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CONTENTS

PARENT MATERIAL OF PAKISTAN SOILS

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INTRODUCTION

Parent material is one of the soil forming factors. Being the material from which the soil has formed, it may be a rock or an unconsolidated secondary desposit like alluvium, loess, sand etc. In early days soils were named after the parent material, e.g. granite soils, glacial till soils. lacustrine soils, alluvial soils etc. The influence of parent material on the physical and chemical properties of soils was recognised both by Russians (Polynov, 1930) and Americans (Jenny, 1941). In general, the younger the soil, the greater is the influence of soil parent material on soil properties. As weathering and pedogenic processes advance, the imprint of the parent material on the soil becomes fainter and fainter.

In Pakistan majority of soils have been formed either in the water deposited materials (alluvium) or in wind deposited and resorted materials (loess and aeolian). Comparatively small areas have soils which are formed from rocks 'in situ' or in colluvium, as is the case in areas of mountains, hills and rock plains. It may be mentioned that colluvium is an important parent material in the semiarid, subhumid and humid parts of mountainous areas. River alluvium, estuary alluvium and piedmont alluvium are the three main kinds of water deposits, whereas loess and aeolian sand are the two types of wind deposited materials. Most of the information presented in this article is based on the Reconaissance Soil Survey Reports (1965-1979) produced by the Soil Survey of Pakistan after extensive field work. All the important soil parent materials met within Pakistan are listed and described in the following paragraphs. Their distribution is shown on a map, "Generalised Soil Parent Materials". Legend of the map is included in the text.

Rocks and their Colluvium

All the three main types of rocks (i.e. sedimentary, igneous and metamorphic rocks) are soil parent materials in Pakistan (Wadia, 1966). Of these the most extensive are sedimentary rocks, including limestone, shale, sandstone, conglomerate and dolomite. The second, type i.e. igneous rocks, include granite granodiorite, rhyolite, tuff and andesite. The third group, consisting of metamorphic rocks, comprises schist, gneises and slate. The

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distribution of these rock types is shown on the accompanying map which has been prepared on the basis of Geological Map of Pakistan (Abu Bakr and Jackson, 1964).

By far the most extensive rocks in Pakistan are the sedimentary rocks of Tertiary age, mainly limestone, calcareous shales and calcareous sandstones (mapping unit 1.1 and 1.2) *. From limestone very limited amount of soil material is formed by weathering because its main constituent is lime and only the impurities in it form the soil material. In arid and semi-arid climate limestone is generally bare, soil material occurring only in cracks or as a very thin mantle in pockets. Even its colluvium has very little soil material and comprises mainly gravel and stones. In sub-humid and humid areas thin soils are formed on limestone. Shales are predominantly calcareous and form calcareous clayey soils. The 'in situ' soil depth varies from a few centimeter to about two meters, and is related to the rainfall. Sandstones are both calcareous and noncalcareous. These form sandy soils in arid areas but sandy and loamy soils in sub-humid and humid areas depending upon the age of the surface.

The igneous rocks forming parent materials are comparatively easily weatherable (mapping unit 1.3, 1.4 & 1.5). They are mainly granite, tuff and andesite. Granite weathers into deep coarse-loamy to loamy, noncalcareous, acidic soils, as in Swat Valley. Minor extent of young volcanic rocks have been mapped in Baluchistan (mapping unit 1.3), comprising tuff and andesite. They are rich in potassium and sodium plagioclase which are easily weatherable and form fertile soils. Rhyolites are hard to weather but their extent is very limited as these occur only as intrusions in other rocks formations. Agglomerates also form a part of this group, but they occur only in spots. As these weather slowly, their importance is reduced further.

Metamorphic rocks are concentrated in the northern part of the country (mapping unit 1.6 and 1.7). Members of this group are slowly weatherable and generally form base-rich loamy and clayey soils. Quartzite and dolomite whether to form noncalcareous coarse-loamy and loamy (silty) soils, whereas sehists, gneiss and slates yield mainly noncalcareous clayey (fine silty) soils. Depending upon the inclusions of calcitic materials, soils formed from these rocks are calcareous to various degrees. Marble predominantly vanishes in solution form with no or little soil cover.

Loess

Loess is quite extensive in Pothwar and Lower Himalayan Valleys. It was deposited probably during the last glacial period when the winds wero

*These are mapping units of "Generalized Soil Present Material" map.

forceful enough to form 10-30 m high dunes in the Thar and Thai areas and to carry silt particle upto Lower Himalayas. Although the process of picking of silt size particles by winds from the southern parts of the country and their deposition in the Himalayan submountainous region is still active, but the scale has been drastically reduced. Loess deposits also occur in Peshawar Vale, Mansra Plain, Pabhi Hills and intermountain valleys of Baluchistan, but only in small patches (not mappable at 1 : 5, 000,000 scale). The loess material is very high in silt (70 to 80 per cent), and is strongly calcareous (lime content about 15 per cent). The sand fraction seldom exceeds 15 per cent and it comprises very fine sand only (Ashraf et,al, 1967). The clay content is about 10 per cent. The material is quite rich in weatherable minerals (Tables 1, 2 and 3).

Aeolian Sands

Extensive deposits of sand are found in Thar, Cholistan. ThaI and Chagi areas, these are either deposited by wind or reworked by wind.

Aeolian Sands of Thar and Cholishtan

The extensive deposit of sand in Thar and Cholishtan (mapping unit 3.1) is conceived to be the oldest of the sand deposits in the country (Brinkman and Rafiq 1971). Although the origin or these sands is not certain but most probably these were lifted by winds from the Rann of Kutch and deposited during the late Pleistocene period. Sandy deposit of the Sutlej River during the late Pleistocene is also an important component of these sands. (Brinkman and Rafiq, 1971). Contribution by the Aravalies is also noteworthy, Some Subrecent intrusions have been made by rivers, leaving behind loamy deposits. On the geological map of Pakistan (Abu Bakr and Jacobson 1964), this material is indicated the old aeolian deposits of the Quarternary age (Pleistocene). In view of their elevation far above the present base levels of the Indus and Sutlej courses in the Late Pleistocene, parts of these sands are conjectured to be older than the last Glaciation period.

The main part of the Thar desert, comprising the highest transverse dunes system having dunes about 100 meters high and about two kilometers apart, is conceived to be oldest, possibly belonging to the glacial period (Middle Pleistocene) preceeding the last one (Rafiq, unpublished information). The material consists of calcareous fine sands of pale brown colour and of great thickness (a few hundred feet). There exist a few layers of lime cemented sand (petro calcic horizons), which were observed in some wells in southern Thar. The material contains less mica and more quartz than the sands of the Indus river system. Although quartz dominates, yet the

TABLE 1—*Approximate mineral composition of the silt fraction 2—20 microns, based on X-ray estimates*

Mineral Sample	Soil Series	III.	Chl.	K	Mt.	Mix.	Q	Pl.	Micro	Ca	He	Goe	Ci	Hb	Pal
L 1	Mansehra	+ +	+	0	0	0	+ + + +	+ +	+	+ + +	+	?	0	0,+	?
L 2	Rawalpindi	+ +	+	0	0	0	+ + + +	+ +	+	+ + +	+	?	0	0,+	?
L 3	Rajar	+	+	0,+	0	0	+ + + +	+ +	+	+ + +	+	?	0	0,+	?
L 4	Guliana	+ +	+	0	0	0	+ + + +	+ +	+	+ + +	+	?	0	0,+	?
L 5	Chakwal	+ +	+	0	0	0	+ + + +	+ +	+	*	0	?	0	0,+	?
L 6	Missa	+ + – + + +	+	0,+	0	0	+ + + +	+ +	+	*	?	?	0	0,+	?
W 1	Daro	+ + +	+ +	0	0	0	+ + + +	+ +	+	*	?	?	0	0,+	?

Note-Samples L1 to L6 are from loess material in Potwar region ond WI from Indus delta. All soil samples were taken from the C horizon.

+ + + + Dominant, + + + very frequent, + + frequent, + present, 0, + rare, 0 absent *CaC0$_3$ removed in preparation of clay fraction, ? doubtful

III.. dioctahedral illite, Chi: chlorite, K: kaolinite, Mt: montmorillonite,

Mix: mixed layer smectite, Q; quartz, PI; plagioclase, Micro: micro cline

Ca: calcite, He: hematite. Goe: goethite Gi: gibbsite, Hb: hornblende, Pal: Palygorskite

Source-de Endredy, A. S. Mineralogy of loess and some alluvial soils from West and East Pakistan (Unpublish ed, 1970) Macaulay Institute for Soil Research, Aberdeen, Scotland, U. K.

TABLE 2—*Approximate mineral compostion of the clay fraction, less than 2 microns based on X-ray estimates*

Mineral Sample	III	Chl.	K	Mt.	Mix.	Q	Pl.	Micr	Ca	He	Goe	Gi	Hb	Pal
L 1	+ + + +	+ − + +	+	+ + − + + +	+	+ +	+	+	*	+	+	0	0,+	+
L 2	+ + + +	+ − + +	+	+	+ +	+ +	+	+	*	+	+	0	0,+	+
L 3	+ + + +	+	+	+	+ +	+ +	+	+	*	+	+	0	0,+	+
L 4	+ + + +	+ − + +	+	+ + +	+ +	+ +	+	+	*	+	+	0	0,+	+
L 5	+ + + +	+ +	+	+ +	+ +	+ +	+	+	*	+	+	0	0,+	?
L 6	+ + + +	+	+	?	+ +	+ +	+	+	*	0,+	0,+	0	0,+	0'+
WI	+ + + +	+	+	+ − + +	+ +	+ +	+	+	*	0'+	0'+	0	0,+	?

Note-+ + + + Dominant, + + + very frequent + + frequent, + present, 0' +rare, 0 absent,

*$CaC0_3$ removed in preparation of clay fraction, ? doubtfnl

III. dioctahedral illite, Chi: Chlorite, K: kaolinite, Mt: montmorillonite,

Mix: mixed-layer smectitte, Q; quartz, PI; plagioclase' Micr: microcline

Ca: calcite, He: hematite, Goe: goethite, Gi: gibbite, Hb: harnbloade, Pal; Palygorakite

Source-de Endredy, A. S. Mineralogy of loess and some alluvial soils from West and East Pakistan (Unpublished 1970) Macaulay Institute for Soil Research, Aberdeen, Scotland, U. K,

proportion of weatherable minerals is considerably high. Some inter-dunal valleys of (Anis Abassi Puniab University, Lahore, personal communication) the old dune system have petro calcic (caliche) and gypsic horizons. The petro calcic horizon is found in southern part of thc Thar and remnants of gypsic horizon are found in Cholistan. In Cholistan cylindrical lime nodules of two to three cm diameter are also found on some large dunes. The presence of petro calcic and gypsic horizons indicate that parts of these stable sand dunes are probably of middle Pleistocene age.

TABLE *3-Mineral composition of clay fraction based on infrared spectra.*

Sample	Kaolinite	Chlorite %	Quartz	Gibbsite	Mica Smectite (by difference)
L 1	5	14	5	0	76
L2	3	6	7	0	84
L 3	3	5	6	0	86
L4	3	9	8	0	80
L 5	3	6	8	0	83

Source,'. de Endredy. A. S.
Mineralogy of Loesses and some Alluvial Soils from West and East Pakistan. (Unpublished, 1970) Macaulay Instllute for Soil Research, Aberdeen, Soctland. U. K.

Then there are dunes of lower heights and smaller wave length. These are possibly of Late Pleistocene age. Detailed studies are needed on mmeralogical composition of the Middle and Late Pleistocene sands.

At a few points in northern part of Bahawalnagar district, developed soils like Wazirabad series are encountered, indicating that the transverse dunes system of low heights is comparable to the Late Pleistocene sandy alluvium of the Upper Indus river and its tributaries.

Aeolian Sands of ThaI

The major part of the ThaI are deposited by the Indus and reworked by winds to give it the present configuration during the Late Pleistocene and the transitional period between the Last Glaciation and the beginning of of the Holocene. (Higgins and Ibrahim 1968). The sands are geneally of fine grade and have a dominance of quartz but contain a high proportion of weatherable minerals and some heavy minerals. They are calcareous, having about 6 per cent calcium carbonate. The silty and clayey materials deposited

as channel infills have been adjudged to be of Late Pleistocene age comparable to the Late Pleistocene silty alluvium and of Subrecent age, occurring in other Punjab doabs. The loamy deposits in the southwestern part of ThaI are probably comparable to the Late Pleistocene loamy alluvium (Hafizabad series), Some Subrecent and Recent alluvial deposits are found in inter-dunal valleys in the southwestern part of ThaI.

Aeolian Sands of Chagi and other Sands of Baluchistan

In Chagi district of Baluchistan sands of alluvial origin are encountered. They are most probably the sandy piedmont deposits of Subrecent age and have been reworked by wind. At present they from barchan type of sand dunes. Not much is known about their mineralogical composition, but these contain more lime than the sands of Thar, Cholishtan and ThaI.

