar
Haroonabad
Bahawalpur
Fort Abbas
Khanpur
Rahimyar Khan
INDUS R.
JHELUM R.
CHENAB R.
RAVI R.
SUTLEJ R.
Thal C.
Upper Jhelum C.
U.C.C.
L.J.C.
Lower Chenab C.
Upper Chenab C.
U.B.D.C.
Upper Bari Doab Canal
Rangpur C.
Haveli C.
Sidhnai C.
Dipalpur C.
Pakpattan C.
Fordwah C.
E. Sadiqia C.
Mailsi C.
Bahawal C.
Panjnad C.
Abbasia C.
D.G. Khan C.
Muzaffargarh C.

FIG. 8

A comparison of the bar graphs reveals :

*a*) There is a slight surplus of water supply in Upper Jhelum and Upper Chenab canal.

*b*) A sizeable surplus water is available in Thal canal area.

*c*) In all the other canal commanded areas the water supply falls short of the requirements for wheat. The deficiencies, however, vary from year to year according to the water supply position. The deficiencies have been lowest in 1967-68 when the overall water supply was better in most of the areas.

*d*) The deficiency of water supply for wheat increases towards south and west.

According to the degree of deficiency, the areas could be grouped as under :

*i*) Highest deficiency in Fordwah, Mailsi and Qaim canal areas in the south west where there are shortages of above nine inches of water. Rangpur canal area of Muzaffargarh also shows deficiencies of this order.

*ii*) High deficiency in Dipalpur, Bahawal, and Panjnad canal areas. Here the deficiencies range between six and nine inches of water.

*iii*) Moderately deficient area of Central Bari Doab, Muzaffargarh, Haveli (Sidhnai), and Pakpattan canal areas, show deficiencies of the order of three to six inches.

*iv*) Small deficiency areas of Lower Chenab, D. G. Khan, East Sadiqia and Abbasi canal areas where the deficiency range between one to three inches.

*v*) Very small deficiency areas of Lower Bari Doab and Lower Jhelum canal areas where the deficiencies are below one inch (Fig. 9).

Whereas it is important to fulfill the overall deficiencies of water for wheat it is equally important that water should be available at the proper timings.

Regarding number of waterings and their timings, several field experiments have been made at the various agricultural experimental stations.[15] The experiments have proved that *a*) timing of waterings is as important as the number of waterings, *b*) growth of wheat is retarded due to water shortages during the vegetative stage, *c*) the yields are affected adversely due to shortages of water just before the reproductive stage.

It is also found through experiments, that the water shortages during the vegetative stage could be covered up by ample supplies before the start of reproductive stage.

Fig 9

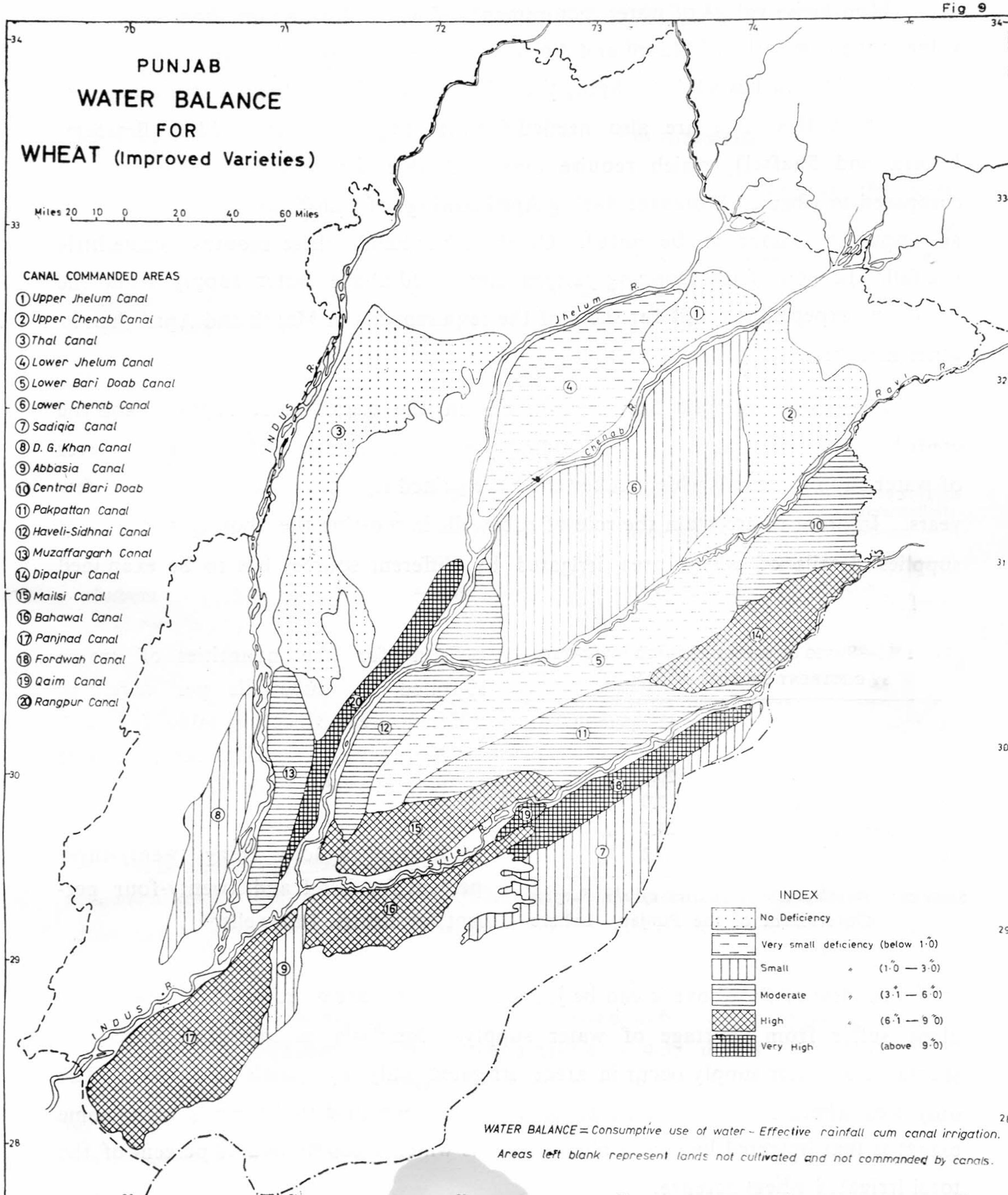
PUNJAB
WATER BALANCE
FOR
WHEAT (Improved Varieties)
Miles 20 10 0 20 40 60 Miles
CANAL COMMANDED AREAS
1 Upper Jhelum Canal
2 Upper Chenab Canal
3 Thal Canal
4 Lower Jhelum Canal
5 Lower Bari Doab Canal
6 Lower Chenab Canal
7 Sadiqia Canal
8 D. G. Khan Canal
9 Abbasia Canal
10 Central Bari Doab
11 Pakpattan Canal
12 Haveli-Sidhnai Canal
13 Muzaffargarh Canal
14 Dipalpur Canal
15 Mailsi Canal
16 Bahawal Canal
17 Panjnad Canal
18 Fordwah Canal
19 Qaim Canal
20 Rangpur Canal
INDUS R.
Jhelum R.
Chenab R.
Ravi R.
Sutlej
INDEX
No Deficiency
Very small deficiency (below 1·0")
Small (1·0" — 3·0")
Moderate (3·1" — 6·0")
High (6·1" — 9·0")
Very High (above 9·0")
WATER BALANCE = Consumptive use of water – Effective rainfall cum canal irrigation.
Areas left blank represent lands not cultivated and not commanded by canals.

FIG- 9

Monthwise values of water requirements of wheat during *rabi* show maximum values for the months of March and April. In these months the requirements are more than four inches while in April, the values exceed five inches. Large quantities of water at this time are also needed for the competitive *rabi* fodders (Berseem, Lucern and Shaftal), which require almost double the quantities of water as compared to wheat. Moreover during April sowings of *kharif* fodder (*chari*) is also an important factor to be noted. On the other hand, these months receive little rainfall. In view of the cropping pattern mentioned above, water supply from the canals is expected to fall far short of the requirements in March and April than in other months.

The above analysis has been based on the canal water supplies and the contribution of effective rainfall. There are, as has been seen earlier, other sources of water supply, among which, tubewells have gained significance during the past few years. In order to ascertain the role of tubewells in meeting the shortages of water supplies details of wheat area irrigated by different sources has to be examined carefully.

TABLE 12—RATIO OF WHEAT ACREAGE IRRIGATED BY DIFFERENT SOURCES IN 1971-72

| | |
|---|---|
| Canals | 42.2 percent |
| Wells | 5.0 ,, |
| Tubewells | 20.0 ,, |
| Canals and Wells | 7.0 ,, |
| Canals and Tubewells | 24.7 ,, |
| Others | 1.1 ,, |

SOURCE: *Development Statistics of the Punjab*, Government of the Punjab, Lahore (1972).

Data for the quantities of water supplied by tubewells per acre, in different areas is not available for *rabi*. In the tubewell irrigation survey report of nine districts of Punjab it is stated that the overall use of tubewells is much below the capacity being twenty-three percent for diesel and twenty-four percent for electric tubewells.[16]

In view of the above it can be judged that wheat areas irrigated by tubewells alone suffer from shortage of water supply. Similarly as indicated above the shortages of water supply occur in areas irrigated only by canals and wells. The only area where shortages of irrigation water are expected to be made up to some extent is that irrigated by canals plus tubewells which amounts to 24.7 percent of the total irrigated wheat acreage.

The ratio of wheat acreage irrigated by canals cum tubewells varies from district to district.

TABLE 13—RATIO OF WHEAT ACREAGE IRRIGATED BY CANALS CUM TUBEWELLS TO TOTAL IRRIGATED WHEAT ACREAGE

| District | Percent |
|---|---|
| Gujranwala | 10.9 |
| Lahore | 22.9 |
| Sheikhupura | 72.4 |
| Sargodha | 23.9 |
| Lyallpur | 34.4 |
| Sahiwal | 11.8 |
| Multan | 41.9 |
| Muzaffargarh | 2.9 |

SOURCE: Same as Table 12.

On the basis of the above figures one can presume that the canal water supplies in these areas are met with to the extent of the percentage of area irrigated by canals cum tubewells.

Extent of compensation in the water shortages (in proportion to the ratio of area irrigated by canals cum tubewells) in the above listed area are arrived at in column 4 of the following table :

TABLE 14—EXTENT OF COMPENSATION IN THE WATER SHORTAGE

| Area | Balance of water supply on the basis of canals (inches) | Proportionate supplies by canals cum tubewells (inches) | Balance + indicates surplus — indicates deficit (inches) |
|---|---|---|---|
| Lahore | —3.89 | 0.92 | —2.97 |
| Gujranwala | +1.48 | 0.15 | +1.63 |
| Sheikhupura | +1.48 | 1.16 | +2.64 |
| Sargodha | —0.72 | 0.17 | —0.55 |
| Lyallpur | —2.82 | 1.07 | —1.75 |
| Sahiwal | —0.020 | 0.003 | —0.016 |
| Multan | —5.95 | 2.49 | —2.46 |
| Muzaffargarh | —9.45 | 0.27 | —9.18 |

It is clear from the above estimates the water supply supplemented thus by tubewells meets the overall water deficiencies only partially. The only deficit area where this supplementary tubewell water almost fulfills the deficiencies is Sahiwal.

The overall average consumptive use of water for Punjab for wheat amounts to 17.32 inches, whereas the canal water supply, based on five year averages, (1965-66—1969-70) is only 12.99 inches. This leaves a deficit of 4.33 inches. Allowing for the compensation in the water shortage in proportion to the area irrigated by canals cum tubewells (24.7%) a deficit of 3.26 inches depth of water over the area under wheat is still to be met with in Punjab.

On the basis of 5,889 thousand acres under new varieties of wheat in 1971-72 in Punjab the total water shortage suffered by the wheat crop in the province, were of the order of about 1.6 m. acre feet.

The problem of water supply for wheat, therefore, has two aspects :

1) to make up for the overall shortages of water supply during the *rabi*.

2) to supply additional water in March and April, the most crucial period for wheat.

The green revolution has brought about definite improvements in the characteristics of agriculture, especially in the production of wheat. These improvements are convincingly indicative of a high degree of adaptability of our farmer to new situations, contrary to the popular belief that he is conservative. What is needed for further improvements is the provisioning of relevant inputs, primarily water, in required quantities. Comparative areal evaluation of water deficiency has been made in this paper for Punjab. It could be extended to other parts of the Indus basin. Areas of higher deficiency obviously demand greater attention for development. Extension of canal cum tubewell irrigated acreage in these lands seem to attain first priority. An increase in the number of tubewells in suitable areas and an improvement in their efficiency are the only cure for water deficiency for wheat cultivation during the months of March and April, when water supply from rainfall and canals is harmfully deficient.

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3. *Ibid*, pp. 577—579.

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# HOW TO PLAN AGROVILLES—LOCATION STRATEGY

MOHAMMAD ASLAM KHAN

THIS paper has been divided into three sections. The first of these deals with the terminology and concept of agrovilles, the second is concerned with the reason for their development, while the third and final part discusses the location aspect of their planning.

1. The term "agroville" has come from Hungary.[1] There agrovilles are usually regarded as towns which may house several thousand inhabitants but a high proportion of their working population devote themselves to farm production. While possessing the usual commercial nucleus agrovilles are largely a mass of farmer dvellings. They are, in effect overgrown villages.

Pakistani planning agencies define agroville in the following words : "A self-contained small town located in a rural area, so planned as to offer its inhabitants a balanced range of essential public services and social and cultural facilities." The policy behind their creation in this country is to check the overcrowding of existing cities, promote balanced urban growth and to bring people and their means of livelihood together to new surroundings, where services and amenities would be defined with reference to the whole community and placed at the disposal of all. The aim on the one hand is to create favourable economic conditions for industry and agriculture, and on the other to provide opportunities to people for a full, satisfying, and self-sufficient life.

The concept of Pakistani agroville has taken birth from 'self contained new towns'. The earliest new towns were planned to become self contained new communities, so too are the latest ones.[2] No one doubts these days that new towns are a feasible way of checking further spread of very large cities and to reduce their congestion. The concept has been advocated not only in western planning agencies but also

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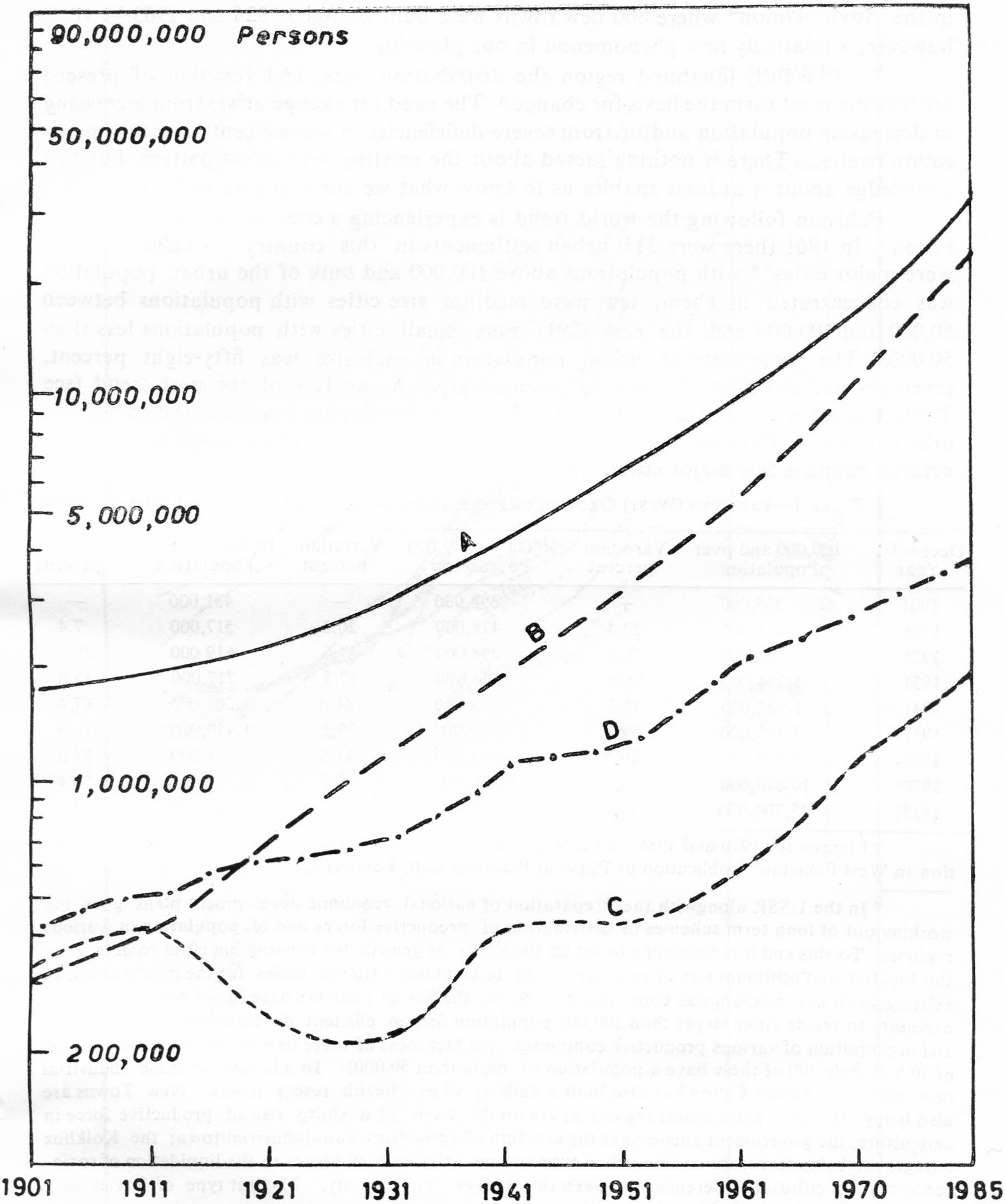


A Growth of total urban population
B Population growth of towns with 100,000 persons and over
C " " " 50,000 to 99,999 persons
D " " " 10,000 to 49,999 "

in the Soviet Union* where 800 new towns were built between 1926 and 1963.[3] It is, however, a relatively new phenomenon in our planning.

2. In a fully inhabited region the distribution, size, and function of present settlements must form the basis for change.[4] The need for change arises from increasing or decreasing population and/or from severe deficiencies in service centres or communication routes. There is nothing sacred about the existing settlement pattern but full knowledge about it at least enables us to know what we are changing and why.

Pakistan following the world trend is experiencing a constant growth in urbanisation. In 1961 there were 313 urban settlements in this country. Twelve of these were major cities** with populations above 100,000 and bulk of the urban population was concentrated in them, ten were medium size cities with populations between 50,000 and 100,000 and the rest (291) were small cities with populations less than 50,000. The percentage of urban population in each size was fifty-eight percent, seven percent and thirty-five percent respectively. An analysis of the past trend (see Table 1 and Figs. 1 and 2) shows that like other developing countries the growth of urbanization in Pakistan has largely resulted from rural-urban migration and is centred round a few major cities.

TABLE 1—PAKISTAN (WEST) GROWTH OF POPULATION IN MAJOR MEDIUM SMALL CITIES

| Decennial Year | 100,000 and over Population | Variation percent | 50,000 to 100,000 Population | Variation percent | 10,000 to 50,000 Population | Variation percent |
|---|---|---|---|---|---|---|
| 1901 | 339,000 | — | 398,000 | — | 481,000 | — |
| 1911 | 415,000 | 22.4 | 478,000 | 20.3 | 517,000 | 7.4 |
| 1921 | 732,000 | 76.0 | 298,000 | 37.6 | 619,000 | 19.5 |
| 1931 | 1,294,000 | 76.8 | 246,000 | 17.5 | 717,000 | 15.8 |
| 1941 | 1,882,000 | 45.5 | 452,000 | 84.0 | 1,201,000 | 67.4 |
| 1951 | 3,185,000 | 69.2 | 486,000 | 7.3 | 1,440,000 | 19.9 |
| 1961 | 5,630,000 | 76.7 | 643,000 | 33.5 | 2,261,000 | 57.0 |
| 1970† | 10,110,000 | 79.5 | 1,206,000 | 87.5 | 2,744,000 | 21.4 |
| 1985† | 25,700,000 | 154.2 | 2,028,000 | 68.2 | 3,820,000 | 39.2 |

† Figures for 1970 and 1985 indicate projected population (Source of projection, "Urbanization in West Pakistan" publication of Physical Planning Cell, Lahore).

* In the USSR alongwith the preparation of national economic development plans goes the working out of long term schemes of distribution of productive forces and of population in various regions. To this end it is necessary to set up the limits of growth for existing big cities to determine the location and optimum size of new towns and to establish rational scales for the development of existing small and medium size communities. So far the Soviet planners have found out that it is not necessary to create cities larger than 300,000 population for an efficient development of production and organisation of various productive complexes (In fact most of these new towns have a population of 50,000, only 100 of these have a population of more than 50,000). In addition to these industrial new towns, the Soviet Union has also built a number of new health resort towns. New Towns are also being created in agricultural regions where on the basis of a sharp rise of productive force in agriculture, the government encourages the creation of agriculture-cum-industrial town; the Kolkhoz villages are being transformed into urban type communities with an object to the liquidation of socio-economic and cultural differences between the village and the city. The last type of Soviet new towns are more akin to Pakistani agrovilles.

** According to the preliminary report of latest Census of Pakistan (1972) the number of these cities has increased to 19 and their population has exceeded ten million—10,395,000. (This was not far from the projected target. See projected figure for 1970 in Table I).

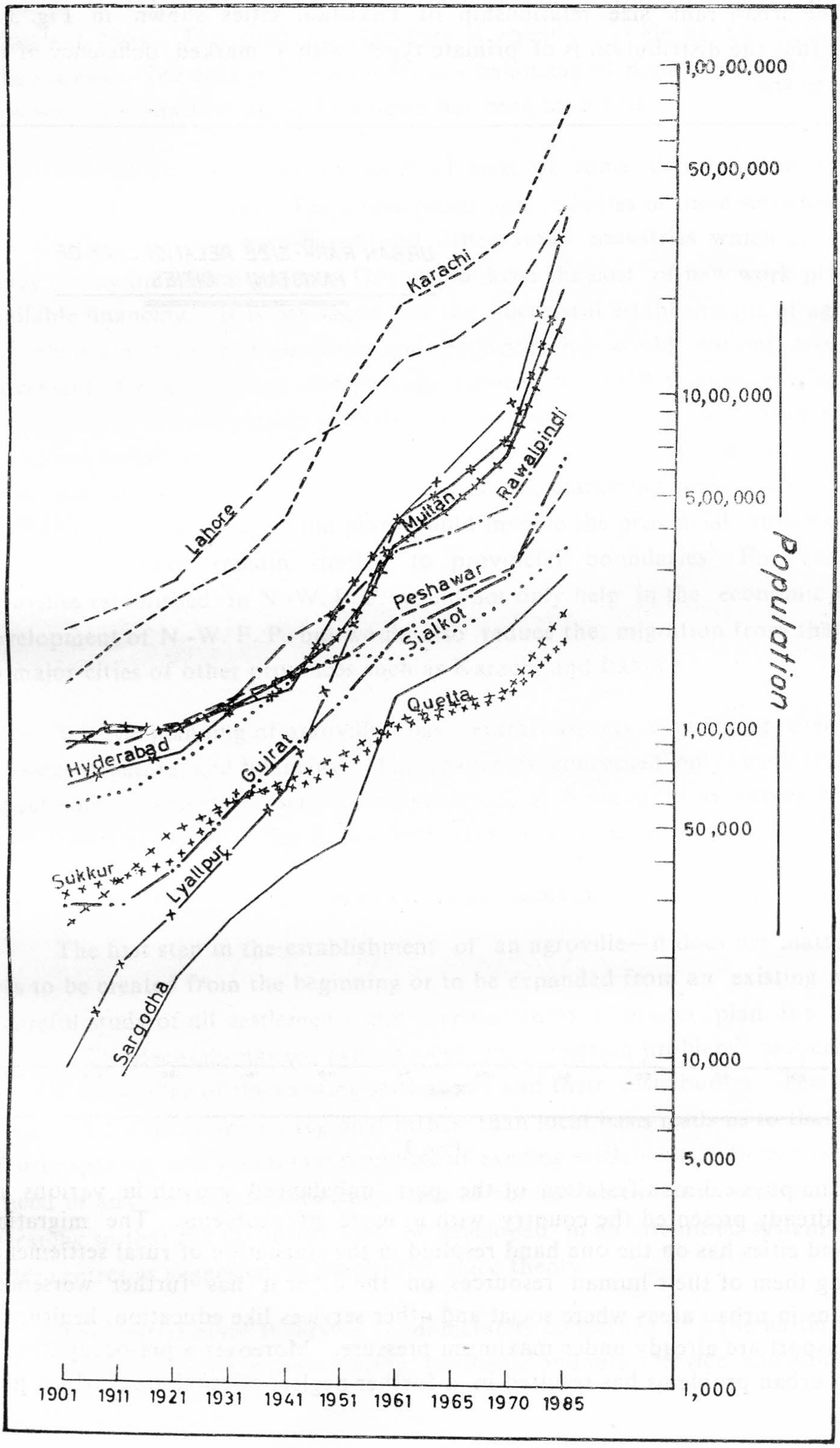
1,00,00,000
50,00,000
10,00,000
5,00,000
1,00,000
50,000
10,000
5,000
1,000
Population
Karachi
Lahore
Multan
Rawalpindi
Peshawar
Sialkot
Hyderabad
Quetta
Gujrat
Sukkur
Lyallpur
Sargodha
1901
1911
1921
1931
1941
1951
1961
1965
1970
1985

FIG. 2

The urban rank size relationship of Pakistani cities shown in Fig. 3 also confirms that the distribution is of primate type[5] with a marked deficiency of intermediate towns.