Piedmont Alluvium

The alluvial material which is deposited near its source (mountain foot) is called pidmont alluvium. The sediment is deposited in the shape of fans with their cones at the top and such fans coalesce down below to form a piedmont plain. Since the minerology of these materials is dependent upon the source, hence their classification is made according to the contributing rocks.

As a general rule the material at higher slopes of the alluvial fans is coarser, comprising stones and gravel with very little fines.

At lower slopes the material is made up of medium and coarse sand which often form sand dunes in arid areas. As the gradient decreases further, the proportion of coarser sediment decreases and we find clayey deposits at the lowest end of piedmont plains. Parts of gravelly and sandy piedmont deposits of our country generally belong to the Late Pleistocene age and the remaining are Subrecent and Recent. The gently sloping and nearly level loamy piedmont deposits are generally of Subrecentage.

In Pakistan three main type of piemont alluvia have been recognized: Himalayan piedmont alluvium, Sulaiman piedmont alluvium, and the piedmont alluvium of the inter-mountain valleys of Baluchistan.

Himalayan Piedmont Alluvium

It is low in calcium carbonate (about 6 per cent), and comprises sandy, loamy (including silty) and clayey deposits. The loamy deposits are most extensive, followed by the clayey and then the sandy deposits. The clayey deposits are encountered in piedmont basins (the lower ends of the piedmont plain) in the districts of Gujrat, Gujranwala and Sialkot. These materials were deposited probably during Late Pleistocene and Subrecent periods.

Sulaiman Piedmont Alluvium

It is generally loamy and clayey, although stony and gravelly materials occur in narrow belts along the mountains and hills. The loamy and clayey materials is high in calcium carbonate (about 15 per cent). At the end reaches of the piedmont plain extensive clayey deposits are found, as in Jatpat plain and in a narrow belt along the western bank of the Indus in D. I. Khan and D. G. Khan districts.

Piedmont Alluvium of the Inter-mountain Valleys of Baluchistan

It is predominantly silty and rich in calcium carbonate (about 20 per cent). In most valleys only silty and gravelly materials are encountered but some valleys do have clayey deposits as well. The alluvia are generally low in salts but in case of closed valleys the lowest parts comprise salty playas which have silty or clayey desposits with high accumulation of salts.

Pleistocene sandy Alluvium

During the last glaciation (Late Pleistocene) the rivers were seasonal and their gradients were greater than the present gradient.. (Brinkman and Rafiq, 1971). So they deposited mainly sand (mostly medium sand). This material which is largely burried under Holocene deposits (silty and loamy Late Pleistocene and Subrecent alluvia), is predominantly micaceous and has low content of lime about 5 per cent). It is extensively exposed in Thal (highest parts of Thal) and in small pockets northeast of a line joining Ha fizabad and Lahore as well as in the the northeastern parts of Bahawalnagar district.. Under subhmiod climate Wazirabad and Pindorian series are formed in these sediments (Gujmt, Gujranwala and Sialkot districts). In semiarid an i arid climate of Thai area, Thai series has developed in this mat~rial.. This deposit is quite thick, extending to more than 100 meter depth and forming the unconfined aquifer of the Indus Plain. (Shamsi and Hamid 1961).

Pleistocene Silty Alluvium

Towards the end of Late Pleistocene period when the temperature rose and permafrost disappeared, erosion of loess sediments in Pothwar and lower Himalayas occurred on a large scale. The rivers became perennial and carried tremendous amounts of silt which was laid on the sands deposited during the last glaciation period. These sediments consists of mainly silt of loes, origin, mixed with some sandy and silty materials derived from shales and sandstone. The material is high (60-70 per cent) in silt particles and is rich in weatherable minerals (Tables 4, 5 and 6). It is moderately calcareous, the lime content being about 8 per cent.. It is relatively rich in iron and manganese but moderate in zinc and copper

TABLE *4-Clay minerals of the three soils constituting a chronosequence in the Punjab Plains, Pakistan*

Samples	Soil Series	Age	Depth cm	Illite	Chlorite	Vermiculite	Montmorillonite	Kaolinite
1.	Shahdara	Recent	0 13	+++	++	tr	tr	++
2.	,,		26-36	++++	+++	a	tr	+++
3.	Sultanpur	Subrecent	0-11	+++	+	+	+	+
4.	"		18-50	++++	+++	a	tr	+++
5.	Bhalwal	Pleistocene	0-12	++	tr	tr	tr	+
6.	,,		62-120	+	a	+++	+++	+

Source :-Ahmad, Mushtaq 1975. A study of a chronosequence of representative soils in the Punjab Plain, Pakistan M.S. Thesis AUB, Lebnon.

TABLE *5-Goethite. norm mineral composition (per cent) of clay fraction of Eminabad and Bhalwal soil series.*

	1*	2*	3*	1*	2*	3*
	Eminabad series			Bhalwal series		
Goethite	12	11	11	13	13	12
average illite	65	58	58	63	57	52
saponite	12	13	12	12	11	13
kaolinite	2	6	11	7	12	12
quartz	5	7	5	2	4	5
excess structural water	2	2	1	2	1	2
C. E. C. (estimate from exch. Ba, pH 7)	50	47	47	38	45	43

Source: BrInkman, R. Department of Soil Science. Agricultural University, Wageningen. The Netherlands (Unpublished data).

* 1 is topsoil,, 2 is B horizon and 3 is C horizon (parent material-representing Pleistocene silty alluvium).

TABLE *6--Approximate mineral composition of clay fraction by X-ray defraction.*

Sample	Soil series	illite	kaolinite	chlorite	smectite	quartz	Randomly interstra-tified smectite-illite
1.	Eminabad	XXX	XX	X	t	–	X
2.	”	XX	X	t	XXX	–	–
3.	”	XX	XX	X	XXX	t	–
4.	Bhalwal	XXX	XX	X	t	–	X
5.	”	XXX	XX	X	X	–	X
6.	”	XXX	XXX	X	X	t	t

Legend

x x dominant
x x major
x mInor
t trace
– not observed

Source: Brinkman, R, Department of Soil Science. Agricultural University, Wageningen. The Netherlands (Unpublished data),

according to the available analytical data. (unpublished data, Nuclear Institute for Agriculture and Biology, Faisalabad). The clay is mainly of illitic type. (table I) This sediment lies over and its thickness varies from abOut one to two meters near Gujranwala to about eight to ten meters near Sahiwal, Faisalabad and Sargodha.

Pleistocene loamy alluvium

At the juncture of Pleistocene and early Holocene periods, when the climate became warmer and large-scale erosion of loessic material had already taken place, the rivers started depositing loamy material (mainly loams and some sandy loams) which was probably a mixture of silty material derived from loess and (sand) coarse material from other adjoining rock formations. In Sargodha area this material forms a sub-terrace, about one to two meters lower than the silty river terrace (Late Pleistocene silty alluvium), but in other areas it is deposited on silty material as channel infills (Faisalabad and Sahiwal districts). This loamy material, together with the silty deposit, described in the preceeding paragraph form the old river terraces (locally called Kirana Bar, Sandal Bar and Ganji Bar in Sargodha, Faisalabad and Sahiwal districts respectively). This material is low in silt (less than 30 per cent) and high in sand (about 50 per cent). The sediments are moderately calcareous (lime content about 8 per cent) and rich in weatherable minerals and it is quite rich in iron and manganese but has moderate amounts of zinc and copper. (Dr. Sindhu, Nuclear Institute for Agriculture and Biology, Faisalabad, personal Communications).

Subrecent silty and clayey alluvium

During the period 10,000 to 6,000 years before the present the climate was warmer and wetter than the present climate, causing a change in vegetation to a denser vegetation in the Himalayas and their foothill and the associated uplands. Consequently, the seoiment load of rivers decreased and river started down-cutting, thus incising silty deposits of the old river terrace, and their courses were entrenched. Later on, around 6,000 years before the present, as the climate became drier resembling the present day climate) and the vegetation in hills and uplands started deerading. So soil erosion became active once again and the rivers started carrying high sediment load comprising mainly silty and sandy materials, as is exhibited by the predominance of silty and loamy deposits which occupy more than two thirds of the Subrecent Indus Plain (mapping unit 5.2). The clayey deposits increase at the cost of silty/loamy deposits from the north to south; in Sind the silty and clayey deposits are almost equal in extent. The proportion of

sandy deposits is low and these occur mainly in the form of meander bars or braided channel deposits. However, these sediments are relatively more extensive in the northern part of the Indus Plain than in the southern part. The silty material contains about 60 per cent silt and about 20 per cent clay, whereas the clayey soils have about 40 per cent clay, the remainder being mainly silt. The sandy soils generally have sand fraction as high as 80 per cent. All the Subrecent alluvia are rich is \\<eatherable minerals (Tables 4, Sultanpur series) and the clay is mainly of illitic type. The calcium carbonate content is moderate (about 7 per cent).

Recent Silty and Sandy Alluvium

This includes the present day deposits of rivers in narrow strips along their courses (mapping unit 5.3). The main bed load of the rivers is generally fine sand and the suspended load mainly silt. The deposits consists mainly of sands covered by silty sediment.. Clayey deposits account for less than 20 per cent of the total areas of deposits. The clay minerals are dominantly illite, with chlorite and kaolinite as subdominant constituents (table 4, Shahdara series). The calcium carbonate content is moderate (about 7 per cent).

Subrecent silty and clayey estuary alluvium

The silty alluvium deposited in the estuary plain has a very high proportion of silt (about 70-80 per cent). This is so, possibly because the material was deposited by large-scale spilling of river water when it was headed back by the high sea tide. The range of particle size distribution is narrow; the coarsest particles are very fine sand and the finest is some clay. This type of silty deposit covers about half the Indus delta area, (Jalaluddin, et aI, 1970-2) whereas the other half comprises clayey material deposited as channel infills and as basin deposits which overlie the silty material.. So the substrate in nearly the whole Indus delta is the highly silty material which has very slow permeability but high capillarity. (Jalaluddin, at al. 1970-1) Regarding lime content and clay type, it resembles the Subrecent river alluvium (Table 1, Daro series).

Mineralogy of Parent Materials

No detailed or systematic study has been conducted on the mineralogicai nature of soil parent materials of the Indus plains except a few limited investigations on a few selected soil samples. Some work on clay mineralogy of selected soils has been done by de Endredy (1970) and Ahmed (1975). The available data is reproduced in Tables 1, 2, 3, 4, 5, and 6. Samples Ll to L6 pertain to soils developed in loess material.. These samples were taken

from the Potwar area around Rawalpindi. Sample WI pertains to a soil developed in estuary plain (Indus delta). In table 4, Samples 1 and 2 pertain to recent deposits being presently laid. Samples 3 and 4 were taken from a soil extensively mapped in the Subrecent flood plains, whereas samples 5 and 6 were collected from a very extensive soil, mapped in the late Pleistocene silty alluvium of the Punjab. These Tables give a fairly good general idea about the clay minerals present in the soils of Pakistan.