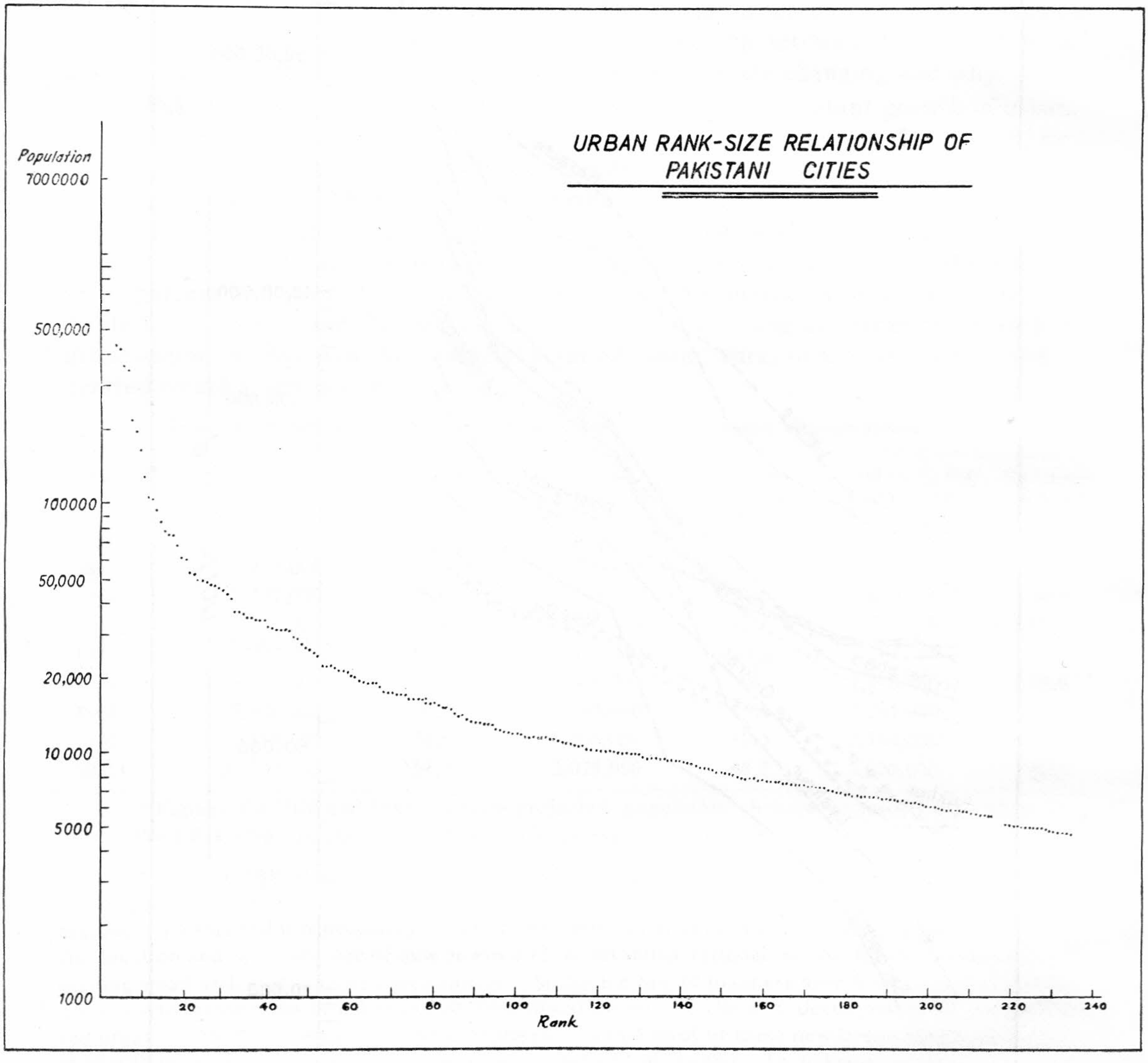


FIG. 3

The physical manifestation of the past unbalanced growth in various urban sectors already presented the country with a maze of problems. The migration to towns and cities has on the one hand resulted in the stagnation of rural settlements by depriving them of their human resources, on the other it has further worsened the conditions in urban areas where social and other services like education, health, traffic and transport are already under maximum pressure. Moreover a pre-occupation with growing urban problems has resulted in a further neglect of rural areas which housed as many as forty-five million (45,000,000) people in thirty-nine thousand (39,000) villages in 1961. The problem therefore is equally significant for both rural and urban areas. The crux of the problem is a balancing of population and employment. It is with this aim that agroville scheme has been launched.

The scheme involves an establishment of some two hundred small towns (agrovilles) in rural areas. The employment opportunities in these settlements will be provided by locating agro-based and other small industries which do not require heavy outlay on capital goods. This would keep the cost of new work places within available financing. It is envisaged that the successful establishment of agrovilles by the enhancement of their amenities and opportunities would not only lessen chaotic movement of migration but also provide services to small neighbouring settlements. Moreover a dispersed pattern of urban development and more proximity of urban settlement would help the farmers of rural areas not only in getting credit, fertilizers, good seeds, machinery and insecticides but also in marketing their product. Although the implementation of agroville plan would involve the provincial authorities but its benefit would not remain limited to provincial boundaries. For example the agrovilles established in N.-W. F. P. would not only help in the economic and social development of N.-W. F. P. but would also reduce the migration from that province to major cities of other provinces such as Karachi and Lahore.

3. The planning of agrovilles has several aspects concerning their location, physical structure, and financing. This paper is concerned only with the location aspect which involves two sets of investigations *a*) A hierarchical survey *b*) Development potential survey. (See Fig. 4 for System Analysis).

## Hierarchical Survey

The first step in the establishment of an agroville—it does not matter whether it is to be created from the beginning or to be expanded from an existing village—is a careful study of all settlements and preparation of a master plan for the whole region. The decision-makers cannot solve the "location problem" properly without the real knowledge of the existing settlements and their distribution. The realisation of this need to plan upon a regional rather than local basis leads us to the evaluation of size, spacing, and functional structure of existing settlements. In addition there is a need to analyse the geographical setting of various settlements in terms of urban hierarchy so that the facilities could be developed in an integrated system of varying order centres as suggested by the central place theory.

The central place theory[6] is fundamentally concerned with the patterns through which market-oriented manufacturing, wholesale and retail service, and administrative

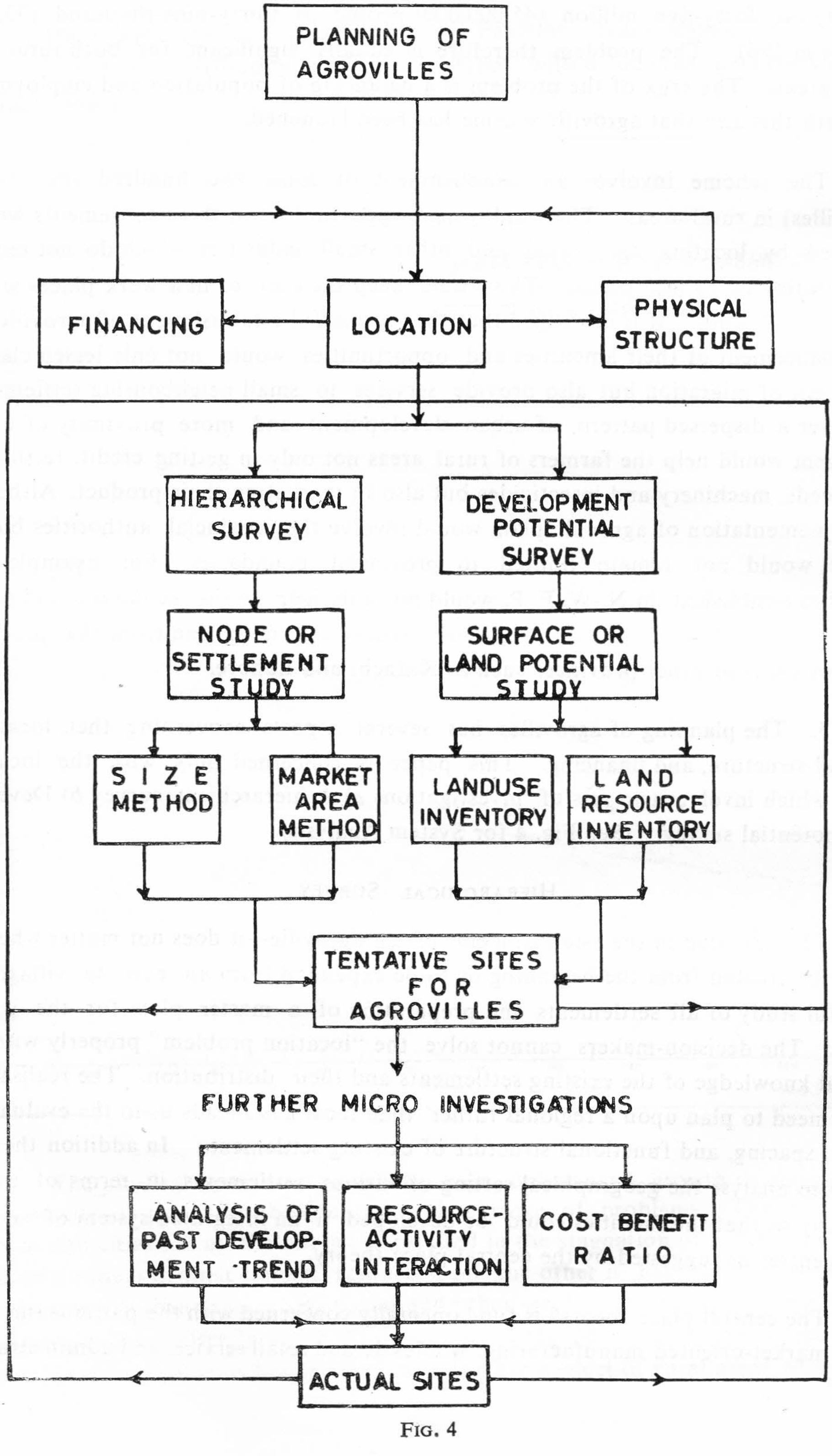
PLANNING OF AGROVILLES
FINANCING
LOCATION
PHYSICAL STRUCTURE
HIERARCHICAL SURVEY
DEVELOPMENT POTENTIAL SURVEY
NODE OR SETTLEMENT STUDY
SURFACE OR LAND POTENTIAL STUDY
SIZE METHOD
MARKET AREA METHOD
LANDUSE INVENTORY
LAND RESOURCE INVENTORY
TENTATIVE SITES FOR AGROVILLES
FURTHER MICRO INVESTIGATIONS
ANALYSIS OF PAST DEVELOPMENT TREND
RESOURCE-ACTIVITY INTERACTION
COST BENEFIT RATIO
ACTUAL SITES

FIG. 4

functions are provided to consuming population efficiently. It generates a complete hierarchy of cities, towns and villages given a set of metropolitan centres. The result of the process is a step-like series of urban centres differentiated by the performance of one or more sets of goods and services arranged in a hierarchy of market area requirements. A number of techniques have been used so far to determine the status of a centre within a hierarchical scheme. They can, however, conveniently be grouped into two major types:[7]

(*i*) Size and Threshold studies

(*ii*) Market area studies

The former is based on assessing the status of centres according to their size referred in terms of functional equipment e.g. availability of shops, education facilities, health services, etc., expressed by their number, floor area, employment or intensity of use. The latter attempts to identify the status of the centres by the measurement of market or catchment area in terms of the origin of shopping trips, delivery limits, or bus service hinterland, etc.

For measuring the functional equipment shopping is a particularly suitable service.[8] One of its biggest advantages is that it is an almost universal activity. There are at least some shops in almost every place because the provision of rudimentary shopping facilities require the outlay of comparatively little expenditure—no more than a counter across the front room of a house. Perspective shopkeepers therefore do not require complicated vagaries of choice of capital investment. Another advantage of using shops for measuring the functional equipment is that they can be conveniently divided into three fairly distinct types, e.g. those which require daily or more frequent visits, those requiring weekly visits and lastly those which require occasional visits. An additional advantage is that use of a shopping centre is not restricted to particular categories of people and that their choice is not influenced by the restriction artificially induced by such extraneous factors as administrative boundaries. However the reliability of the results should be further checked against such factors as the population, and other social and educational facilities.

Methods for ranking the service centres into various orders are also quite numerous ranging from simple plotting of centres against the functional equipment (e.g. the number of shops) on a simple graph and finding the break points to multivariate analysis*—factor and principle component analysis and cluster analysis** requiring computer use.

Comparison of settlements with respect to facilities and their population can give substantial assistance in deciding which place should extend both as regard to population and buildings providing services to bring about the optimum distribution of services alongwith population.

## Development Potential Survey

A second important consideration in the location survey for agroville requires the determination of development potential from such factors as the agricultural productivity of the surrounding area and the potential of the town for industrial development. A land-use map is indispensible for this purpose. Such a map however will have to be used with care, since the mere occupation of large area of land by a particular use e.g. agriculture, is not an indication that it has a high development potential particularly if the productivity in the area is very low. Conversely some extremely important uses which take up little space may be impossible to show at regional scale. It is therefore necessary to combine the land use with other regional surveys and resources inventories. Aerial photographs and topographic maps can serve as a good framework. Multispectral images taken by NASA'S EARTS (I) (Earth Resource Technology Satellite (I))*** and converted into black and white as

* *Multivariate analysis*.—Quantitative methods have made rapid progress in Geography in recent years. The electronic digital computer has greatly facilitated large scale data handling, processing and multivariate analysis. Multivariate methods provide one of the most powerful tools in the analysis of multicomponent problems. It attacks the problem at the very point where standardization fails and recognizes that all measurements are not of equal weight but that many of them may overlap and give us the same result about the ways in which a set of observation (settlements) may vary. When several measurements show basically the same patterns of variation, we suspect that some are redundant and that a more basic pattern lies beneath : the principal component analysis is an approximation of that basic pattern. (For further details of factor and principal component analysis see Herman, H.C., *Modern Factor Analysis*, Chicago (1960), and Berry, B. J. L., *An Inductive Approach to the Regionalization of Economic Development*, University of Chicago, Department of Geography, Research Paper 62 (1960), pps. 78—107.

** Cluster analysis is a mathematical method of classification which has been applied in a number of fields particularly biological taxonomy (see Sokal and Smeath 1963, *Principles of Numerical Taxonomy*, H H. Freeman & Co., San Francisco). By this method a measure of resemblance or similarity is computed between all possible pairs of objects being classified ; the objects are then linked progressively to form groups, by the criterion that average similarity between members of the same group is greater than the average similarity between number of different groups. See Khan, M. A., *Growth and Morphology of the Central Area of Coventry*, Ph. D. Thesis, Faculty of Science and Engineering, University of Birmingham (1971).

*** The Earth Resource Technology Satellite (EARTS) programme has been launched by NASA (USA). It is a major first step in the merger of space and remote sensing technologies into a research and development system for developing and demonstrating the techniques for efficient management of earth's resources. The first experimental Satellite EARTS I was launched for this purpose in July 1972 and EARTS-B is scheduled for launch in late 1973. Their purpose is to acquire and transmit multispectral images of the earthly surface for conversion into black and white or colour photographs and computer tapes.

well as coloured photographs can also be extremely useful in this aspect. Data provided by this satellite is already being used in earth resource management and land use planning in America.[9]

The combination of the hierarchical and development potential survey can be used to prepare a map which can serve as a guide to the tentative selection of sites for agrovilles. On the basis of evidence it gives, there may well be several sites of apparently equal suitability. This evidence however will considerably limit the area for further micro investigations such as development trend of the past and interaction of resource activity* pattern and analysis of cost-benefit** ratio.

## CONCLUSION

The implementation of agroville scheme needs careful and considerate approach because the success or failure of the scheme depends on that. A thorough survey of existing conditions is imperative because its findings are in itself a safeguard against serious errors.

It is not simply enough to find space for the development of agrovilles, prior consideration must be given as to how the location is geared to existing values of site and thorough assessment must be made of its development potential. The scheme should be so oriented as to reduce waste attributable to improved location of population on the one hand and social and economic facilities on the other.

One very important point constantly emphasized at various U. N. discussions and conferences on regional planning and urbanization must also be mentioned here. This relates to the fact that new town or agroville scheme should not be treated as an isolated exercise in physical planning. It is desirable that new towns should serve as an instrument to develop a national policy for urban and regional development. Such a policy would include the evaluation and distribution of the productive forces within a national and regional framework. Unless physical planning concepts and processes are effectively integrated with economic planning concepts and processes it might not be possible to ensure the provision of desirable physical environment for human needs and welfare.

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* (1) Numerous urban/regional models are used for this purpose. (For details see Chorley and Hagget Edit. (1967) *Models in Geography*, (2) Khan, M. A., *Gravity Concept in Geography*.

** Construction and development cost forms a major element in the evaluation of alternative sites and decisions on the building of new towns or expansion of an existing village into a town is very often influenced by the comparative cost of building of alternative locations. See 1) Prest, A. R. and Turvey, R., ' Cost of Benefit Analysis : A Survey,'' *Survey of Economic Theory : Resource Allocation*, London: McMillan (1966), pp. 155—207, 2) "Lichfield Nathanial Cost Benefit Analysis in Town Planning : Problems and Possibilities," Lawrence, J. R. (Ed.), *Operational Research and the Social Sciences*, Tavistock Press, 1966.

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# RURAL DEPOPULATION IN SCOTLAND: A STUDY IN RETROSPECT*

A. H. RATHORE

## INTRODUCTION

BEFORE the advent of the Agricultural Revolution in the middle of the eighteenth century, the economy of Scotland was predominantly agricultural. The population in 1755 was small and more evenly distributed than it is now. The northern division, that now has less than one-fifth of the total population, had a half of the total at the turn of the century.[1] Towns were few and the largest did not exceed 30,000 in the middle of that century.[2] The cultivable land was devoted to arable farming and the country produced all the food it needed. The situation, however, was not as simple as that. Farming was of primitive type and centuries old system of cultivation, known as "run-rig",[3] prevailed. Stock farming was important but the stock feed was neither satisfactory nor adequate, consequently, the quality of stock was poor. Since farming was a cumbersome process, needing a lot of effort, a labour force in excess of the necessity was maintained. Living was poor and precarious. Sub-tenants, early marriages and reduction in infant mortality due to the introduction of vaccination against small-pox had ultimately caused the population pressure beyond the available resources. The system, however, was entrenched in the old social order characterised by clans, each working under its chief and observing its traditions. This was a subsistence economy and it was never far from the danger line. A freak of the elements or some irregularity in seasons disturbed the precarious balance causing starvation and misery. The disaster wrought by the potato famine in 1848 only reflected "the measure of persisting and chronic weakness of a highland agrarian system." [4] The conditions of society and economy, as these, stood exposed to the impact of social and economic changes of which Scotland was, in due course, to have full share. These changes came in the wake partly of the political changes such as the Union of Parliaments, the colonies and the opening up of other lands, especially the New World, and partly of the Industrial Revolution.

## THE IMPACT OF THE AGRICULTURAL REVOLUTION

Changes in agriculture started in the early eighteenth century before the Industrial Revolution although in their later stages their development was simultaneous,

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characterised by interaction. The Union of Parliaments in the first decade of the eighteenth century (1707) was a land mark in the Scottish economy. It threw open the English market, hitherto held up by restrictions, and offered opportunities for a cattle trade—a boon for Scotland where cattle farming was of prime importance. It also gave opportunities for trade with the colonies. More important, perhaps, than other changes that followed the Union was the movement for improving agriculture known as the "Agricultural Revolution", the ideas for which came from England considered at the time to be "centuries" ahead of Scotland.[5] The civil and political unrest that had been a feature of the country for long ended after the 1745 rebellion and the agricultural revolution got underway. The later part of the eighteenth and the earlier decades of the nineteenth century saw the transformation of the rural landscape. Some basic changes in the structure and methods of farming were introduced. The old system of run-rig was abolished, except in some Highland glens and the Hebrides where it continued to linger. The main results of the improvement were consolidation of holdings and granting of long leases. New crops such as potatoes, turnips, clover and artificial grasses were introduced. Farms were enclosed and improved through liming and reclamation of wasteland. Thus not only was agricultural output increased but the range of stock-feeding was broadened and better stock was produced for the competitive market. The improvement went on to an extent that in a little over half a century, by the first decade of the nineteenth century, Scottish agriculture was in the "leading" position in the world.[6] This prominence resulted from both technical innovations and a close adjustment of the type of farm to the environmental conditions. The phenomenal change and the prosperity it brought to farming could not but have deep effect on the attitude of the farmer and he began to look beyond the subsistence range. Commercial farming had already established itself and the farmers were looking for profits that could only accrue from better market prices and low expenditure on farms.

Improvement of the old and introduction of new farm implements, such as threshing machine, was a great technical advance in the industry. The improved plough required one man and two horses to work it as against three men and six to eight oxen needed for the old one. The threshing machine not only reduced the need for labour but also cut down the wastage of grain. In many cases labour requirement was cut down by as much as one-half. A period of labour redundancy on land began, for the first time in Scottish history, and the operation of other forces accelerated the drift of people from the country-side.

## Internal Movement of Labour

### *Historical Development*

Movement of people, particularly farm workers, within the country existed even before this change. In the earlier periods, however, the causes and their effects were mostly local in character. For example, in the seventeenth century the scarcity of fuel (peat) drove many a person from his home. Where peat deposits were found to be depleting, the farmers dispensed with some of their labour. Furthermore, the small holders, apart from farming, were engaged in different, and often illegal, pursuits such as illicit distillation. Suppression of the trade caused the families involved to migrate and thus had strong local effect on population.

It was, however, in the eighteenth century that a country-wide situation of the farm labour mobility developed. The amalgamation of small holdings into large farms, the use of improved implements and the abolition of sub-letting created the problem of labour in the agricultural industry on a national scale. The process of amalgamation had some noteworthy results. Stock-farming has always been basic to Scottish farming. Commercial cattle-farming existed even before the era of improvements. Commercial sheep-farming was practised in southern Scotland since the twelveth century.[7] To the Highlands and the north of Scotland, however, it came with the improvements and spread in a relatively short period. Some farmers from the south migrated to the north around 1760 where cattle farming was losing ground as an economic proposition. The new outlook had begun to make farmers and farm workers economically conscious. The kelp industry, started in 1790 in the Western Isles and the west coast, had a short-lived boom during Napoleonic wars but could not survive the import of cheap potash, nor did other pursuits like fishing and the linen industry offer much prospects. Farmers, therefore, saw hope in the sheep since wool and mutton both were in demand. Large income from high rents and relief from the burden of maintaining large labour force encouraged adoption of sheep-farming on a large scale. By the close of the century, amalgamation of small holdings into large sheep walks and recession of arable land under grass had become the order of the day. Here it may be pointed out that towards the end of the eighteenth century many evicted tenants were settled on reclaimed waste land near the towns to produce grain and rear stock. In such cases there was no diminishing of population. Where, however, sheep walks were formed at the expense of arable land, population decreased. It was these changes in land use which resulted in Highland Clearances.

As a consequence of these developments farm workers and tenants, particularly in Highland area, were thrown out of work in thousands. Some of them flocked to the towns to find work in industries ; others crossed the Atlantic to settle in Canada and in the United States of America. This was the period of great population mobility in Scotland and also one of large-scale emigration. The change involved the exercise of some form of compulsion also since the tenants were loath to leave the land and farmers, on the other hand, were intent on relieving themselves of a situation that was in conflict with their interests. This is evident from the accounts of eviction commonly referred to as "Highland Clearances". In the Highland region, as the historical accounts suggest, the impulse to move out had already come from the rising rents before the Agricultural Revolution came and sheep farms became common. The crofters and small holders could ill-afford to pay high rents exacted by the new lairds. It was, however, sheep farming that gave impetus to large-scale migration. The situation did not cause alarm until after the middle of the century ; it gathered force towards the 1760s' and 1770s' and became what was described as "fever". In one year (1773) a thousand people went overseas from the mainland of Inverness-shire.[8] The flow was interrupted by the American war of Independence. When the war concluded in 1783, Scotland was suffering from an acute food situation. The outward movement resumed and became intense so much so that in the earlier decades of the nineteenth century it was rather distrurbing. In a decade (1811-1820) an estimated number of 15,000 people left their homes in Sutherland.[9] The trend continued unchecked and was further augmented by such calamities as the potato crop failure in the mid-nineteenth century.[10] In the Highlands and particularly in the Western Islands people had come to depend too much on potato as the main food crop.

It is to be noted that the position was by no means similar in other parts of the country. Although the state of the economy prior to the improvements was unsatisfactory in other regions, it was not as precarious as in the Highlands. The operation of different factors had varied effect according to the local conditions. In the North East region, for example, there was an overall increase in population following the improvements in the first half of the eighteenth century and it continued as late as the third quarter of the century. One of the causes of increase, and perhaps a potent one, was the reclamation of wasteland. The famine in the year 1782-83 marked the point of decline. This is illustrated in the change in the population of Skene parish (Aberdeenshire) and is fairly representative of the conditions of the region. The improvements in the methods of farming and the reclamation of waste land had brought prosperity to the rural economy and, consequently, caused growth of the population. Again, in the first half of the nineteenth century there was increase in population in the parts of the country outside the Highland region. A contributory factor to this situation was the improvement in communications. The railway and the steamship gave a tremendous fillip to the cattle trade, especially in the north-east. It was not until the middle of the nineteenth century that a period of dormancy, and then decline, in rural population set in.

TABLE 1—POPULATION OF SKENE

| Year | Population |
|---|---|
| 1775 | 1251 |
| 1777 | 1306 |
| 1787 | 1256 |
| 1791 | 1233 |
| 1801 | 1140 |

*Movement Overseas*

Movement overseas, as already indicated, was an important feature of the mobility in the period. It was not, however, as new a development as it sounded. In a subsistence economy, the lot of peasantry under feudalism was hard and the desire for better living elsewhere was latent, though in the circumstances it did not find expression on the mass-scale. Statutory regulations against workers leaving their masters were strict.[12] However, people had been going out for a long time. Early in the seventeenth century thousands of Scots had gone to Poland and eastern Prussia where many of them served in the army as mercenaries.[13] The unsuccessful venture of some, towards the end of the seventeenth century, to plant colonies on the coast of the Gulf of Darien in Central America had also acquainted them with the situation across the Atlantic and quite a few of the Scots had migrated to the north-east of the United States early in the eighteenth century.[14]

## THE IMPACT OF THE INDUSTRIAL REVOLUTION

The Industrial Revolution influenced rural demography and economy in different ways. The traditional industries associated with agriculture were those of woollen cloth and linen. This enterprise had for centuries been confined to the farm-towns. Towards the closing decades of the eighteenth century (1780) use of machinery in cotton and flax was a prelude to another change. Spinning and weaving, that had until then been a cottage industry and, apart from the craftsmen primarily employed in it, a supplementary job for many of those engaged in farming, was dissociated from farming and brought into the sphere of factory. This change disturbed the already none-too-strong balance of the rural economy. While on one hand improvement and amalgamation drove many a person out of the farm, on the other the shifting of manufacturing enterprises to separate establishments drew many craftsmen farm-workers away from farming. The cotton industry, expanding continually up to the first half of the nineteenth century (1830), promised them better prospects. The farmers as well as the factory-owners encouraged this development since it was in the economic interest of both.