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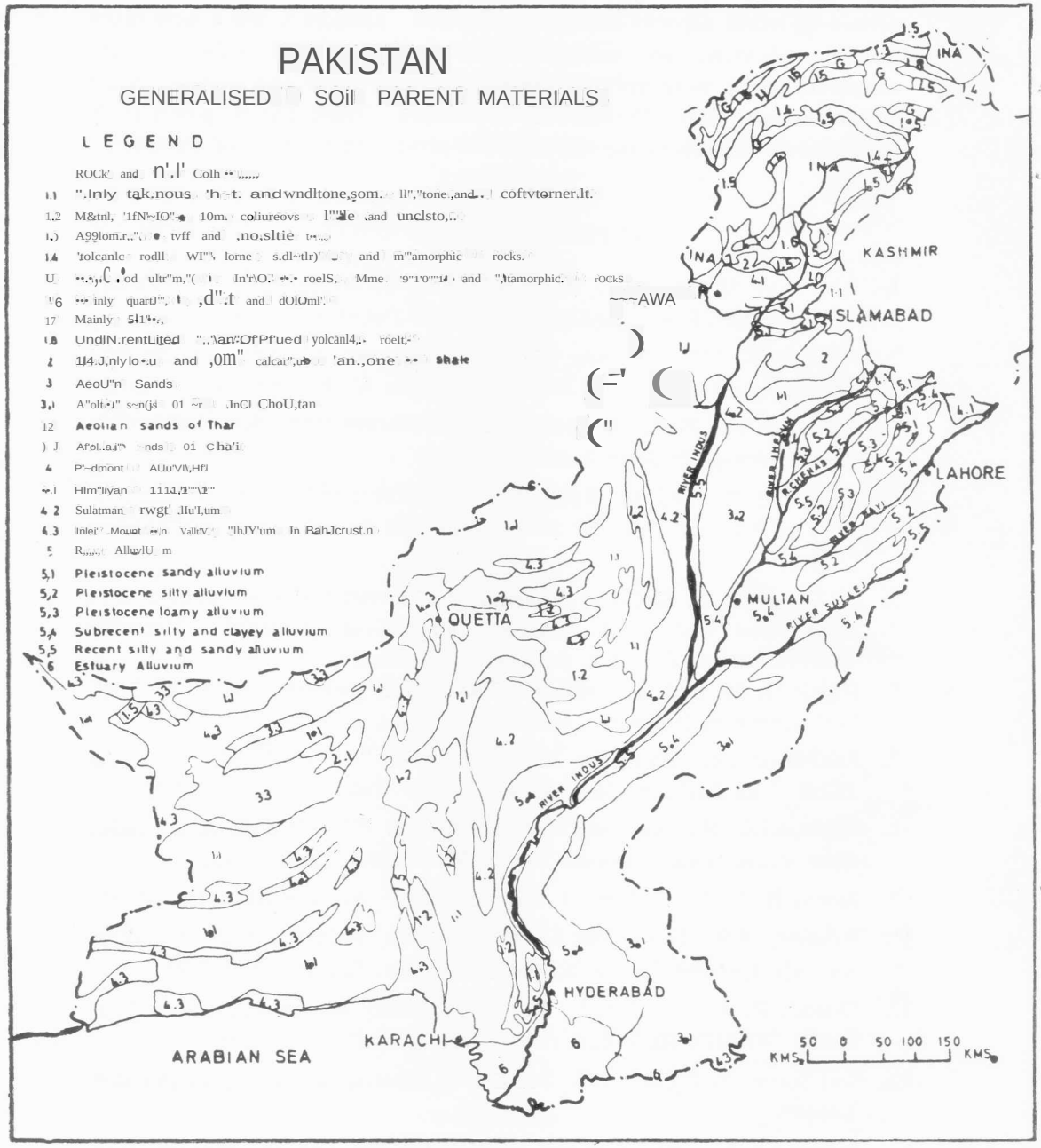
PAKISTAN
GENERALISED SOIl PARENT MATERIALS
LEGEND
5,1 Pleistocene sandy alluvium
5,2 Pleistocene silty alluvium
5,3 Pleistocene loamy alluvium
5,4 Subrecent silty and clayey alluvium
5,5 Recent silty and sandy alluvium
5,6 Estuary Alluvium
KASHMIR
ISLAMABAD
LAHORE
MULTAN
QUETTA
HYDERABAD
KARACHI
ARABIAN SEA
RIVER INDUS
RIVER JHELUM
RIVER CHENAB
RIVER RAVI
RIVER SUTLEJ
50 0 50 100 150
KMS

CROP WATER REQUIREMENT IN JHELUM DISTRICT

PROF. M. K. ELAHI* AND ANIS A. ABBASI**

INTRODUCTION

The Jhelum District with limited water resources, and growing population to feed, needs more and better crop production. Water today has acquired number one priorty amongst all the natural resources, development and planning. In this paper an effort has been made to predict the right amount of water requirement for the optimum production of crops of the District..

Crop consumptive use of water is defined as the amount of water required to meet the vegetative water needs of plants during its life cycle. Water requirements of growing crops requires comprehensive knowledge of the climate and plant physiological factors. Climate, is one of the most important factor which determines the plant water requirement, at different stages of the growth of plant. Practically each of the factor that constitutes climate has some influence on how much water is needed from the sprouting of the seeds to the maturity of the crop.

Background

Temperature, humidity, precipitation, sunshine hours are some of the important climatic elements which control the efficient growth of plants. Measurement of evapotranspiration has been favourite research occupation of a large number of scientists in the past. The work done by Makkink (1957), Blaney-Criddle (1964), Jensen-Haise (1963), Penman (1948-56). Halkais (1955). Lowry-Johnson (1942). Thornthwaite (1955), Turc-Langbein (1954). Blaney-Morin (1942), Prescott (1949), Halstead (1951). Rohwer (1931), Turc (1954), Hargreaves (1956), Christiansen (1966), Thornthwaite, Mather, Munson (1960), Olivier (1961), Linacre (1967), Van Bavel (1956) to estimate crop water requirements is of significance. The data required by these scientists includes two or more of the variables such as temperature, air humidity, dry-wet bulb temperature, Daylight hrs., sunshine hours, cloud cover, radiation, wind velocity, evaporation data, crop data, crop factor, soil factor, correction factor, precipitation, barograph data. A number of methods have been developed by some of

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these authors to predict evapotranspiration from climatic variables alone. While most of these formulas are only applicable to environments under which they were developed. Many of empirical formulas derived for evapotranpiration are based on average temperature. Lowry and Johnson uses temperature only, Thornthwaite considers precipitation, temperature and crop factor. Blaney and Criddle allow for differences between the responses of different crops in addition to sunshine percentage and mean temperature. Hargreaves includes atmospheric humidity as well. Haude, Rijtema, calculate evaporation from saturation deficit and wind speed.

The physical and physiological factors for plant growth vary greatly, their individual consideration would make the calculation of consumptive use of water almost impractical.. Some crops transpire water from the beginning of spring to their maturity in the autumn while other may have relatively short period to consume water only during a few summer months. The consumptive water needs of all the crops must be fully met with if optimum production is to be obtained.

Blaney-Criddle's Formula

Blaney-Criddle's formula is widely used for computing consumptive use of water in many countries of the world for different crops. In this article it has been examined whether the formula fits well with the climate of District Jhelum or some adjustments are required in it. The formula considers temperature It) and percentage of daytime hour (p) as the major climatic factors for the calculation of evapotranspiration.

According to Blaney and Criddle (1962) if sufficient soil moisture is available to the crop than consumptive use varies according to the following equation:

$$U = u = kf = k\,(tp/IOO)$$

Where f = consumptive use factor and is expressed as :

$$f = (p \times t)/IOO$$

Where temperature is in degrees Fahrenheit and (p) is the percentage of annual daylight hours.

Temperature

Amongst other climatic factors, temperature is the single most important factor determined by the net solar radiation. Temperature in a single year may vary from the mean temperature, but the average show good results. The mean daily temperature, which is the sum of maximum and minimum divided by the number of days for the month is the mean for the month. Table **No.1,** gives the mean monthly temperature of Jhelum which has been averaged for ◊ period of 30 years.

Percent Daylight Hours Data.

The Daylight Hours are characteristics of a latitude. The average latitude for the district has been adopted as 38° north. The data for sunshine hours is given in Table I.

Growing Period

The data for growing period of each crop has been collected through field interviews with the farmers and is also based on the records of the Irrigation and Revenue Departments. The growing periods for different crops of the District is given in Table II.

Crop Co-Efficient

The crop co-efficient (k) originally employed in by Criddle and Blaney in their articles * published in 1958 and 1959 respectively are not according to crop calender of the area under study. The originally published seasonal consumptive use co-efficients ks and Maximum monthly values of k are given in Table III. Some modifications in the value of k have been made by WAPDA in their planning and investigation report No. 209 and by Tipton and Kalambach engineers in their regional plan, Northern Indus plains 1967 keeping in view the loeal available data modified values of co-efficient k, which are given in Table V and Table VI. The values of 'k' given in Table VII show 30 days periods of growth begining the seeding and harvesting of the crop and are independent of the seeding and harvesting dates.

Consumptive Use Factor "{"

The consumptive use factor **'f'** which predicts the effect of climate veriables on evapotranspiration was calculated from the product of mean monthly (t) temperature and percentage sunshine hours (p) according to the following formula

$$f = \frac{t \times p}{100}$$

Monthly computed values of consumptive use factor are shown in Table No. I, Coulmn 6.

*Criddle, W. D., Methods of Computing Consumptive use of water Proc, Am. Soc. Civil Engineers, Journal ofIrrigation and Drainage Division, Vol.. 84, No. IRI, pp. 1-27, Jan. 1958, and

Blaney, H. F., Monthly Consumptive use requirement for Irrigated crops proc. Am. Soc. Civil Engineers, Journal of Irrigation and Drainage Division, Vol. 85 No. IRI, pp. 1-2, March 1959.

Consumptive Use Factor

TABLE I

Months	Max. temp.	Min. temp.	Mean(t)	Percent** daylight hours (p)	Consumptive use Factor (f) $f=\frac{t-}{100}$
January	65.5	41.4	53.45	7.15	3.82
February	71.6	45.1	58.35	6.95	4.05
March	80.3	54.6	67.45	8.36	5.63
April	93.1	63.3	78.20	8.76	6.85
May	102.6	72.9	87.75	9.68	8.49
June	106.0	78.9	92.45	9.65	8.92
July	97.6	79.1	88.34	9.83	8.68
August	93.7	77.4	85.55	9.30	7.95
September	95.3	73.7	84.50	8.35	7.05
October	91. 3	61.6	76.45	7.91	6.04
November	81.2	47.4	69.30	7.07	4.89
December	69.3	41.1	55.20	6.99	3.85

t = mean monthly temperature (FO)

p = per cent daylight hours. (monthly)

f = consumptive use factor (monthly)

** Percentage daylight hours latitude 32' - 56° = (33°) compiled from Smith Sonian Meteorologieal Tables, 1951 and American Ephemeral and Nautical Almanac.

Consumptive Use

Monthly consumptive use requirements for different crops were obtained by the multiplication of consumptive use factor t<f " and two different sets of crop co-effieients "k" separately. The results for different crops are tabulated in monthly coulmns Table V & VI. In each monthly coulmn the upper values show the result obtained by using continued.

TABLE II

GROWING PERIODS FOR DIFFERENT CROPS IN THE DISTRICT

KHARIF SEASON

Crops	*Day and Months*
Maize	23 June to 15 Nov
Millets	15 June to 15 Nov
Rice	25 June to 30 Nov
Fodder	23 Mar to 31 Aug
Pulses	1 June to 30 Oct
Groundnut	1 Apr to 10 Nov
Vegetable	1 Apr to 30 Sep

RABI SEASON

Wheat	21 Oct to 1 May
Fodder	1 Sep to 31 May
Gram and DaIs	15 Oct to 7 May
Oilseeds	21 Sep to 31 Mar
Tobacco	22 Dee to 15 Jan
Vegetable	1 Oct to 31 Mar

In table No. VII WAPDA 'S crop co-efficients are shown in the upper part of the column, while the days of the month in the lower part of the coulmn for each crop. the uk" values recommended by Tipton and KaJambach have been used.

TABLE III

Consumptive Use Co-efficient for Selected Crops*

Crop	Seasonal consumptive use co-efficients Ks	Maximum monthly value of k
Corn tmaize)	0.75-0.85	0.80-1.20
Pasture, grass, hay, annuals	0.75	0.85-1.15
Potatoes	0.65-0.75	0.85-1.00
Rice	1.00-1.20	1,10-1.30
Small grains	0.75-0.85	0.85-1.00
sorghum	0.70	0.85-1.10

Based on-

*Criddle, W. D. Methods of Computing Comsumptive use of water, Proc. Am. Soc: Civil Engineers, *Journal of Irrigation and Drainage Division,* Vol. 84, No. IRI, pp.1-27 Jan. 1958 and Blaney, H. F., Monthly Consumptive use requirement for Irrigated crops Proc. Am. Soc. Civil Engineers, *Journal of Irrigation and Drainage Division* Vol., 85 No. IRI, pp. 1-12, March 1959.