Meanwhile, the metal industry continued growing from the early eighteenth century. The establishment of Carron Iron Works (1759-60) and the discovery of blast furnace in 1828 were great advances. The textile and the metallurgical industries flourished in the first half of the nineteenth century. In the second half, however, political situation abroad, particularly the war (1861-66) in the United States, had adverse effect on the cotton trade and cotton manufactures. The metallurgical industries, based on the local reserves of iron and coal, continued to progress. In due course, a host of other industries developed in the Central Belt.

The growth of industry had yet another indirect impact on rural demography. Towards the end of the nineteenth century the vigour of sheep farming had weakened due to a fall in the prices of sheep and wool. The Highland farmer could no longer count too much on this enterprise. In the lowlands the growth of industry had, in the meantime, created a wealthy class that acquired estates for sporting purposes. Sheep and shepherds were replaced by deer and over extensive areas 'deer-forests' came into existence. From about two million acres in 1883 the acreage under deer forests grew to more than three and a half million acres by the second decade of the present century.[15] It is, however, not to be supposed that there was complete absence of sheep on the deer forests for these, in general, carried a number of sheep. On the other hand, on large sheep farms a portion was set apart for deer.

## DRIFT FROM COUNTRYSIDE

*Some General Features*

The Industrial Revolution, synchronising as it did with the change in rural economy, attracted large number of the redundant population of which Glasgow, probably, is the best example; in the case of other towns the rate of increase was more

TABLE 2—POPULATION INCREASE 1781—1851

| | 1781 | 1801 | 1821 | 1841 | 1851 |
|---|---|---|---|---|---|
| Glasgow | 43,000 | 81,048 | 147,034 | 274,234 | 344,986 |
| Edinburgh | — | 82,560 | 138,235 | 166,450 | 193,929 |
| Dundee | — | 26,084 | 30,575 | 62,873 | 78,931 |

even.[16] Some proportion of the farm workers from the Highlands and from other rural areas settled on the reclaimed land situated near the towns in the industrial belt and took to intensive farming producing grain, vegetables, milk and poultry for the growing urban population. The increase in the density per square mile in the counties of Lanark and Renfrew is suggestive in this connection.[17]

| | 1750 | 1795 | 1801 |
|---|---|---|---|
| Lanarkshire | 87 | 113 | 155 |
| Renfrewshire | 117 | 277 | 344 |

The greater proportion of the influx from the countryside, however, went into the core of iron industry. This is borne out by the increase in the population of Old Monkton, one of the typical centres of the industry in Lanarkshire.[18]

| | 1801 | 1821 | 1831 | 1841 | 1851 |
|---|---|---|---|---|---|
| Old Monkton | 4,006 | 6,938 | 9,580 | 19,709 | 27,333 |

In the eighteenth and nineteenth century stages of the movement, distance and destination were, in general, determined by the economic position of the migrants and also, to an extent, the part of the country they came from. For instance, people from the Outer Isles and the western sea-board, who could afford the fare, chose the New World. Others with lesser means went to Ireland where, after finding the situation there equally desperate, they joined the groups of migrants to North America. In the inland parts of the country the trend of movement was mainly to the industrially developing Central Lowlands and rural population, in general, found its way to the towns. The influence of distance-factor was a latent feature of the process. People from remote areas moved to the nearby towns or distant places according to their circumstances and the position of the labour market. Certainly, housing accommodation was also a factor in the choice of the destination since that was one great difficulty in the over-crowded towns. It is possible to imagine that a certain proportion of this process of drift was marked by stages. Peoples first moved to the nearby towns and settlements; thereafter they moved on to large towns. A large number of them, of course, emigrated.

The changes in the types and techniques of farming and the impact of Industrial Revolution on the economic life upset the relative balance that had since long been a feature of Scotland's rural demography. More important than the material change was the change in the outlook of people to which the development of transport contributed substantially. Until the beginning of the nineteenth century Wade's roads were the only luxury Scotland enjoyed in respect of the movement of people and goods. In the middle of the eighteenth century construction of improved roads, known as turnpyke roads, was started in the Lowlands and this development came to the Highlands towards the end of the century. Travel became popular and intercourse wide. Canals were another means of transport, the important ones in the Highlands being the Aberdeen-Inveririe Canal opened in 1805 and the Caledonian Canal opened in 1822. The introduction of railways ushered in a new era. By the end of the nineteenth century a large part of the country had fairly developed rail and road connections. This, however, was a doubled-edged development. If it proved an important factor in the growth of internal and foreign trade, and thus brought prosperity to farming and to the industry, it also stimulated the drain of population, especially the farm workers, from the rural areas.

Since the middle of the nineteenth century the drift from the land has gone on unabated. Movement of farming people within the country and also their migration, except during the periods of the two wars and also the period of depression in the

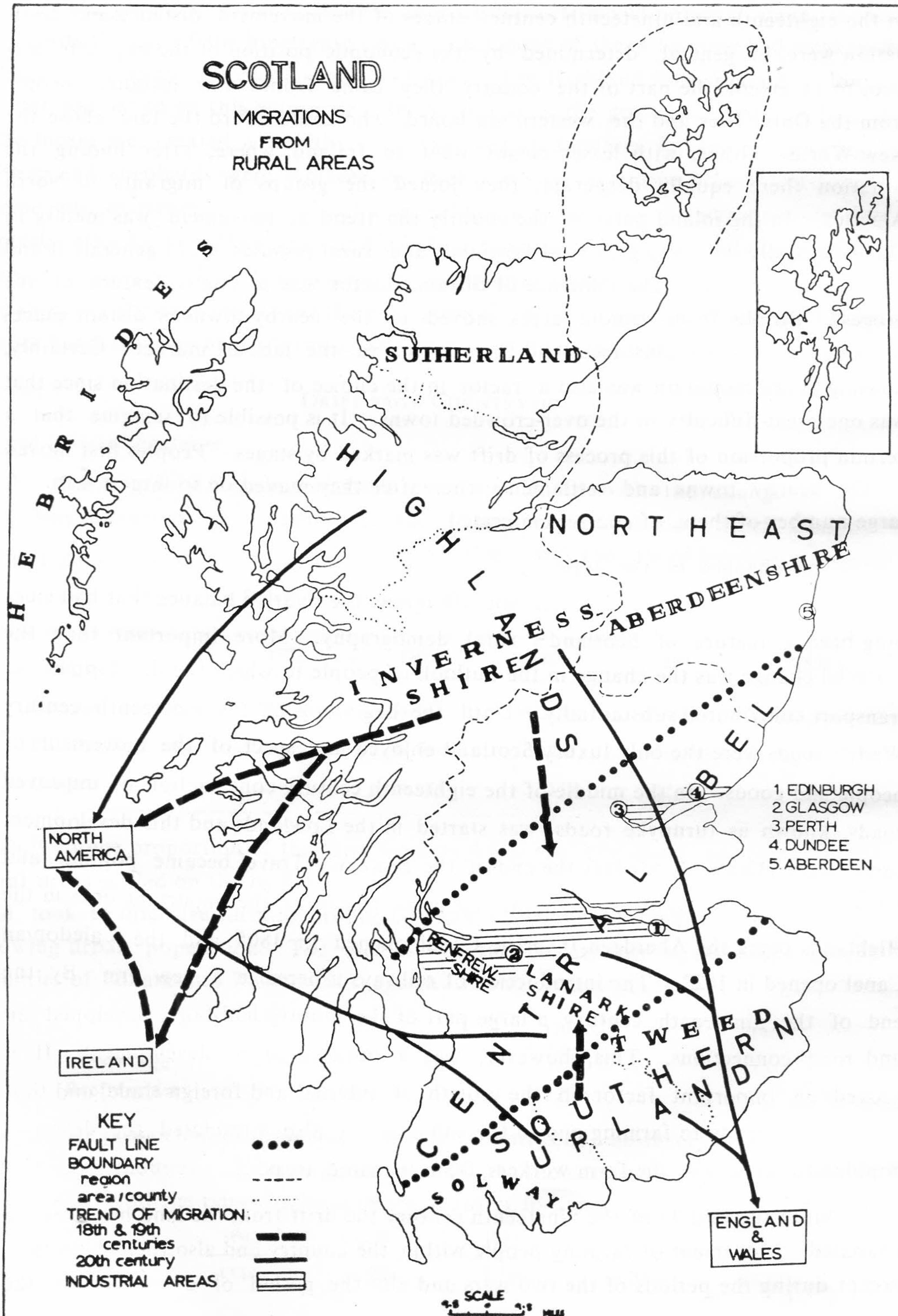
SCOTLAND
MIGRATIONS FROM RURAL AREAS
HEBRIDES
SUTHERLAND
HIGHLANDS
NORTHEAST
ABERDEENSHIRE
INVERNESS SHIREZ
CENTRAL BELT
RENFREWSHIRE
LANARKSHIRE
TWEED
SOUTHERN UPLANDS
SOLWAY
1. EDINBURGH
2. GLASGOW
3. PERTH
4. DUNDEE
5. ABERDEEN
NORTH AMERICA
IRELAND
ENGLAND & WALES
KEY
FAULT LINE
BOUNDARY
region
area/county
TREND OF MIGRATION
18th & 19th centuries
20th century
INDUSTRIAL AREAS
SCALE

FIG. 1

thirties, has been at a fast rate. This is borne out by the urban-rural ratio in 1861 and 1931.

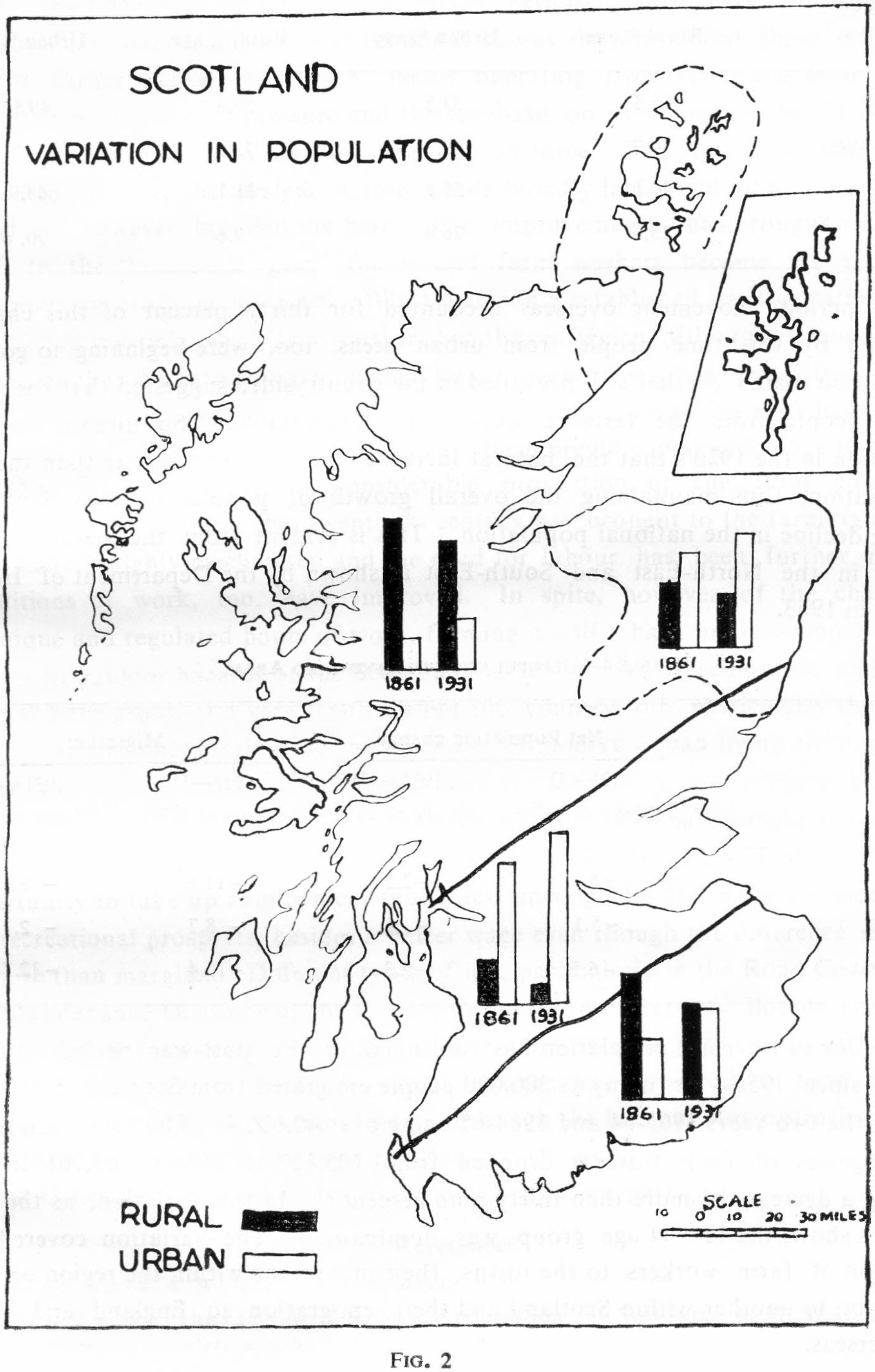


FIG. 2

TABLE 3—DISTRIBUTION OF RURAL AND URBAN POPULATION[19]

| Region | 1861 | | 1931 | |
|---|---|---|---|---|
| | Rural %age | Urban %age | Rural %age | Urban %age |
| South | 66.5 | 33.5 | 50.9 | 49.1 |
| North & West | 84.7 | 15.3 | 73.3 | 26.7 |
| North & East | 40.1 | 59.9 | 31.1 | 68.9 |
| Central | 23.6 | 76.4 | 9.6 | 90. 4 |

In this period, movement overseas accounted for thirty percent of this change. Although by this time people from urban areas, too, were beginning to go out, "emigration mania",[20] that still prevailed in the countryside, suggested that the share of the people from the farming sector was considerable. So intense was the emigration in the 1920's that the natural increase that had been higher than the loss by migration, thus maintaining the overall growth of population, was depressed causing decline in the national population. This is evident from the percentage of change in the North-East and South-East as shown by the Department of Health Survey in 1963.