MONTHL Y CONSUMPTIVE CO-EFFICIENT (K)

TABLE V

Crops	Apr.	May	Jun	Jvly	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
KHARIF												
Maize	—	—	0.70	0.80	0.80	0.60	0.50	0.50	—	—	—	—
Millets	—	—	0.70	0.85	0.80	0.70	0.60	0.55	—	—	—	—
Pulses	—	—	0.70	0.80	0.80	0.70	0.60	-	—	—	—	0.50
Vegetable	0.65	0.70	0.75	0.80	0.80	0.70	—	—	—	—	—	—
Orchards	0.60	0.60	0.65	0.70	0.70	0.65	—	—	—	—	—	—
RABI												
Wheat	0.70	0.70	—	—	—	—	0.70	0.65	0.60	0.50	0.70	0.75
Gram and DaIs	0.60	0.55	—	—	—	—	0.75	0.75	0.60	0.60	0.65	0.75
Fodder	0.90	1,00	—	—	—	0.60	0.65	0.70	0.60	0.50	0.70	0.80
Oilseeds	—	—	—	—	—	0.70	0.75	0.70	0.65	0.55	0.70	0.75
Tobacco	0.80	0..85	0.75	—	—	—	—	—	0.60	0.60	0.65	0.75
Sugarcane	—	—	—	—	—	—	0.90	0.85	0.75	0.75	0.80	0.85
Vegetable	—	—	—	—	—	—	0.60	0.55	0.50	0.50	0.55	0.60
Orchards	—	—	—	—	—	—	0.60	0.55	0.55	0.50	0.55	0.55

Modified Blaney-Criddle Comsumptive Use Co-efficient (K)

TABLE VI

Crop	Number of days Following Initiation of Land Preparation											
	0-30	31-60	61-90	91-120	121-150	151-180	181-210	211-240	241-270	271-300	301-330	331-365
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Sugar Cane	0,40	0.50	0.75	1,00	1,20	1,30	1,25	1,05	0.90	0.70	0.60	
Cotton	0,40	0.50	0.80	1,05	0.90	0.50						
Rice	0.90	1,10	1,35	1,20	0.90	0.80						
Maize	0.35	0.60	1,05	0.75	0.65							
Millets	0.40	0.55	0.80	0.60	0.45							
Wheat	0,40	0.60	0.85	1,20	0.75	0.55						
Kharif Fodder	0.35	0.50	0.60	0.75	0.80	0.80	0.60					
Rabi Fodder	0,40	0.60	0.70	0.90	1,05	0.90	0.60	0.35				
Oilseeds	0.40	0.55	0.85	0.90	0.55							
Pulses	0,40	0.50	0.75	0.85	0.60							
Fruit	0,40	0.50	0.60	0.65	0.65	0.65	0.60	0.55	0.55	0.50	0,45	0,40
Kharif Vegetables	0,40	0,45	0.60	0.75	0.75							
Rabi Vegetables	0,40	0.60	0.85	1,00	0.75							
Kharif Miscellaneous	0,45	0.50	0.60	0.75	0.75							
Rabi Miscellaneous	0,40	0.60	0.85	1,00	0.80							

u=kf

TABLE VII

Crop	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
	KHARIF SEASON											
Maize					*	1.45	7.17	6.57	4.25	3.12	1,22	
						7 days	31 days	31 days	30 days	31 days	15 days	
					**	0.72	5.38	8.62	5.28	4.04	1,58	
Rice						1,70	11.28	9.93	7.75	5,43	4,40	
						5 days	31 days	31 days	30 days	31 days	30 days	
						1,33	9.54	10.73	9.54	5,43	3.91	
Fodder						0.65	3,42	5.09	6.24	6.94	6.36	
						7 days	30 days	31 days	30 days	31 days	31 days	
						0,45	3,42	5.09	6.69	6.94	6.36	
Pulses							6.24	6.94	6.36	4.93	3.62	
							30 days	31 days	31 days	30 days	31 days	
							3.56	4.34	5.96	5.99	3.62	
Groundnuts				3.76	4.66	6.24	7.37	6.36	4.93	3.62	0.977	
				30 days	31 days	30 days	31 days	31 dpys	30 days	31 days	10 days	
Vegetable						4,45	5.94	6.69	6.94	6.36	4.93	
						30 days	31 days	30 days	31 days	31 days	30 days	
						2.74	3.82	5.35	6.51	5.96		

• P & I Publication No.9.

** Tipton and Kalambach Inc., Regional Plan, Indus Plains.

TABLE VII

CROP	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
			RABI SEASON									
VVheat	1.91	2.83	4.22	4.79	0.19					1.40	3.17	2.31
	31 days	28 days	31 days	30 days	1 days					10 days	30 days	31 days
	4.58	3.03	4.66							0.8	2.93	3.27
Fodder	1.91	2.83	4.50	6.16	8.49			4.23	3.92	3.42	2.31	
	31 days	30 days	31 days	30 days	31 days			30 days	31 days	30 days	31 days	
Gram and Dals--	2.29	2.63	4.22	4.11	1.05				2.26	3.66	2.31	
	31 days	28 days	31 days	30 days	7 days				15 days	30 days	31 days	
Oilseeds	2.10	2.83	4.22					1.48	4.53	3.42	2.50	
	31 days	29 days	31 days					9 days	31 days	30 days	31 days	
	2.10							0.84	3.32	4.15	3.46	
Sugar-cane	2.86	3.24	4.78						5.43	4.15	2.88	
	31 days	28 days	31 days						31 davs	30 days	31 days	
	3.82	4. 86	7. 31						2.41	2.44	2.38	
Vege-table	1.91	2.22	3.37						3.62	2.68	1.92	
	31 days	28 days	31 days						31 days	30 days	31 days	
	3.82	3.03							2.41	2.93	3.27	

Discussion:

The results of monthly consumptive use of water by crops for District Jhelum so obtained gives a broad general picture of water requirements for different crops. However, local conditions in district Jhelum including miroclimate, size of the fields, methods of irrigation, cultivation, vary considerably from place to place, which may have some effect on the values of evapotranspiration. Climate may vary from year to year and is largely

dependent on solar energy input, which outside the atmosphere may be considered fairly constant, but the variation in cloud cover may bring change in the evaporation values upto 20%. Some variations of distance from the meteorological observatory may also effect the values. Since there are no large orographical features in the district which may alter the course of air masses, it appears that the possibility of any major changes in the consumptive use values are not prominent..

The results obtained by using two sets of value of consumptive use co-efficients yielded slightly different results. However, it is suggested that the average values of the consumptive use obtained from using two different "k" values may be applied.

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HISTORY OF CENSUS-TAKING IN THE PUNJAB, PAKISTAN

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Introduction

The idea of holding a periodic enumeration of people was not unknown in the Indo-Pakistan subcontinent in ancient times when the rulers of the country, impelled by military requirements, for taxation purposes or for a variety of other reasons, attempted to enumerate the population and their households. This is supported by numerous historical accounts.[1] This was particularly true in the case of the Punjab which, situated in the cradle of the subcontinent's oldest civilization-the Indus Civilization, had a well developed culture and a flourishing economy more than two thousand years before the beginning of the Christian era.[2]

Megasthenes, the Greek envoy despatched to the Mauryan court in c. 300 BC by Alexander's general, Seleucus Nicator, wrote a detailed account of Indian life which, being the first authentic and connected description of the subcontinent by a foreign traveller, is of great significance. During his long stay in the Mauryan Court, Megasthenes came across men who were assigned by the Indian rulers to the job of collecting census and vital statistics:

> "The third body of superintendents consists of those who inquire when and how births and deaths occur, with the view not only of levying a tax but also in order that births and deaths among both high and low may not escape the cognizance of Government."[3]

The testimony of Megasthenes is amply corroborated by the relevant account given in Kautilya's treatise, *Arthasastra* (c. 300 BC).[4] Further, it seems that the then census operation was not merely a periodic event but was rather in the nature of a permanent institution run by a large and permanent department.[5]

During the greater part of the Mauryan dynasty (c. 322-c. 183 BC) motivated by the strong administration, the sytem of enumeration of people seems to have remained operative and the State department as well as the civic bodies entrusted with the job of collecting statistics, particularly about births and deaths, continued functioning. A few centuries later, when Indian civilization reached its heyday during the Gupta period (c. 320-650), there is a

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strong evidence of the continuation of census operation as a permanent activity.6 Then, after the lapse of anothcr few centuries, during the reign of Akbar (1556-1605), it can be argued that there must be some sort of regular enumeration of population to help provide the basis for the orderly and strong administration the period is known for. No detailed statistical record of these ancient and early enumerations however exists.

The history of systematic census-taking in the subcontinent in the modern period goes back to the mid-nineteenth century, though a limited beginning had been made in 1822, when an attempt at a regular enumeration was made in Madras Presidency, following the firm establishment of the East India Company rule.

Punjab's Censuses

The population of the Punjab was enumerated for the first time on 1st January 1855. It was in fact a sort of "exercise" to count roughly but, as far as posible, accuartely the number of people in the Province. The second attempt, which could be termed as the first "all India" census, was a nonsynchornized operation held in different parts of the subcontinent during the period 1868-72. In most parts of the Punjab it was held on 10 January 1868. Despite its low quality, it established a statistical base and thus paved the way for the first regular census, which was conducted in 188!. Since then, system:ltic c~nmses have been held at ten-yearly intervals except Pakistan's last two censuses which were carried out after intercensal gaps of 11 years, 8 months and 8 years, 5 months respectively (Table 1).

Following is a brief resume of the censuses held in the Punjab since 1855.

Census of 1855

In 1855, no elaborate planning or preparation for a census operation was made. The enumeration was held on the night of 31 December 1854/1 January 1855. It was rather a 'Tough count" since no attempt was made to record particulars separately for each enumerted person. Instead, the head of the house was made the source of information about the number of persons sleeping under his roof. In view of the partial and hasty coverage, the quality of data cannot be ascertained. Nevertheless, it was acclaimed to be the first enumeration since the reign of the Mughal emperor, Akbar (1556-1605).7

Census of 1868

The second enumeration of population was a non-synchronous operation. It was held in the various parts of the subcontinent at different times between 1867 and 1872. Although it made a partial areal coverage, it could be termed as an "all India" censuS. Further, it is referred to, in most

census literature, as the country's first census since the enumeration of 1855 is not regarded a census in the true sense of the word.

In the punjab it was held on 10 January 1868 and covered the Province's British Territory as well as Dera Ismail Khan, Bannu, Peshawar, Hazara and Kohat districts of the present NWFP in addition to Delhi which had been merged into the Punjab after the events of 1857. As in 1855, the particulars of each person were not recorded separately. The statistics collected, therefore, cannot be regarded as wholly reliable.[5] The experience gained however was very valuable, and this census provided a base for the first systematic and regular census, conducted in 1881.

TABLE 1—*Population Censuses Held in the Punjab*, 1855-1981

Serial umber	Census Year	Census Date	Inter-Censal* period	Census Method	Remarks
1	1855	1 Jan. 1855	—	de facto	"Rough" count
2	1868	10 Jan. 1868	13. 0. 9	de facto	non-synchronous
3	1881	17 Feb. 1881	13. 1. 7	de facto	near-synchronous
4	1891	26 Feb. 1891	10. 0. 9	de facto	near-synchronous
5	1901	1 Mar. 1901	10. 0.3	de facto	near-synchronous
6	1911	10 Mar. 1911	10. 0. 9	de facto	near-synchronous
7	1921	18 Mar 1921	10. 0.8	dd facto	near-synchronous
8	1931	26 Feb. 1931	9, 11, 8	de facto	near-synchronous
9	1941	1 Mar. 1941	10. 0. 3	de facto	near-synchronous
10	1951	9-28 Feb. 1951	10. 0.0	de jure	*synchronous-First Census of Pakistan*
11	1961	12-31 Jan. 1961	9. II. 0	de jure	*synchronous-Second Census of Pakistan*
12	1972	16-30 Sep. 1972	II. 8. 0	de jure	*synchronous-Third Census of Pakistan*
13	1981	1-15 Mar. 1981	8. 5. 15	de jure	synchronous-Fourth *Census of Pakistan*

*Years. months. days

SOURCES:
1. *Census of India* 1881-1941 (7 vols)
2. *Census of Pakistan* 1951
3. *Census of Pakistan 1961*
4. *Census of Pakistan 1972*
5. *Housing and Population Census of Pakistan 1980-81*

Census of 1881

Held on the night of 17/18 February, this was, in fact, the first regular and systematic census of the whole subcontinent. Conducted with adequate thoroughness and detail, it produced fairly accurate results, at least in the actual number of people by sex.[9] It was a near-synchronous operation since, except in a very few difficult areas, enumeration was simultaneous in all areas. The published volumes contained statistics of the density and distribution of population, urban-rural character, age and sex composition, marital status, literacy and education, religious groupings and migrations.

Census of 1891

This was held on the night of 26/27 February and was technically improved by the issue of more detailed instructions to the enumerators, refinement of definitions and expansion of the questionnaire so as to include questions on race and parents' tongue. More elaborate arrangements ensured completeness. The non-synchronous area became smaller. The results were published in 1892 and contained elaborate data about the same aspects as the preceding census.

Census of 1901

The first census of the twentieth century was taken on the night of 1/2 March 1901, or ten years and three days after the previous enumeration. Arrangements for the operations were further elaborated and the non-synchronous area further reduced. A "slip system", to facilitate tabulation through hand sorting, was introduced. The published volumes contained, in addition to the aspects covered in the previous censuses, data on caste, tribe, race, types of marriage and common infirmities.

Census of 1911

No significant change was made from 1901 in the method of enumeration. However, a notable addition was the inclusion of a separate schedule for collecting particulars of the workforce employed in the industrial units and factories with 20 or more staff. The census operation commenced on 9 April 1910 with the house numbering and was followed by the training of the census staff and preliminary enumeration. The census itself was held on the night of 10/11 March 1911 when the record of the preliminary enumeration was corrected. The results were published in 1912, when detailed statistics appeared on the population distribution by geographical areas and by residence, movement and growth of population, age and sex composition, linguistic and religious classification, caste and literacy as well as occupations

and infirmities. The census was commended for its completeness and a high degree of accuracy.

> "The census of India is remarkable for a standard of accuracy probably not attained elsewhere, for the comprehensiveness of the data collected, for the exhaustive analyses and for its interesting, informing and authoritative deducations"[10].

Census of 1921

The arrangements for this census actually started in July 1920, when a complete list of households and a census code were prepared. In August, a pamphlet of instructions was brought out, and on 15 September the numbering of houses commenced. Preliminary enumeration in the rural tracts took place throughout February 1921, while in the towns it commenced and finished a fortnight later. The final census took place on the night of the 18/19 March. However, in inaccessible areas this had been completed in the autumn of 1910. Thus, it was, like the preceding censuses, not a completely synchronous operation. However, it could be regarded as "near-synchronous". The results were again published with maximum details on all the aspects as in 1911. In addition, data pertaining to place of birth and common diseases were published.

Census of 1931

Preliminary enumeration for this census continued through January and until mid-February 1931. The final census, which was the process of checking and updating the entries already made, was held on the night of 26/27 February.

This census coincided with a period of political upheaval, marked by communal conflicts and civil disobedience. In addition, this was a period of economic depression. The census results were adversely affected by the Non-Cooperation Movement. Although the census operation itself was not considered so objectionable, the opportunity of harassing the Government was too good to be missed.[11] As a result, there was effacement of the census numbers on houses on a massive scale which made the enumerators' job excessively difficult. Further, as a consequence of the *Sarda* (or Child Marriage Restraint) Act of 1927, which prescribed the minimum age of marriage at 18 for males and 14 for females, there was a decrease in the enumerated married population and an overstatement of ages.[12] Further, since the people knew that the guarantees and safeguards and political rights of various communities to be provided by the future constitution would largely depend on the census figures, different communities tried to inflate their numbers through wrong entries. In quite a few cases the enumerators did not hesitate to collaborate. Thus, there was a tendency to

omit and suppress the actual figures through a boycott on the one hand, and of artificial inflation on the other. However, the extent of overall omission, particularly in the Punjab, is believed to be very low.[13] The published documents contained statistics on the same aspects as in 1921.

Census of 1941

In all the censuses from 1881 to 1931, the final enumeration took place at night. In 1941, however, the final count was held in the day time, on the 1st March. In addition, there was another departure from previous practice. In order to save time and money and to reduce the possibility of error and omission, the old census schedule was replaced by an enumeration slip.[14]

The intensity of the Civil Disobedience or the Non-Cooperation movements' which had affected the previous census, had largely dissipated. However, the results of this census were affected by overreporting, since various communities tried to overrepresent their numbers for political considerations. Some aspects were, in particular, strongly affected by communal considerations, notably those concerned with language. It was decided, therefore, not to tabulate statistics on language.[15] The final publication of data which was greatly curtailed owing to the exigencies of war time, contained statistics regarding the distribution of population, town and country classification, sex distribution, religious composition and level of literacy.

In summary then, a regular census activity has been going on in the Punjab since 1881. Each census marked a degree of improvement over the preceding one in its areal coverage as well as in the scope and quality of the data collected. The 1931 and 1941 censuses, however, became the victims of the then political climate, resulting in underenumeration in the former and overreporting in the latter.

There are only a few post-census studies on the quality of the census data of this period.[16] Although some of the greatest scholars of high repute were associated with the subcontinent's censuses,[17] all these censuses were planned by and held under the direct supervision of the Civil Service. The paucity of post-census studies could be due partly to the attitude of the civil servants who would not be inclined, particularly during a colonial rule, to encourage any degree of direct or indirect criticism on the functioning of the government machinery. In every census report, therefore, the respective Census Commissioner claimed a high level of accuracy in the census returns. And, given the general immobility of the population on the "census nights", a high degree of completeness of enumeration seems likely.

Regarding the subcontinent's population censuses to be thorough and a remarkable source of information, Davis (1951) estimated the extent of regis-

tration in various parts of the subcontinent in 1931. According to his estimates, 99.5 per cent of British Punjab's population was registered in that year.[18] This certainly hints at the completeness of the population numbers. However, the accuracy of various population attributes such as age, marital status, literacy etc. is not easy to ascertain.

Census of 1951

The first census of independent Pakistan was conducted in 1951, on a *de jure* basis. The main objective of this census was to assess the population strength of the new nation and to make available, for planning and other purposes, statistics on social, economic and educational aspects. It was, in a way, a "stock taking report" of the new country, envisaged to establish a standard model for the future as well as to gather statistics about the vast multitudes of the people displaced in the process and as a consequence of the Partition .[19]

The circumstances for such a gigantic operation were least favourable. The lack of statistics regarding Pakistan and especially for the province of the Punjab, which had been divided on Independence, made it imperative to adhere to the normal census season of early spring.[20] Thus, the enumeration was held between 9 and 28 February. This was the time when the Government's administrative structure was in the formative stages. Further, owing to the large scale migration to and from the Punjab, the previous statistical information on population had become obsolete. The movement of population was still continuing and, even more than three years after Independence, thousands of *muhajirs* (refugees) were pouring into Pakistan, particularly into the Punjab. However, despite these abnormal circumstances, the unstable demographic situation and the slender resources available, strenuous efforts by a devoted census staff coupled with a helpful public attitude resulted in the production of the essential population data.

In scope, this census covered almost the same grounds as the previous census of the subcontinent, a conspicuous departure being the omission of caste and race statistics. However, more detailed information on language, literacy, education, labour force and occupation was obtained and special attention was paid to the collection and publication of *muhajirs'* statistics. Although not evaluated in sufficient detail, the information collected on all these aspects was claimed to be reasonably accurate, However, owing to a certain degree of apathy and frustration in the organizational stages, especially in a few large urban localities, there was possibility of some underenumeration.[21]

Census of 1961.

Pakistan's second census was taken in 1961, again on a *de jure* basis, during the period 12-31 January. It was a synchronous operation, except in a few hilly areas where the enumeration had been accomplished earlier. A small part of Murree *tehsil* in Rawalpindi district was one such area, where the counting had been done between 15 November and 15 December 1960.

Considered to be much better planned, with its organizational set-up far superior to that of 1951, this census obtained more detailed information particularly on education and labour force. Further, an elaborate publication programme was successfully accomplished within almost two years after the enumeration in which, in addition to the main ccnsus bulletins and reports, a separate census report for each district (OCR-District Census Report) was brought out for the first time. Thus detailed statistics on age, sex, martial status, religion, birth place, mother tongue, literacy, education, economic activity, occupation and fertility were published.

This census was followed by a Post Enumeration Quality Check (PEQC) Survey conducted by the Census Organization itself, on the presumption that making it known prior to the census date that the PEQC would be conducted, would help in improving the quality of the census. **In** addition, numerous inquiries were conducted on the operation and results of this census, most of which, while pointing out a small number of pitfalls, generally praised the efficiency of the Census Organization and the standard of work.[22] However, some of these inquiries pointed out the extent of inaccuracy and inadequacy of data in certain areas of the census. **In** one such study, Krotki (1963) pointed out an underenumeration of 3.95 millon or 8.4 per cent in Pakistan's 1961 census population.[23] The Planning Commission's (1964) estimate of underenumeration on the other hand was 3.22 million or 7 per cent.[24] The US Bureau of the Census (1965) gave an estimate of the undercount in the vicinity of 3.72 million or 7.5 per cent[25] while Bean *et al's* (1968) estimate was 2.88 million or 6.2 per cent.[26] Thus, although the magnitude of the estimated underenumeration differed, there was a general accord amongst most experts about an undercount of population in the 1961 census.

Census of 1972

The third census of Pakistan, which was due in 1971, could not be held on schedule because of the unprecedented political chaos, economic turmoil and the accompanying deterioration of law and order before and after the disintegration of the country and severance of its eastern wing (East Pakistan). This census was, therefore, held only in West Pakistan

(which now forms Pakistan) between 16 and 30 September 1972. It was completed in three phases. During the first phase (1-15 September 1972), households were listed; during the second phase (16-30 September) the "Big Count"-a hundred per cent count of population-took place; and during the third phase (August-November 1973) the Housing, Economic and Demographic (HED) sample survey was conducted. Another significant departure from the earlier censuses was the shortening of the enumeration schedule. It now included only six questions : the relationship with the head of the household, sex, age, marital status, religion and literacy.[27] This schedule was used during the "Big Count", while the data regarding housing conditions, migrations, educational attainments, labour force, and fertility were collected on the basis of a sample during the final phase of the census. This sample consisted of 255,000 households out of which 122,000 were urban.

The 1972 census operation, therefore, dislodged the century-old census history of the area in two distinct ways: first, by increasing the normal 10 years intercensal period to 11 years and 8 months ; and second, by including in the enumeration schedule the minimum number of questions ever asked in a population census. This census too was followed by a Census Evaluation Survey (CES) conducted now by an independent organization. In addition, a number of investigations about the quality of census were conducted. Considering the Pakistan Government's commitment to a strong population policy and the resultant effectiveness of family planning programmes, the failure of development plans to meet health targets and to achieve planned reduction in mortality, a fair degree of government-induced migration (mainly to the Middle East for employment) and only a negligible net immigration due to repatriation from East Pakistan (Bangladesh), Bean (1974) suggested an overenumeration of population in the 1972 Census. And, whereas he supported his hypothesis with the vital rates yielded by the Population Growth Estimation Survey (1962-65), he also pointed out a tendency of overreporting in Pakistan's smaller provinces.[28] Afzal (1973) however argued that there was an underenumeration to the tune of 2.47 to 3.6 per cent in the 1972 Census.[29]

Another study about the authenticity of the 1972 Census results was conducted by Krotki (1976). In his critique of the 1972 Census Evaluation Survey (CES), he concluded, through a study of age distribution as well as fertility and mortality levels, that there was a 3 per cent undercount in the 1972 census population of Pakistan.[30] In a subsequent study, Krotki and Parveen (1976) reasserted the earlier view about underenumeration.[31]

Although delayed by one year and 8 months due to the conditions mentioned above, this census enjoyed a more congenial climate than the country's earlier censuses. the Census Organization, which had by now attain-

ed the status of a permanent body, had longer time for the planning and execution of its programme. The experience of the two earlier censuses in view, a marked improvement in method and technique was registered. Thus, due to the shorter census schedule, better planning and improvement in the areal coverage, the 1972 census is believed to have yielded better enumeration as compared to the 1961 census. However, in the publication programme, the census organization seems to have failed in meeting its targets due to some explained and unexplained snags.

A computer had been employed, for the first time, with a view to making availabe the census results correctly and expeditiously. It was envisaged that, by employing sophisticated machinery, new techniques and statistical experties the 1972 census results would be much better and quicker than the previous ones. But all such hopes were dashed since it took more than six years to publish the census results. A frustrating aspect of the published material was that there were a large number of discrepancies of data in the various publications. The Organization obviously failed to maintain the pace and standard it had achieved in 1961. The publication of the Punjab's data in particular, suffered to a maximum dagree, not only due to the longest delay but because of numerous errors and omissions as well. It seems as if the Punjab met an increased degree of apathy at the hands of the Census Organization, which is hard to explain.

Another serious set-back the 1972 census seems to have suffered was over-reporting in the smaller provinces, particularly in Sind and Baluchistan, reflected by an abnormal increment in their growth rates. The census operation coincided with the time when the new constitution of the new ("East Pakistan less ") Pakistan was in the making. Thus, it is quite likely that, in order to secure strong representation in the Federation, population might have been overreported or overcounted in these provinces.

Census **of 1981**

Pakistan's fourth census of population was taken from 1 to 15 March 1981. Earlier, the Housing Census of the country had been held between 1 and 15 December 1980, which did not merely comprise household listing but was rather an attempt to gather statistics about housing and the related aspects in the greatest possible detail. Further, in order to have a more comprehensive and fuller picture of the country's population size and demographic characteristics the census activity was extended for the first time in its true sense to the Federally Administered Tribal Areas (FATA) where data were now collected in respect of each and every individual.[32] Earlier the data used to be based generally on estimates provided by the Tribal chiefs.

During the preparatory stages of this census it was envisaged that the time between the holding of the census and publishing the collected data will be reduced to its shortest possible. The schedule for the "Big Count" was also enlarged. It now contained ten questions: relation with the head of the household, residential status, sex, age, marital status, reli3ion, if Muslim whether able to read th~ Holy Quran or not, literacy, educational attainment and language generally spoken in the house. Thus, not only were the new questions pertaining to residential status, educational levels and language included in the schedule but for the first time it contained questions about the ability of a person to read the Holy Quran.

Until the time of writing this article (i.e. July 1981), only one census bulletin has appeared which contains provisional figures of total population, intercensal growth rate and sex ratio (males per 100 females) for the provinces and their constituent divisions and districts. Another table in the same bulletin provides population (total as well as its distribution by sexes) in the twelve largest cities of Pakistan. In the absence of more detailed statistics of population it is too early to comment on the quality of the enumeration or of the published data.