TABLE 4—DEPOPULATION IN LANDWARD AREAS

| | Net Population change | | Migration | |
|---|---|---|---|---|
| | 1921—31 (%age of 1921) | 1931—47 (%age of 1931) | 1921—31 (%age of 1921) | 1931—47 (%age of 1931) |
| Solway | -5.3 | +2.2 | -11.8 | - 6.0 |
| Tweed | -5.1 | - .4 | - 8.7 | - 2.1 |
| North-East | -6.5 | -2.3 | -15.4 | -12.7 |

The decline in the rural population has continued in the post-war period. In the decade since 1950s' as many as 300,000 people emigrated from Scotland, figures for each of the two years 1963-64 and 1964-65 being over 40,000.[21] The total number of all categories of farm workers dropped from 105,127 in 1950 to 63,761 in 1965 showing a decrease of more than thirty-nine percent.[22] In this variation, as the 1959 statistics show, the 15—44 age group was dominant.[23] The variation covered the migration of farm workers to the towns, their movement within the region or from one region to another within Scotland and their emigration to England and Wales and overseas.

*Twentieth Century Trends and Contrasts with Earlier Periods*

The drift from the land in the twentieth century differs in some respects from that in the nineteenth century or the earlier periods The relative difficulties of the environment underlie all the socio-economic causes that produced these differences. In the earlier periods the "push" factor operating from within was all important. The growing population pressure and the emphasis on economic rather than social criteria in matters of land use were the driving force. The Agricultural Revolution helped to improve the system within limits broadly laid down by the environment. It did not, however, broaden the base. The improvements thus brought about gave birth to the "economic gain" factor and farm workers became the victims of economy and profit on the farm. When machinery established itself in national life, it attracted not only the farm worker but the craftsmen, although it would be safe to assume that the former were in far larger proportion than the latter. In the twentieth century the causes as well as the composition of the drift have become more complex. The farm workers no longer have previous preponderance in numbers but they still account for a considerable proportion of the rural population. Technical changes that the twentieth century has brought to the farming industry have made it highly mechanised and the need for labour has been further reduced. Conditions of work, too, have improved. In spite, however, of the changes in technique and regulated hours of work, farming is still a hard job in as much as it is subject to outdoor hazards of the Scottish climate. Urban development and urban outlook have grown at a very fast rate but the country-folk, particularly those associated with farming, rarely have the amenities of modern urban living although these are not out of their reach. The development of transport in this century has minimised time and distance in travel. This change appears to have caught the imagination especially of the younger worker in farming and he is on the look out for an opportunity to take up employment that is less uncongenial and promises wider social and recreational prospects, besides a better wage even though the difference may not be more than marginal. Different types of job, particularly in the Road Construction and Maintenance Divisions of the County Councils, the Electricty Boards and Road Haulage are some of the avenues open to the farm workers. In the twentieth century-stage of drift from rural areas, the "pull" factor has appeared to have assumed greater emphasis than the "push" factor, although the latter is also operative. Long established contacts and kinship, in England and Wales as well as overseas, particularly in Canada and United States, still play a significant part.

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# LANDFORMS OF PESHAWAR VALE

MOHAMMAD NAWAZ SYAL
MOHAMMAD AFZAL

## INTRODUCTION

THE region under discussion makes a distinct geographic unit of West Pakistan and includes Peshawar and Mardan Districts and parts of Khyber, Mohmand and Malakand Agencies and Swat state. This unit is characterised by its exquisite landforms, variegated soils and parent materials, and unique sedimentary and erosional history. The region provides such an interesting, soil-geomorphology research study that it can be called a museum of landforms soils of West Pakistan.

The main object of this article is to describe the landforms of the region giving a detailed account of their genesis and morphology in a simplified form. In addition it is aimed at incorporating all the information collected from the area during frequent visits after the completion of soil investigation in the year 1967.

## LOCATION AND EXTENT

Except for the south-eastern boundary which is demarcated by the Indus river, the area is ringed on all sides by mountains: Swat Range in the north, Khyber Range in the west and Kohat Range in the south. Only a narrow belt of these ranges is included in the study, the total area is about 3,440 square miles.

## CLIMATE

The area has a hot subtropical continental climate which is semiarid in the north western corner and subhumid in the remaining parts. In the northern parts more than half of the total rain is received in the winter whereas in the eastern parts of the vale summer rainfall gradually exceeds winter rainfall.

## HYDROLOGY

Kabul and Swat Rivers discharging in the Indus River near Attock mainly govern the surface and groundwater hydrology. A network of gravity and lift canals emanating from these rivers is the chief source of irrigation supplies. The rivers are

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largely rainfed and hence seasonal. Serious floods from these rivers are rare. Catastrophic floods in the Indus River, however, may create a temporary blockade for natural discharge of Kabul River damming or sometimes reversing its flow. As a result of seasonal flood situation, groundwater table has risen in piedmont alluvial plains. In the remaining area intensive irrigation has locally created high watertable conditions. The gradient being higher, the Kabul and Swat Rivers also serve as drainage channels. Most of the water-logged areas could easily be drained through a system of drains. Due to uneven relief especially in the upper reaches of the valley, runoff from the adjoining areas is responsible for accelerated erosion and hence for rejuvination of the land surfaces. No arrangements have been made to control the runoff in the area.

## Description of Landforms

The description of the main landforms starts with a brief account of the nature of parent material and its mode of deposition. This is followed by the main surface features on the basis of which each landform is characterised. Summarized in another paragraph is the basis of split of each main landform. Names of the sub-regions used in the following text, are as given by Frazer.[1]

The descriptions of landforms are based on Reconnaissance Soil Survey of Peshawar Vale, Peshawar and Mardan Districts.[2] They are improved and recapitulated on the basis of latest criteria and nomenclature, standardized and used by Soil Survey Staff, Soil Survey Project of Pakistan.

### *Piedmont Plains*

The piedmont plains have developed predominantly in Subrecent and Pleistocene mountain outwash deposits originating from ranges such as Khyber, Kohat and Swat. They are quite extensive in the area and occur in Bara piedmonts and Barani rims. The nature of the derived detritus of each range varies and reflects the nature of the parent rocks. The material of Bara piedmonts is reddish and that of Swat Range piedmonts brownish in colour. In texture both are almost similar. At places, piedmont deposits also contain loess admixture derived from severely eroding loess covers of the mountains.

Piedmont plains are characterized by their distinctive slope from the mountain base to the basins or other plains, their aggrading stream patterns close to mountains and by their peculiar calibration of sediments along the slope.

Piedmont surfaces are largely constructional, but as a result of occasional lowering of base levels of streams, they had been switching over to erosional cycles which obliterated some parts of the surface significantly. In addition, some local uplifts have exposed the pleistocene alluvial fans which represent the oldest piedmont material of the area. The exhumed fans were also subjected to severe erosion in the past and reduced to badland. A part of the old piedmont plains (south of Peshawar city and south south-west of Nowshera) received a thick mantle of loess in the Late Pleistocene. Due to uneven original surface the loess cover was subjected to severe erosion in the Early Holocene and it ultimately acquired a ridge-and-trough configuration. Loess cover remnants are on the ridges and gravelly piedmont deposits in the troughs. This surface has not been included in the Loess plains as most of the loess cover has gone and only small ridges are left.

Based on the nature of the sediments, degree of dissection, relief conditions and other surface features such as presence of gravel pavements and coalescing stream pattern, the following landform units have been recognized (Fig. 1).

*Gravelly alluvial fans* (P1) occupy the uppermost reaches of the piedmont plains. They constitute alluvial fans which are built up at the base of the mountains by torrential streams emerging from them. Having higher gradients the streams attain considerable energy while passing through the mountains. They remove unconsolidated material of various calibres ranging from stones to clay. As the streams enter the plains, their gradient abruptly drops, and hence the acquired energy. The bulk of the coarse stream-load is deposited in streambeds, thus clogging them completely. The streams are forced to seek other courses. Repeated change of courses leaves behind a braided stream pattern. When braided patterns of one stream coalesce with others, vast extremely gravelly plains are evolved.

In the Late Pleistocene probably the entire old gravelly piedmont was covered with a loess mantle. Most of it was essentially removed by erosion and only isolated pockets are intact. Apex of the fans (stony land) lie close to the mountains and the main body of the fans (gravel land) radiates away from the mountains. Extensive gravelly stream beds in lower and middle reaches of piedmont plains are also included in this unit.

*Dissected plains* (P2) represent the middle reaches of the piedmont plains. At places middle reaches appear to be lowest reaches as original lowest of the sequence have been eaten up by erosional streams running across the piedmont plains. This surface is largely erosional but preserved due to presence of gravel pavement at the surface. Small areas which represent table lands are comparatively stable. Higher parts of this unit gently merge with extremely gravelly sloping plains (alluvial fans) and lower parts with level aprons. At places where level aprons are absent this unit links with piedmont river plains or redeposited piedmont plains, usually through an escarpment.

The sediments are gravelly loams throughout or gravels may be present in the profiles as thin veneers (Milward and Mansooka series).

*Level aprons* (P3) represent the lowest reaches of the piedmont plains. They are nearly level and the surface is largely stable (Early Holocene). Some torrential streams pass through it and a small area adjacent to them is slightly eroded or susceptible to erosion in future. The surface of this unit resembles level loess plains. Probably due to this reason I. S. Frazer named a part of this unit as Basin plains. The alluvium is mostly reddish brown clay or silty clay and contains considerable proportion of loess admixture (Peshawar soil series). This thickness of alluvium increases downslope.

*Piedmont alluvial plains of Kabul and Swat rivers* (P4) has been a controversial landform unit due to the diversity of its surface features. It exhibits riverain pattern typical of a floodplain, as well as features representative of a piedmont plain. Presence of levees, backslopes, backswamps and meander scars indicates that this unit is a floodplain. However, higher gradient of streams, its characteristic fan shaped appearance and sortation of sediments along the slopes, classifies it as a piedmont plain. This unit is about ten feet lower than the surrounding landforms, loess plains, piedmont plains and river terraces. The extent of this unit is discontinued below Nowshera, as the Kabul river follows a course modelled by some geologic upheaval of piedmont deposits near Jehangira.

Nearly level parts (Warsak and Charsadda series) are extensive, whereas basin (Shabqadar series) and levees (Khazana series) are minor. This unit represents Early Holocene sediments.

*Redeposited level plains* (P5) have been formed in erosion products of the level or undulating plains. It is younger in age than the rest of the units of piedmont plains. It is perfectly level and is flooded occasionally by Bara river. The surface is mainly depositional. It may have a thin gravel cover at the surface. A part of this unit occurring south of Nowshera, is saline due to high water-table conditions.

The reddish brown fine silty material (Tarnab series) occurs north of Pabbi whereas brownish material (Toru series) occurs on its south, both on right bank of Kabul river.

*Loess plains*

The loess plain is one of the most important and characteristic main landform of the region. It is quite extensive in Peshawar vale. The remnants of loess pockets all over the valley indicate that it had probably mantled the entire vale to begin with.

This landform has been recognized in the wind-deposited material known as loess which constitutes thick deposits of silt, usually accompanied by some clay and fine sand. The loess material originated presumably from unstable and young flood-plain deposits of Late Pleistocene. It has been transported by cold winds and deposited far away from the source. At the time of deposition loess particles were fresh except for their oxidation which imparted them a characteristic yellowish brown colour. Loess deposits are further characterised by their homogenity which is attributed to uniformity and fineness of particles and thus to incapability of showing up distinct layering. Some layering at lower depths of loess deposits is, however, observed in the deep gullies (as near Lundkwar). This stratification of silty and fine-sandy materials is attributed to redeposition during the following interglacical periods of melted loessic mud of the early glacials. Physical characteristic of stratified and overlying homogeneous loess is strikingly similar. This confirms at least two loess ages. In Rawalpindi area a third loess age has also been confirmed.[3]

Deposited spontaneously, loess covers valleys, sloping piedmonts, pediments and low slopes of mountains facing winds of glacial periods. Unlike fluvial sediments it does not even out the land features, rather leaves their reminiscence. Evidence of fluvial loess redeposited under permafrostic conditions explains occurrence of vast loess deposits only in valleys, thereby obscuring entire original features. As a result of redeposition, loess sediments have not been contaminated with any other materials. The only change that might take place in the process of redeposition is preferential resorting of particles which, though not significant, has been pointed out while recognizing the soils of the region.

On the basis of degree of severity of erosion, age and configuration of the land surface, the following units have been recognized in this landform :

*Level plains* (L1) represent the Pleistocene stable surface and are least affected by erosion. They occupy table lands of loess plains. These areas were probably perfectly level at the time of deposition of loess. Micro-relief differences are barely discernible. The silty material has developed to fine-silty or clayey. Soils are deeply homogenized with redistributed lime and a thick kankar zone. Soils of convex sites in subhumid area and concave sites in semiarid climate are *Guliana series*.