CONCLUSION

The history of census-taking in the Punjab goes far back into the ancient times when in order to assess their military strength or levy taxes or for a variety of other reasons, the rulers of the country occasionally counted their populations. But no detailed statistical account of these early enumerations exists. Modern census activity in the area began with the advent of British rule. The first enumeration of population, which was merely a rough count, was held on 1 January 1855. It was followed by another attempt in 1868 which laid the basis for a regular census-taking. Since Independence, Pakistan has held four censuses and in each successive attempt the quality of enumeration and the areal coverage have improved.

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IRRIGATION AND CROPPING PATTERNS IN THE PUNJAB CANAL COLONY DISTRICTS, 1890-91 TO 1940-41

FAREEHA ZAFAR*

Introduction

In the Punjab cultivation has always depended on additional supplies of water owing to the scarcity and uncertainty of rainfall. The diligent use of rain water at the time of its occurence and of flood water in the *sailaba* or riverine tracts, in combination with wells, cuts and inundation channels and canals, has been a characteristic of the agricultural practices in this region since early times. In the 1880s, the construction of perennial canals by the British in the canal colony districts[1] of the Punjab, added a new dimension to cultivation extension and cropping patterns by providing sufficient supplies of water throughout the year. Increase in the area under cultivation, extension of double-cropping, changes in crop rotation and the harvest pattern helped to shift the emphasis from subsistence to cash crop farming.

Pre-Canal Cropping Patterns

Throughout the Punjab loss of crops was largely due to the deficiency or excess of moisture. The rainfall was capricious both in amount and distribution. Moisture deficiency at the time of its occurrence, either resulted in a shrinkage of the areas sown or the destruction of the growing crop, whereas in a bad season it resulted in both. If the rains failed at seed time, the shrinkage of the area was marked in unirrigated land, but well irrigated crops were also affected. Heavy rainfall was harmful to crops cultivated on light sandy soils, while floods could be disastrous to autumn crops although improving the chances of *arabi* harvest.[2]

Specialised crops like indigo, sugarcane and vegetables were grown mostly on well irrigated land in carefully manured small fields, and "the rectangularity of these minute divisions, the straightness of water courses, the perfect level of the field and the uniform degree of thickness in the growth of the crop" gave an "unusual appearance of careful farming".3 Scientific methods were also followed in the cultivation and tilling of land as evidenced by the repeated ploughing of the land, the use of manure, the

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rotation of crops, the cUltivation of special crops for improving soil fertility and the preparation of *dofusli* (double cropped) land where conditions permitted.[4]

(Pressure on the land was low so most cultivation was single cropped with *rabi* and *kharif* harvests alternating on the same land, thus allowing it to remain fallow for a number of months.[5] **In** fact, almost all land remained fallow for one year out of three. The best lands around the cities and villages were most intensively cultivated producing between three to four crops a year of vegetables and grains, and good yields of rice, poppy, indigo, tobacco, sugarcane and cotton from small heavily manured fields irrigated mainly by wells and in some areas by canals.[6] Indigo being the major revenue raising crop was widely cultivated and its production had increased since the opening of the inundation canals in Multan district under the administration of Diwan Sawan Mull.[7] The choicest land for indigo was located at the tail of the canals.

The *rabi* staples were wheat and barley, their cultivation depending heavily on the monsoon rains and in the case of wheat also on irrigation. The *kharif* staples, cotton, millet *(bajra, jowar),* rice, pulses *(moong, moth, mash,)* and indigo, were almost totally dependent on irrigation, although *bajra, jowar* and the pulses, also grew under *barani* conditions in the northern district as did cotton under special conditions.[8] The spontaneous growth of fruit trees especially dates along river banks and in groves around wells, not only added to the cultivator's diet, but also formed an important item of trade.[9] The choice of crops cultivated in the Punjab Canal Colony Districts, varied with the incidence of the rainfall, soil conditions, and market demand.[10]

As part of crop rotation, fodder crops like *churree* (a *kharif* crop), and turnips (a *rabi* crop), were cultivated in the *sailaba* and *bet* zones, where cattle were brought from the *bar* in the hot summer, besides which every village had almost half its area as waste where free grazing was possible during the rainy season.[11] Although the area under cultivation in the Canal Colony Districts at this stage was very small, culturable waste and the wide tracts of the *bars* covered with grass and "open jungle of stunted thick stemmed deep rooted trees", supported an immense number of animals.[12] The importance of herding was manifested by the fact that in years of scarce rainfall the area under valuable crops was sacrificed to fodder crops in order to keep the animals alive.[15] Many of the *bar* areas were surplus producers of *ghi* (butter), milk and wool and a regular trade in these products in exchange for food crops from the lowlying area was in practice. This trading pattern was also followed

between the drier western districts and the more cultivated and settled districts of the eastern part of the Punjab.

Extension of Cultivation

The immediate result of canal irrigation was to extend the area under cultivation. This manifested itself in two ways, (i) by providing irrigation to areas hitherto unsettled and uncultivated for lack of a sufficient supply of water/rainfall, and (ii) by providing water to areas already under cultivation, that is, converting area from *barani* to irrigated areas thereby extending the period during which cultivation could be carried on, as well as assuring regular and greater supplies of water to areas irrigated by other means. Whereas, the former affected the Crown wastelands and as such included the *bar* sections of the *doabs* to the east of the river Jhelum, the latter encompassed land already owned by cultivators, which was located between the *bar* and the immediate vicinity of the rivers. The initial experiments with canals in the eastern part of the Punjab had not envisaged colonisation, and as such those schemes had been carried out in areas already settled and cultivated, resulting to some extent in greater intensity of cultivation. The true impact of the canals could best be gauged from the extension of cultivation in the Canal Colony Districts.

TABLE *I-Punjab Canal Colony Districts, Relationship between the Total Cropped Acreage, Irrigated Area, and Canal Irrigated Area, 1890-91 to* 1940-41. *(in acres)*

	Total Cropped Acreage	Total Irrigated Area	Canal Irrigated Area	% Cropped Irrigated	%Cropped Canal Irrigated
1890-91	4,434,347	2,717,202	957,162	61.28	21.59
1900-01	5,098,156	3,746,998	2,211,971	73.50	43.39
1910-11	8,378,124	5,797,452	4,383,432	69.20	52.32
1920-21	9,406,429	7,265,727	5,860,944	77.24	62.31
1930-31	11,018,504	9,018,635	7,205,230	81.85	65.39
1940-41	11,951,697	9,791,639	8,027,915	81.93	67.17

Note. Figures are calculated on a five year average basis.

Source: Agricultural Statistics of British India, and Report on the Seasons and Crops of the Punjab.

Extension of the irrigated area and cultivation. Figures for the nine Canal Colony Districts show that the total irrigated area for the districts increased from 2.7 million acres in 1890-91 to 3.7 million acres by the turn of the century, an increase of over one million acres, while the canal irrigated area showed a rise of 1.25 million acres.

Correspondingly, the total cropped area (including the area cropped twice), increased from 4.4 million acres to 5. 1 million acres. One can conclude that during this period not only was canal irrigation extended into new land, but it also provided water to land already cultivated either under *barani* conditions or by other means of irrigation. The most substantial increases were made during the first decade of the twentieth century, when the sown area increased by 3.3 million acres, while the irrigated area increased by 2.05 miilion acres and the canal irrigated area extended to a further 2. 17 million acres (Table 2). By 1910-11, therefore, within a period of twenty years, the cropped area, and the canal irrigated area had both doubled. Consequently, canal irrigation was responsible for the increase in cultivation, which benefited not only from the direct application of canal water, but also from the moisture left in the ground after irrigation.

From 1910-11 to 1920-21, both the irrigated area and the canal irrigated area showed greater increases (1.47 million and 1.48 million acres respectively) compared to the cropped area (1.03 million acres). This was the period when the Triple Canals were constructed and large areas in the Rechna and

TABLE *2-Punjab Canal Colony Districts, Changes in Cropped area Irrigated area, and Canal Irrigated Area,* 1890-91 *to 1940-41*

	Cropped Acres	Area %	Irrigated Acres	Area %	Canal Irrigated Acres	Area %
1890/91-1900/01	663,809	15	1,029,796	38	1,254,809	131
1900/01-1910.111	3,279,969	64	2,050,454	55	2)71,461	98
1910/11-1920/21	1,028,305	12	1,468,275	22	1,477,512	34
1920/21-1930/31	1,612,075	17	1,752,908	24	1,344,286	23
1930/31-1940/41	933,143	8	733,004	9	822,685	11

Note. Figures are calculated on a Five year average basis.

Source: Agricultural Statistics of British India, and Report on the Seasons and Crops of the Punjab.

Bari Doabs were brought under the influence of the canals. Between 1920-21 and 1930-3], no major irrigation work was undertaken, but existing canal branches were extended resulting in the increase of the sown area by 1.6 million acres, and canal irrigated area by].3 million acres. The total area under irrigation for the first time increased more than the canal irrigated area (1.75 million acres), which can be explained by the greater construction of wells and an emphasis on the improvement of supplementary means of irrigation. From]930-31 to 1940-41, the Haveli Project and the Sutlej Valley Project Canals were constructed, but as these were of a lesser magnitude when compared to the older canals, the sown area only increased by a little over 900,000 acres, while the irrigated area registered an increase of 773,000 acres. Further extension of cultivation into the wasteland *bar* regions of the Punjab was connected with the provision of canal irrigation to over 800,000 acres of land in the Nili Bar region.

The canals had been designed with an irrigab]e capacity of 60 to 75 per cent, but in most cases, the intensity of irrigation carried out was hundred per cent, as the demand for canal water increased and the cultivated area (sown plus fallow) expanded rapidly. In the Canal Colony Districts, this increased from around 3.5 million acres in 1885-86 to over five million acres by the turn of the century, and by 1910-11 was over eight million acres. At thi<;stage, the cultivated area included large amounts of land left fallow at each harvest, and as the area referred to as culturally commanded by the canals increased in extent, the amount of fallow also increased, since water was available for only part of the land grants given to the colonists who were thus forced to leave large parts of their farms uncultivated. By 1940-41, the cultivated area had increased to almost 12 million acres, of which eight million acres were canal irrigated. Thus, between 1890-91 and 1940-41, the cultivated area trebled in extent, while the canal irrigated area increased fourfold. (Figure 1).

The Decline in fallow. Canal irrigation also substantially reduced the area left fallow at every harvest.. Although other factors such as pressure of population and the decrease in the size of holdings were also responsible, the availability of canal water and the associated need to make the canal profitable resulted in maximum use of the land and fallowing as part of the rotation system slowly declined.[14] This has been considered by some writers as an indication of the move towards intensive farming,[15] But if it was so, it was a spontaneous response to the changing agrarian environment as a result of canal irrigation. The decline in grazing areas prompted the cultivation of fodder crops, which were cut from the top and

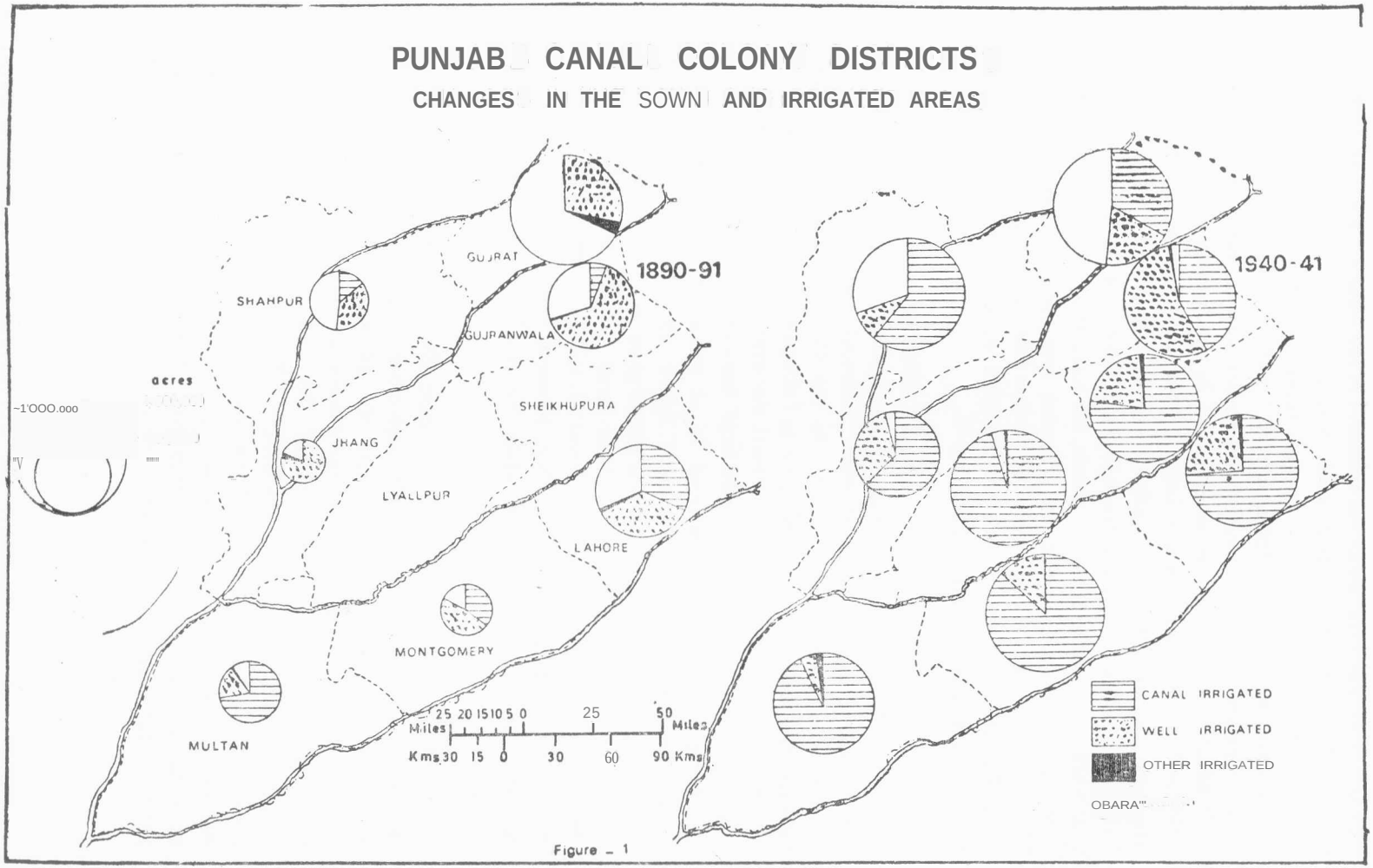
PUNJAB CANAL COLONY DISTRICTS
CHANGES IN THE SOWN AND IRRIGATED AREAS
1890-91
1940-41
GUJRAT
SHAHPUR
GUJRANWALA
SHEIKHUPURA
JHANG
LYALLPUR
LAHORE
MONTGOMERY
MULTAN
acres
~1'000.000
25 20 15 10 5 0 25 50 Miles
Miles
Kms 30 15 0 30 60 90 Kms
CANAL IRRIGATED
WELL IRRIGATED
OTHER IRRIGATED

Figure – 1

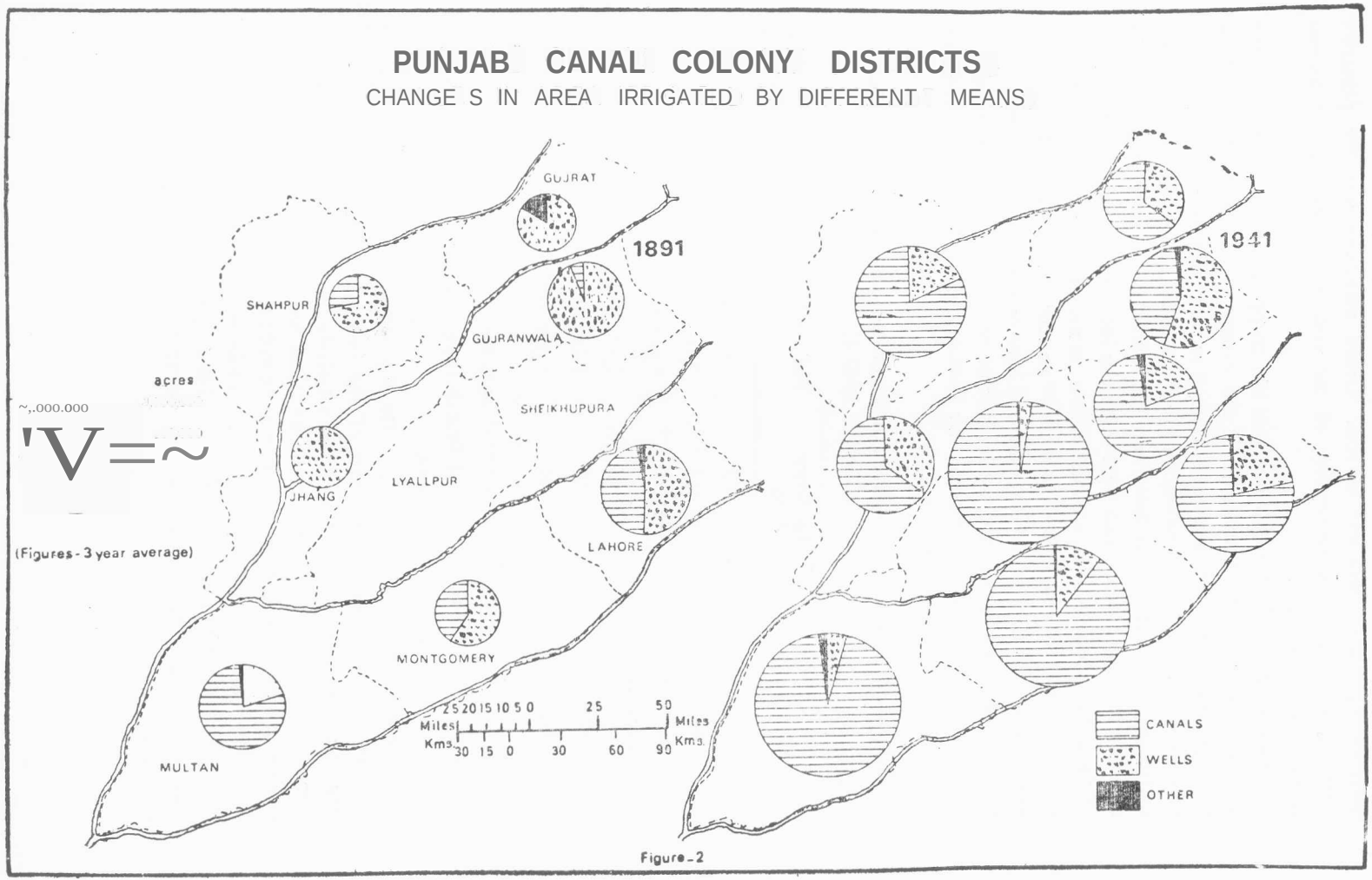
PUNJAB CANAL COLONY DISTRICTS
CHANGE S IN AREA IRRIGATED BY DIFFERENT MEANS
1891
1941
GUJRAT
SHAHPUR
GUJRANWALA
SHEIKHUPURA
JHANG
LYALLPUR
LAHORE
MONTGOMERY
MULTAN
acres
(Figures-3 year average)
25 20 15 10 5 0 25 50
Miles
Kms. 30 15 0 30 60 90
CANALS
WELLS
OTHER

Figure-2

their roots ploughed back into the soil.. Green manuring was the peasant's cure for the depletion of the fertility of the soil in the absence of animal manures and fertilizers.

Fallowing could not disappear from the cropping pattern because of the continued dependency on rainfall, and the extent of fallow land tended to correspond closely to the amount of rainfall in anyone season. While the cultivated area was fast extending into the wastelands, the area under fallow increased.16 Besides, larger areas were left fallow because of lack of water channels in many areas, which were otherwise included in the cultivated areas of the canal colonies. The area left fallow increased from 13 per cent - of the cultivated area-in 1890-91 to over 19 per cent by 1920-21.. It was only after 1921, when most of the best land had been brought under the plough and the new varieties of wheat and cotton became popuiarised that the extent of fallow land substantially decreased. By 1940-41, fallow land constituted only 10 per cent of the cultivated land.

TABLE *3-Relationship between the Total Area Sown and Fallow Land, 1890-91 to 1940-41*

	Total Sown Area	Fallow Land	Ratio of Fallow to Sown Area ("Is)
1890-91	4,882,907	680,669	12.23
1900-01	6,923,411	1,063,595	11.32
1910-11	8,255,011	1,482,207	15.52
1920-21	9,001,096	1,971,634	17.97
1930-31	10,865,769	1,815,818	14.32
1940-41	12,255,736	1,386,457	10. 16

Note. Figures are for the years shown, and in acres.

Source: Agricultural Statistics of British India and Report on the Seasons and Crops of the Punjab.

Increase in double cropping. On the other hand, availability of irrigation water during the dry part of the year increased the area which was double cropped. While there was relatively less change in the proportion of area sown more than once to the total art"a sown, the average area double cropped almost trebled between 1890-91 and 1910-11 and was more than 1.5 million acres by 1940-41.. While most of this increase was the result of canal irrigation, some of the double cropped area was also associated with well irrigation, with the fields located nearest to the well being double cropped.

TABLE *4-Total Punjab Canal Co!ony Districts, Area Double Cropped 1890-91 to 1940-41*

	Area Double Cropped (in acres)	Area Double Cropped as a %age of total Sown Area
1890-01	386,329	8.71
1900-01	564,056	11.06
1910-11	958,266	11.35
1920-21	1,053,811	11.20
1930-31	*1,399,126*[a]	12.70
1940-41	*1,54,984*[b]	12.90

Note. Figures have been calculated on a five year everage basis.

a Calculation on a two year average basis.

b Calculatian on a three year average basi.:.

Source: Agricultural Statistics British India and Report on the Seasons and Crops of the Punjab.

For the individual Canal Colony Districts, the figures show that the districts of Lahore, Gujranwala and Sheikhupura had just under one-fifth of their sown area as double cropped by 1940-41.. (Table 5). A combination of canal irrigation, well irrigation, and a heavier rainfall compared to the other Canal Colony Districts, would appear to be the reasons behind this !ncrease. For the other districts the increases were smaller. In terms of the actual area soWnmore than once, the district of Montgomery registered an increase of more than 200,000 acres between 1890-91 and 1940-41, with Multan, Gujranwala and Sheikhupura districts following close behind. The district of Lyallpur with over 98 per cent of its cultivated area under canal irrigation actually experienced a decline in its area double cropped between 1910--11 and 1940-41, reflecting the often wasteful use made of the water from the Lower Chenab Canal..

Changes in Crop Rotation.

In the Punjab, rotation of crops varied not only with the type of soil, but also with the source of irrigation water.17 This had been the practice from days gone by, but in the Canal Colonies, the commonest rotation which emerged was one which included wheat and cotton, the former being the most profitable *rabi* crop and the latter the most valuable *kharif* crop.IS Even though a rotation system based entirely on the cultivation of wheat and

TABLE 5-*Punjab Canal Colony Districts, Area Double Cropped as a Percentage of Total Sown Area,* 1890-91 to 1940-41.

	1890-91	1900-01	1910-11	1920-21	1930-31	1940-41
1. Sheikhupura	×	×	×	9.86	13.39	18.69
2. Gujranwala	8.62	10.53	8.04	10.52	15.44	18.65
3. Lahore	10.93	15.50	1~.36	15.30	17.74	18.13
4. Lyallpur	×	×	15.36	15.19	14.17	13.27
5. Montgomery	3.56	6.08	6.78	10.02	13.48	12.60
6. Jhang	11.23	6.05	9.94	9.86	9.34	10.73
7. Multan	5.60	10.01	10.96	8.52	12.94	10.14
8. Gujrat	9.20	15.42	6.92	8.57	7.88	9.61
9. Shahpur	6.76	7.45	10.60	7.68	8.30	8.73

Note. Figures have been calculated on a two year average basis.

Source: Agricultural Statistics of British India and Report on the Seasons and Crops of the Punjab.

cotton with small periods of fallow in between was by no means the best as there was not sufficient time to prepare the soil for cotton, the peasant cultivator with his small holding had practically no choice in the matter. The main *zaid* (extra) *kharif* crop was oilseeds, and from the different varieties grown in the Punjab, *toria* fitted best into the rotation pattern with American cotton and wheat. Its cultivation increased with the growth of the Canal Colonies, its particular advantage being that it was harvested at the time when the *kharif* revenue had to be paid, and so fitted well into the cash crop cultivation system. The cultivation of other cereals apart from wheat such as *bajra, jOlvar* and maize, was largely for their use as fodder crops, *chari* which was *bajra* cut in its green state being the most popular in the Canal Colonies, as well as providing food during scarcity times. But, on the whole, the consumption of wheat increased at the expense of the other food grains, forming together with gram and pulses the staple diet of the people.

For the canal to pay its way and bring in land revenue, canal water was given for valuable crops like cotton, sugarcane, oilseeds and wheat, all of which required frequent waterings.[9] The Punjab soils needed slow watering

and the excessive use of canal water in the initial stages produced large patches of alkali land within a few years and the productivity of the soil began to decline.[2] Cultivation of other crops like rice, maize and *senji* which also required more water was restricted mainly to well irrigated land, while gram which as a crop enriched the soil, was cultivated only as a *barani* crop even though it was able to benefit from the moisture left in the soil after an irrigated crop. Meanwhile, canal irrigation was being carried out to its maximum, the plans of providing water for 75 per cent cropping intensity being replaced by hundred per cent intensity in most colony districts, and to ensure this intensity, it was necessary to restrict the cultivation of crops which required large amounts of water to areas irrigated by *kharif* channels and wells. Sugarcane, maize, *toria, chari,* and vegetables were the major well crops.