*Dissected plains* (L2) represent a subrecent erosional surface in Pleistocene loess parent material. Three types of original surfaces eroded chronologically to sculpture this unit. Firstly, some parts of the loess plains remained stable for a considerable period and developed as *level plains*, but subsequently eroded (in the subrecent) as a result of lowering of base level of erosional streams. This fact is reflected in the striking similarity of some characteristics of soils of this unit with those of level plains. Presence of thick kankar zones inherited from older profiles at shallower depths (Tangi series) and comparable texture of the sola, are examples. Secondly, the slightly sloping or very gently undulating original surfaces eroded slowly concurrent with their development and evolved moderately sloping or undulating surfaces (Mackeson). Thirdly, the entire loess plain in general, and sloping original surface in particular, were encroached by geologic erosional cycle in the subrecent and caused severe gully erosion. Most of the loess cover on sloping sites was removed exposing the underlying resistant strata *i.e.* gravelly piedmont surface etc. Intricate shallow and moderately deep gully pattern associated with active mass wasting in the upper reaches and steep gullies, pinnacles and flat gully bottoms (peneplains) in the lower reaches of loess plains, are the characteristic surface features of this unit. Recent erosional surface wherefrom loess mantle of considerable thickness has gone (Rajar series) represents extreme sheet erosion whereas extreme gully erosion has reduced the surface to severely eroded land or *badland*. The flat gully bottoms receive fresh sediments from young streams and have developed narrow belts of floodplains at places.

*Redeposited level plains* (L3) represent subrecent surface. It developed in erosion products of level and undulating loess plains. These preweathered outwashes settled in the outskirts of their sources in level areas where erosional streams peterout in basins. This subrecent depositional surface merges gradually with the Pleistocene surface. No sharp line separating Subrecent and Pleistocene surface could be drawn in the vale. However, transitional zone as well as true Subrecent surfaces are represented by *Sarchri series*.

*River terraces and floodplains*

The river plains of the region are also quite interesting, in the sense that their characteristics are comparable to the landforms of river plains of the Punjab. They are developed largely in mixed and locally in local alluvial deposited by the Indus and some tributaries of Kabul river such as Kalpani and Badri Khwar. Unlike Punjab, the landforms of this region are, however, not associated with braided river system, but developed in upper valley deposits wherein sedimentation has been gigantic and erosion catastrophic all under different situations.

Age of land surface is considered the main criteria for naming and describing these landforms is addition to surface configuration.

*Rolling River Terrace* (T1) includes the entire Sari-Maira subregion. It is characterized by its high elevation and by its rolling topography. The sediments of the terrace were sandy or coarse loamy at the time of deposition, (excavated material of a newly drilled well near Jagannath canal rest house of Machai Branch, showed semi-consolidated river-wash sand similar to terrace material, under thick mantle of loess).

Thick body of alluvium of the terrace is suggestive of the fact that they are not associated with normal high floods of the rivers. It appears that abrupt rise of local base level of Indus river probably due to land-slides or ice-plugging in gorges at Tarbela or due to some other unusual event linked with crustal movement, reduced its energy considerably. Most of its load settled under dammed conditions which confirms abnormal thickness and uniformity of sediments.

At some later stage, essentially after one soil development stage, the base level of the Indus river abruptly dropped and it sculptured a terrace from its valley floor. The huge alluvial fill was reduced to a well-defined terrace.

Evidences of covering of the terrace by the last loess are available from outside the area.[4] Presence of sandy river-bed material under loess very close to the river terrace as pointed out earlier is the only evidence available within the area. The entire loess cover has presumably eroded away completely.

Strangely enough, some big boulders (up to 5′ in diameter) are observed on the river terrace in addition to gravels and scattered pebbles. The nature of boulders may be erratic (subject to mineralogical analysis of terrace sediments). As given by Wadia the material of these blocks (mostly granitic) suggests their derivation from higher and central ranges of Himalayas.[5] The size is too big to be transported by river water. Such big boulders are essentially transported by valley glaciers. Question arises, how did the boulders came up on the terraces. If we link the alluvial fills of these terraces with moranic activity, the existence of boulders could be explained.

Exposed mudstone strata on right bank of Indus near Lahore village is strong evidence of uplift of Sari Maira terrace. Mudstone is semi-consolidated laminated silty material. It shows characteristic varved structure and is essentially of glacio-lacustrine origin. Exposed mudstone strata has been observed at places all along the southern edge of Sari Maira terrace which collectively make an excellent fault line. This fault line has been indicated in the geomorphological map of Peshawar vale.[6] It can be inferred from the above evidence that the *boulders on the terrace may be remnants of upturned bouldery riverbed material essentially of glacial origin.* As a result of uplift the loess mantle would have at once eroded and the terrace material was thus saved from further over-sitting by younger sediments.

*The Subrecent level plains* (S1) have developed in the Subrecent mixed river or local outwash alluvia. It makes an intermediate flat surface between the terrace and annually flood recent surface along the rivers. They are separated from Recent plains by a steep bluff two to four feet high, but locally transition between the two plains is gradual. It is not frequently flooded, only depressional areas are flooded occasionally by peak spills. The spill deposits from rivers or outwashes from terraces have evened out all the riverain or past erosion features. The drainage pattern of level plains above Attock gorge is perpendicular to the Indus river. In addition, a few meander scars and levee remnants are also observed within level plains. Both these evidences confirm that this part of level plains has developed largely in local alluvium from terraces which has been admixed with river alluvium. At places level plains have developed in mixed river alluvium of Kalpani and Badri Khwar rivers.

*Levee remnants* (S2) cover small areas occurring within the Subrecent level plains. They are elongated ridges and comprise of coarse sandy Indus alluvium. The soils are mostly decalcified (Sodhra non-calcareous variant).

*Infilled basins* (S3) comprise the Mardan basin occurring slightly lower than redeposited loess plain and the old course of Indus river which runs along the southern scarp of the Rolling river terrace. The basins have been filled by the sediments derived from soils of the loess plains and by sheet floods from the Indus river respectively. Mardan basin is represented mainly by Mardan series and infilled river bed by Marghus soil series.

*Miscellaneous Areas*

Full investigation of areas having no soil cover or those wherein orderly soil examination is neither possible nor feasible, is beyond the scope of reconnaissance soil mapping. All such areas are identified as miscellaneous and named in terms of landforms and constituent materials. Landform units which are extremely rocky, steep, sandy, dissected, obscured by urban structures, flooded or wet have been classified and interpreted separately.

Despite their inaccessibility for regular examination, some miscellaneous areas exhibit excellent records of the past history of the respective landform units. A very close field examination of some areas of the region for example rock out-crops, exposed mudstone strata, exposed alluvial fan remnants, exposed sand deposits, and deep gullies and ravines in loess throw light on stratigraphy, age, nature of deposits, processes of sedimentation and evidences of tectonic movements. At places piedmont materials intercalated with thick loess deposits represent different glacial and interglacial periods.

So, purely for academic interest, the miscellaneous areas found in the region are described below on the basis of factual, though incomplete observation.

*Dissected fault scarps* (M1) represent exposed mudstone material presumed to be of glaciolacustrine origin and the oldest sediment deposited in the Peshawar Synclinorium and underlies all the sediments.

Mudstone is predominantly silty in texture and varved in structure. Silty plates have loamy or sandy laminations indicating yearly sortation, sands settled first and fines thereafter. Mudstone is faintly mottled indicating past restricted drainage. Thickness of laminations is not the same in all the exposed sites in the valley. This probably indicates unevenness of the lake bottom.

The exposure of the mudstone is definitely linked with tectonic movements. Tilted exposed strata on the left bank of Kabul river near Jehangira support this fact. Further, a chain of exposures all along the southern bluff of the Sari Maira terrace make an excellent fault line. At places old piedmont alluvial fans have also been exposed by tectonics along with the mudstone. Lower Swat canal cuts through both of these sediments near Tangi.

Mudstone is as soft a geologic material as loess. Both of these materials have been entrenched by rain-storms and quickly transformed to closely spaced narrow ravines completely devoid of any vegetation, characteristic of a badland. In Peshawar vale deep ravines near Lunkhwar show a sequence of strata : Conglomerate, mudstone and two loesses. Lower loess is mottled.

*Rocky hills* (M2) is miscellaneous area mapped as narrow bordering rim for plain parts of the region. Width of the rim is selected at random. Mountains and rock outcrops occurring within the plain parts are included. Detailed account of stratigraphy and orogeny of these formations is beyond the scope of this paper. Most of the outcrops of Peshawar vale are aligned along the fault lines observed during the survey.

The area is dominantly rocky or stony and includes only small areas having thin soil cover which supports vegetation. Local relief is generally more than 500 feet.

Minor areas occupied by urban land, active river-beds and marshland are grouped with the surrounding landform unit as inclusions.

## Geomorphological History

The landforms of the area have mainly been influenced by Cenozoic events. Within this era information regarding the Tertiary period is mainly based on works of Wadia,[7] whereas the Quaternary exclusively on our own research during Reconnaissance Soil Survey of the area.

*The Quaternary* of the Cenozoic era of the region provides very interesting events that have been studied to explain the present landforms chronologically. It has been subdivided into two parts, the Pleistocene and the Holocene. The Pleistocene (representing ice age) has been again divided into three main time units that explain its major episodes. They are : Early Pleistocene, Middle Pleistocene and Late Pleistocene. Two main divisions of Holocene i.e. Early Holocene and Late Holocene explain landform differences of the floodplains. All the Subdivisions of the Quaternary have been based on the degree of soils development and are tentative. The soil characteristics that determine relative age of soils and hence of landforms are depth of homogenization and decalcification and illuviation of weathered clay or undifferentiated soil mass, presence or absence of ferromanganeze and lime nodules. In addition, the physiographic position, origin and nature of parent material also furnish geochronometric evidences for relative dating. Absolute dating is beyond the scope of this study.

The *Early Pleistocene* (first and second glacial) is represented by large scale uplifts. The rejuvinated tributaries of the Indus deposited thick beds of fluviatile gravel and boulders in the Peshawar Syncline. First and second glacials (as represented by Wadia),[8] could not be distinguished during this study. The sea further receded and deposition of sandy material from rising Himalayas in the Indus floodplains started. The fines of these sandy deposits became the source of loessial deposits in the valley as explained in the foregoing text. Boulder and gravels partially consolidated to form conglomerates.

During the Middle Pleistocene the Peshawar Syncline was transformed into a glacial lake fed by surrounding piedmont glaciers. The lake received alternating silty and fine sandy laminae from the melting glaciers. These laminae are characteristic varves and represent particle size variation due to seasonal changes of interglacial periods. The varves are pretty young and have not been consolidated to siltstone. This glaciolacustrine deposit has been referred to as mudstone in the following text.

The third glacial resulted in deposition of a thick blanket of loess all over (first loess). The Peshawar lake was also silted by loess and converted into a marsh. The loessic sediments were mottled during the subsequent interglacial.

The depositional cycle was interrupted by large scale upheaval, folding and faulting (middle part of Middle Pleistocene). The tertiary sediments tilted to varying degrees, and were partially exposed (rock outcrops of valley). The upheaval changed the drainage pattern of most of the streams. The Kabul river flowing some other direction was thrown in the faulted area and acquired the present course. The Indus river course was also blocked by this upwarping or consequent landslides above

Terbela. The creation of dam-like situation resulted in a huge water storage. The dam ruptured and abrupt release of storage caused flash flooding down stream. The Attock gorge being narrow, the Indus split into a second course around Kala Chitta Range in Campbellpur District. As a result of flash floods the river deposited thick mainly sandy alluvium along its courses.

Another uplift (later part of Middle Pleistocene) exposed mudstone strata along different fault lines the most conspicuous of which was that linking Lahore and Jhangira town. The overlying bouldery riverbed material and sandy flash flood deposits were also uplifted, along this fault line. Consequently an erosional cycle started and shaped Sari-Maira terrace. The loess deposits completely eroded from all but the basinal site. In general the Middle Pleistocene ended in the start of an erosional cycle all over the area.

*The Late Pleistocene* is the most important period of evolution of the landforms. The last glacial resulted in deposition of another thick cover of loess in the entire area. The sloping sites of loess eroded and Piedmont deposits extended over the dissected loess plains close to the mountains. The lower reaches of the piedmont plains received clayey sediments or gravelly loams. The higher reaches (alluvial fans) received mainly gravels and stones. Dissection of piedmont plains and gently sloping loess plains started. Soil formation started in level loess plains, piedmont aprons and river terraces. A part of the terraces was reworked by wind to undulating surface. The exposed mudstone eroded to badland and only a part of it weathered in place and partially eroded.

The Early Holocene is represented by 1) continuation of erosion cycle started in the Late Pleistocene in loess plains, piedmont plains and river terraces, 2) redeposition of erosion product from Pleistocene landforms in the adjoining low areas, 3) continued soil formation in level loess plains, 4) deposition of finer material in flood plains and piedmont alluvial plains of Kabul and Swat rivers. A part of loess plains eroded to form sloping and undulating plains and preweathered sediments derived from eroding loess plains deposited in the areas where erosional streams petered out. Erosion product of piedmont plain deposited similarly and evolved redeposited piedmont plains.

During the Middle Holocene negative movement of base levels once again sculptured subrecent terraces i.e. piedmont alluvial plains of Kabul and Swat rivers, Subrecent level plains, Subrecent levee remnants and Subrecent basins and channel infills (S 3). Partial erosion and occasional deposition by river spills is still going on in these landform units. Erosion of sloping and soil formation in level landform units continued.

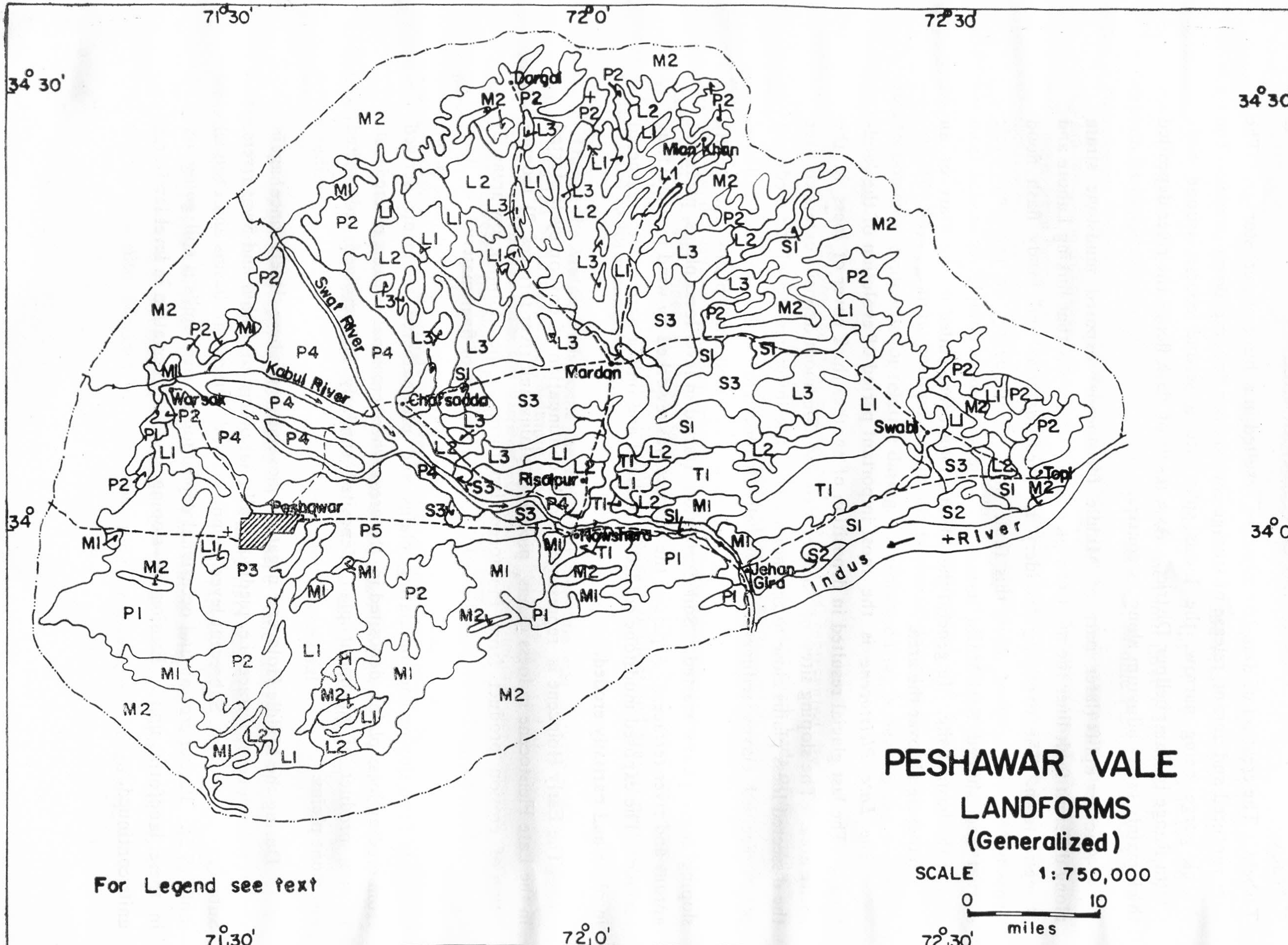
PESHAWAR VALE
LANDFORMS
(Generalized)
SCALE 1:750,000
0 10
miles
For Legend see text
71°30'
72°0'
72°30'
34°30'
34°0'
Swat River
Kabul River
Indus River
Dargai
Mian Khan
Mardan
Charsadda
Warsak
Peshawar
Risalpur
Nowshera
Jehan Gira
Swabi
Topi

FIG. 1

## *GENERALIZED LANDFORMS OF PESHAWAR VALE MAP LEGEND*

| *Map symbols* | *Landforms* | *Main soils and land types* |
|---|---|---|
| | *Piedmont plains* | |
| P1 | Gravelly alluvial fans | Gravel land, stony land, Rajar, Mansooka, Nammal gravelly. |
| P2 | Dissected plains | Miliward, Mansooka, Peshawar. |
| P3 | Level aprons | Peshawar. |
| P4 | Piedmont river plains of Kabul and Swat rivers. | Warsak, Charsadda, Shabqadar, Khazana. |
| P5 | Redeposited level plains | Ternab, Toru. |
| | *Loess plains* | |
| L1 | Level plains | Guliana. |
| L2 | Dissected plains | Tangi, Mackeson, Rajar Badland. |
| L3 | Redeposited level plains | Sardheri. |
| | *River terraces* | |
| T1 | Undulating plains | Wazirabad, Kunda. |
| | *Subrecent floodplains* | |
| S1 | Level plains | Toru. |
| S2 | Levee remnants | Sodhra non-calcareous variant. |
| S3 | Infilled basins | Mardan, Marghuz. |
| | *Miscellaneous areas* | |
| M1 | Dissected fault scarps | Badland, Dune land. |
| M2 | Rocky hills | Rough mountainous land. |

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*Mobility and the Small Town 1900—1930*, Norman T. Moline, University of Chicago Press, Chicago (1971), ix, 169 pp., tables, maps, photographs, bibliography.

*Mobility and the Small Town* is a research study concentrated in and around Oregon a small town in Illinois which had experienced population stability and moderate growth throughout the 20th century. The study considers the increase in mobility from the arrival of the automobile and improved roads and the consequent changes in the spatial dimensions of small town activity during those years.

The various means of transport are so commonplace to most of us today that we are apt to forget the vital role which the development of transport modes has had on the development of an area. In the present century, the private automobile has played the most important role. Succeeding generations have witnessed the development of new and improved means of transport demanded by a social and economic system that requires increasing mobility for its very existence.

In the introduction the author gives the methodology used by him, a few words on which would be of great value. The research was carried out by unstructured interviews with citizens, detailed readings of newspapers of the year 1900—1930, personal diaries (of which only four were available), country and city records, hotel registers, railroad records and railway timetable. Newspapers always reflect the perceptions, the opinions and the biases of the editor, but still they provide the most complete written record on time.

The first two chapters are devoted to the study of geographical location of Oregon and means of transportation before the arrival of the automobile. The people had a great desire for better transportation but they were helpless as it was in the hands of the state government to provide railway links. Moline makes a detailed study as to how people of Oregon tried for electric Interurban Railway but failed in their efforts. The principal means of transportation before the arrival of the automobile was by animal driven carts, buggy or by foot. So one can say that in 1900 Oregon hardly possessed any characteristic which could be classed as mobility.

The third and fourth chapters mark the arrival of the automobile in Oregon. The effects of the automobile on the growth of urban activity have been so great as to render the impact of public means of transportation insignificant by comparison. The arrival of the automobile had its obvious counterpart in the decline of the horse and buggy. While motor transportation was rising to a position of importance and horse drawn transportation was declining there was a marked period of transition on which a lot of emphasis has been placed by Moline ; this was a period when both automobile and horse drawn vehicles occupied the streets and country roads. The horse drawn buggy had the obvious limitation of slow speed over dirty or muddy roads and the fatigue of the horses. Accompanying the rise of automobile were improvements in roads and the evolution of a true highway system.

Moline has reflected the feelings of the people to every change that occurred in transport, the quest of the people for better transport means is revealed by the fact that they worked together for the improvement of roads and transport.

Chapters five and six deal with the effects of the automobile transport on the social and economic life of the people of Oregon. Oregon's desire for good surface external connection, together with the growth of the automobile and good roads gave to the area residence new potential for movement. The commercial character of the town also underwent certain changes ; new services related to automobile arose, and the commercial life of Oregon boosted, grew and expanded its trade territory. The tourist industry is also related to the automobile.

An extreme event relating to the effects of automobile was that in 1920 there were people who lived in one town but worked in another. The beginning of movement of the people to the suburban areas was also a feature of this time.

At certain places one feels that Moline has deflected from his true path of research when he gives too much detail on certain events of lesser importance, such as tracing the history of automobile manufacture. But still all this has been written in such a way, with reference and footnotes, as to make the study interesting.

One of the aspects the author has missed out is a study of fare and freight rates which change with changing means of transport and would have added more to the usefulness of this research work.

*Mobility and the Small Town* based entirely on personal research is in such a detail which is indeed commendable. It offers much as a model for young geographers doing research. The maps, figures, and photographs all contribute to the high value of the study. Perhaps the illustrations of the tables by statistical diagrams would have made the book more attractive and useful. The time-distance maps in the book however should be of great interest to the readers. The most impressive aspect of the book is its richness in footnotes and bibliography which reveals that the author has taken great pains to collect geniune information.

Moline has explained the facts so well that one feels himself to be very familiar with the arrival of the automobile and the changes that occurred thereafter. Perhaps no one has done anything comparable on the affect of the automobile on rural life in the United States.

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*Heart Disease, Cancer and Stroke in Chicago*, Gerald F. Pyle, University of Chicago Press, Chicago (1971), xxi, 292 pp , tables, figures, graphs, maps, appendix, bibliography.

Health planning is an entity which has only recently received anything more than cursory attention by urban planners. Urban planners have been made use of in the field of Health Planning only during the 1960's and it is even newer to urban planning agencies, many of which are just now starting to consider planning of health care facilities as part of their responsibility.

*Heart Disease, Cancer and Stroke in Chicago* views the complex process of change towards more and more planning on the part of health care interests as a part of a longer continuum in which many external elements have forced the changes. Changes in health planning appear to be aligned strongly with urban change. The problem presented in the study is development of a locational efficiency model for treatment of 1980 incidence of heart disease, cancer and stroke. The approach to the problem has several important steps that offer contributions to urban geography and health care planning.

In the first chapter development trends in health care facilities system after 1946, show the implanation and rise of hospitals and other health care planning agencies. With the growth of planning agencies came the notion about geographical area coverage; the idea about health care functions of hospitals having already been well established.

The importance of planning had become clearly apparent, new health legislations were geared to a metropolitan power base, suggestions included the projection of future need, planning for an orderly distribution of facilities, projection of financial resources, scheduling construction work and devising means to carry out plans. The public was made aware of the available facilities through publication of various bulletins, technical reports and research papers. As public confidence in hospitals grew the death house stigma was removed and public demands led to unprecedented growth.

Proper planning of health care facilities depends heavily upon the analysis of spatial and temporal aspects of disease incidence. The second chapter deals with ways in which heart disease, cancer and stroke are apt to vary spatially.

Three approaches are used for an understanding of the spatial variability of disease: 1) Physical environment, 2) Epidemiological variables, 3) Geosocial pathology (geographical version of medical sociology). As techi ological advances bring more environmental and epidemiological control, all areas of the urban settlements do not benefit equally. More recent studies indicate that now social causes are more important than environmental ones but the latter cannot be ignored. Health differences in poverty stricken and non-poverty stricken areas are extremely pronounced.

The primary intent of chapter three is to build a calibrated sub-model which will function as the mechanism for providing mobility and mortalit\ inputs to the final allocation model for the treatment of heart disease, cancer and stroke.

In this study the important point is that methods of path analysis are used to show how a larger number of variables important to urban ecology tie into the key variables used as dependent elements in the construction of the mobility/mortality model. Both the disease and ecological variables change over time in their spatial distribution; very different forecasting models are used to predict disease distribution in 1980.

In chapter four internal affects of past growth, the nature of existing hospital hierarchy and the comparative cost of different sized hospitals are explored.

The subject of chapter five is primarily to inventory the existing treatment facilities for the major cases of stroke, cancer and heart disease.

In the sixth chapter the inventory is utilized for a series of allocations. Included with general counts of facilities are actual use data. These data are projected to determine approximately as to how many additional facilities will be needed, since the patients expected by 1980, will exceed existing capacities if no new facilities are added. Studies of mobility/mortality ratios combined with various reported survival rates are used to estimate the possible supply of patients.

The allocation model works best for cancer treatment. There are several reasons for this, cancer is often easier to identify whereas the morbidity estimate for heart disease and stroke are less precise and in many cases overlap strongly.

In the seventh chapter a general conclusion is drawn as to actual hospital allocations on the basis of population, mortality and morbidity estimates for 1980.

The monograph is rich in footnotes, maps, tables and bibliography. It may be noted that the cartographic methods employed while not new to disease mapping, have rarely been used and this effort is the first attempt to apply it to urban area disease mapping. Appendixes A-E at the end of the book contain some very valuable tables such as Disease forecasts for 1980, reported mortality and morbidity estimates and Demographic and Socio-economic forecasts from 1967 and 1980.

The determination of optimal locations of new treatement facilities is the major accomplishment of this study. Concentrations of surplus patients if no new facilities are added by 1980 have been estimated with a fair degree of accuracy. Knowledge of where these facilities are needed should influence where the new facilities will be added over the next decade.

*Heart disease, cancer and stroke in Chicago* opens a vast field in health planning before the geographers and should make them aware of the great responsibility that rests on them.

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