Increase in the cultivation of fodder crops. Changes in the cropping pattern combined with the depletion of natural sources of manure, could have proved disastrous to the fertility of the soil, but for the increased role of fodder crops in the rotation system, whose cultivation was necessitated by the reduction of grazing grounds, the compulsory raising of mules, camels, and horses in the colonies, and the demand for milk by the growing market towns established in the colony districts for the collection and export of agricultural produce by the Colonial Government. The situation was also saved by the natural propensity of the Punjab soils to fix nitrogen from the air, and the resistance shown by the peasant to new varieties of crops which were. in most cases, less resistant to drought and required greater amounts of water as compared to the *desi* varieties.

TABLE *6-Punjab Canal Colony Districts. Area under Fodder Crops,* 1900-01 to 1940-4 1.

	Area under Fodder Crops		Ratio of Fodder to Area Sown (%)
1900-01	343,929	acres	6.75
1910-11	816,935	"	9.75
1920-21	1,498,767	"	15.93
1930-31	1,838,070	"	16.68
1940-41	2,380,148	,,	19.91

Note. Figures have been calculated on a five year average basis.

Source: Agricultural Statistics of British India and Report on the Seasons and Crops of the Punjab.

The increased cultivation of fodder crops demanded in the colonies was shown by the increasing ratio of fodder crops to the total sown area, as colonisation spread into the *doabs* and the natural grazing grounds were converted into cultivated land. The rate of change in the growth of fodder crops was most rapid in the first two decades of this century, but at that time, the actual amount of area involved was small. Very often young crops of wheat, gram, and barley grown together under unirrigated conditions were cut green to be used as fodder for the animals, so that the amount of fodder produced was probably considerably more than was indicated by the statistics.

Cultivation of Cash Crops.

The importance of cotton and wheat. The proportion of land devoted to the cultivation of cotton showed an increase from the start of colonisation.

TABLE *7-Punjab Canal Colony Districts, Cotton Acreage,* 1890-91 to 1940-41.

	Area under Cotton	Ratio of Cotton to Area Sown (%)
1890-91	253,578 acres	5.72
1900-01	388,407 "	7.62
1910-11	567,728 "	6.78
1920-21	1,026,258 "	10 .91
1930-31	1,521,008 "	13 .80
1940-41	2,038,481 "	17.61

Note. Figures have been calculated on a five year average basis.

Source: Agricultural Statistics of British India and Report on the Seasons and Crops of the Punjab.

Table 7 shows that not only did the area under cotton increase throughout the period 1890-91 to 1940-41, but the proportion of the cotton area to the total area sown also showed substantial incre-ases. Although most of the perennial canals had been constructed by 1920-21, *the* acreage under cotton doubled between 1920-21. and 1940-41, that is, from just over one million acres to just over two million acres. The increase in the total area sown for the same period was 1.4 million acres, so that most of the increase was in the direction of the cotton crop (See Table 9). The rate of increase for cotton was also the highest compared to any of the other important colony crops including wheat.

TABLE *8-Punjab Canal Colony Districts, Rate of Change* (%), *of Area under Different Crops, 1890-91 to 1940-41*..

	Cotton	Wheat	Foodgrains	Foodgrains minus Wheat
1890/91-1900/01	53.17	27.45	4.64	-17.89
1900/01-1910/11	46.17	52.21	46.22	37.06
1910/11-1920/21	80.77	6.24	11.16	19.53
1920/21-1930/31	48.21	10.94	9.81	8.12
1930/31-1940/41	34.02	0.22	-0.53	-1.68

Note. Figures have been caleulated on a five year average basis.

Source: Agricultural Statistics of British India and Report on the Seasons and Crops of the Punjab.

The biggest jump in the wheat acreage occurred during the 1900-01 to 1910-11 period as did the acreage under all foodgrains. The next decade, however, saw a tremendous jump in the cotton acreage (80.77 per cent), while the rate of change for wheat fell below 10 per cent. Between 1930-31 and 1940-41, the area under cotton continued to increase, while the increase in the wheat acreage was neligible and the area under foodgrains other than wheat actually decreased. The continued demand for cotton in the internal and international markets despite the fall in prices in 1929, was responsible for the increased cultivation of the crops while the decreased demand for wheat accounted for its lower production. It was comparatively easy to switch from the cultivation of wheat to cotton by reducing the area of wheat grown under canal irrigation to cotton. Also, while the cultivation of wheat increased at the expense of other foodgrains between 1890-91 and 1920-21, thereafter it increased less slowly. This was mainly because the extensions of the cultivated area after 1920-21 took place more slowly.

After 1920-21, most of the increase in the area sown was absorbed by cotton, with the area under foodgrains as a whole actually showing a decline. This occurred inspite of a continually growing population. Thus whereas the percentage change for cotton for the entire period 1890-91 to 1940-41 was over seven hundred per cent, for the same period the area under wheat increased at a rate of 141 per cent, while the area under foodgrains apart from wheat increased by only 32 per cent.

TABLE *9-PunjJb Canal Districis, Relationship between Sown Area, Wheat Area, and Area under Foodgrains,* 1890-91 *to 1940-41.*

(in million acres)

	Total Sown Area	Area under Foodgrains	Areas under Wheat	Area under Foodgrain minus Wheat
1890-91	4.4	3.6	1.7	1.9
1900-01	5.1	3.7	2.3	1.4
J910-11	8. ~	5.5	3.4	2.1
1920-21	10.5	6.1	3.7	2.4
1930-31	11.0	6.7	4.1	2.6
1940-41	11.9	6.6	4.1	2.5

	% Foodgrains of Sown Area	% Wheat of Sown Area	% Wheat of Foodgrain Area
1890-91	80.49	39.98	49.67
1900-01	73.29	44.32	60.50
1910-11	65.18	41.05	62.97
1920-21	64.54	38.84	60.18
1930-31	60.50	36.78	60.80
1940-41	55.48	33.99	61.25

Note. Figures have been calculated on a five year average basis.

Source: Agriculmral Statistics of British India and Report on the Seasons and Crops of the Punjab.

In the Punjab Canal Colony Distncts, the emphasis on cash crop cultivation was also evident from the diversion of irrigated wheat cultivation in some districts to its unirrigated cultivation, the water being reserved for the cultivation of cotton and vegetables. Both Lyallpur and Lahore districts registered a decrease in the cultivation of wheat as a whole and together with Shahpur disirict, experienced a decline in the area under irrigated wheat, with the irrigation water being diverted to other crops. The districts of Gujrat, Shahpur and Sheikhupura showed a decline in the proportion of their irrigated wheat area to the total area under wheat after 1920-21 for similar reasons. (Table 10). The declining role of foodgrains in the total agricultural produc-

TABLE *lO-Punjab Canal Colony Districts, Total and Irrigated Wheat Acreage* 1890-91 *to 1940-41*..

	1890-91	1900-01	1910-11	1920-21	1930-31	1940-41
1. *Gujranwala*						
Total area	237,853	339,332	446,061	326,084	395,817	413,890
Irrigated	192,568	264,474	345,946	253,454	296,006	312,234
% Irrigated	80.96	72.64	77.56	77.73	74.78	75.44
2. *Gujrat*						
Total area	327,858	218,759	339,282	365,596	403,886	411.028
Irrigated	87,701	63,805	63,713	191,633	167,820	175,932
% Irrigated	26.75	29.17	18.78	52.42	41. 55	42.80
3. *Jhang*						
Total area	181,712	679,849	318,919	336,907	364,846	361,531
Irrigated	142,062	400,301	288,714	304,563	321,341	320.297
% Irrigated	78.18	58.88	90.53	90.40	88.08	88.59
4. *Lahore*						
Total area	408,035	389,835	500,490	361,323	368,312	326.085
Irrigated	337,466	285,863	353,534	295,499	292,180	279,415
% Irrigated	82.71	73.90	70.64	81.78	79.33	83.14
5. *Lyallpur*						
Total area	x	x	660.036	649,969	630,453	587,867
Irrigated	x	x	657,767	646,652	628,114	581,830
% Irrigated	x	x	99.66	99.49	99.63	*98.917*
S. *Montgomery*						
Total area	203,462	157,942	272,092	369,951	493,997	531,~5l
Irrigated	155,914	110,544	216,922	344,309	476,260	509,487
% Irrigated	76.63	69.99	79.72	93.07	96.41	95.89
7. *Multan*						
Total area	297,698	283,265	413,058	456,713	590,776	675,023
Irrigated	251,406	235,549	354,821	407,532	544,964	537,629
% Irrigated	84.45	83.15	85.90	89.23	92.25	94.46
8. *Shalzpur*						
Total area	225,525	181,645	539,323	421,237	505,124	505,142
Irrigated	159,111	84,543	397,309	340,522	333,651	329,430
% Irrtigated	70.55	46.54	73.67	80.84	66.05	65.22
9. *Sheikhupura*						
Total area	x	x	x	260,904	356,808	365,203
Irrigated	x	x	x	242,776	301,292	284,393
% Irrigated	x	x	x	93.05	84.44	77.87

Note. Figures have been calculated on a two year average basis.

Source: Agricultural Statistics of British India and Report on the Seasons and Crops of the Punjab.

tion of the districts was indicative of the change towards cash crop production. Based on similar evidence, other writers have worked out trends for agricultural output for the whole of the Punjab and reached similar conclusions which point to a downward trend in foodgrains since 1920-21 after an initial period of increase.[21]

Other cash crops. While wheat and cotton were the staple crops as well as the major export crops, oilseeds and sugarcane covering a much smaller proportion of the total cropped acreage were the major revenue paying crops. Oilseeds were cultivated during the *rabi* season, and were harvested just at the time of the payment of the *raM* land revenue. Sugarcane was a *kharif* crop, and provided the cultivator with ready cash to meet the revenue demand at the end of the *kharif* season. Its cultivation was also advantageous from the point of providing food and fodder as well as fitting into the rotation pattern of the Canal Colony Districts. While sugarcane was cultivated for domestic purposes and export, oilseeds had a large export market..

TABLE *II-Punjab Canal Colony Districts, Acreage under ai/seeds and Sugarcane,* 1890-91 *to* 1940-41. *(ill* '000 *acres)*

	Total Crops Acreage	Area under Oilseeds	Area under Sugarcane
1890-91	4,434	185 (4.2 'Yo)	35 0.8 'Yo)
1900-01	5,098	260 (5.1 'Yo)	57 1.3 'Yo)
1910-11	8,378	588 (7.0'Yo)	89 (1.1 'Yo)
1920-2 I	9,426	493 (5.2 'Yo)	133 (1.4 'Yo)
1930-3 I	11,0 19	602 (5.4 'Yo)	140 (1.3 'Yo)
1940-41	11,952	383 (3.2 'Yo)	150 (1.3 'Yo)

Note. Figures have been calculated on a five year average basis.

Source: Agricultural Statistics of British India, and Report on the Seasons and Crops of the Punjab.

The area under sugarcane and oilseeds, especially the former, remained small in proportion to the total cropped area during the period 1890-91 to 1940-41, although in absolute terms it more than doubled in the case of oilseeds and trebled in the case of sugarcane during the same period.

Changes in the Harvest Pattern

The ability of the perennial canal to provide water throughout the year, resulted in an increase in the *rabi.* (spring) harvest in the Canal Colony District.[22] Previously, the cultivation of wheat, gram, *toria.* barley, and

senji the main *rabi* crops, had depended on available supplies of water in wells but more usually on the meagre rainfall of the winter months. The *kharif* (autumn) harvest had, therefore, been more dominant, with crops of sugar-cane, rice and some cotton receiving water from the inundation canals, wells, and the monsoon rainfall.

TABLE *12-Punjab Canal Colony Districts, Percentage of Rabi to the Total Harvest,* 1901-02 *to 1940-41.*

	1901-02a	1910-11	1920-21	1930-31	1940-41	% Change 1901/02-1940/41
1. Shahpur	65.3	68.2	70.4	66.0	66.1	5.2
2. Jhang	67.9	72.6	70.1	69.3	65.8	-3.1
3. Gujranwala	62.4	70.2	67.3	67.2	65.6	5.2
4. Lyallpur	x	73.5	71.9	67.7	63.1	*-14.2b*
5. Gujrat	53.5	63.2	65.4	64.9	62.6	17.0
6. Sheikhupura	x	x	*64.6c*	64.5	60.2	*6.8d*
7. Lahore	64.9	72.2	67.0	65.3	58.9	- 9.2
8. Montgomery	64.3	75.3	61.4	62.3	57.0	-11.4
9. Multan	62.6	64.9	60.5	60.8	56.3	-10.1

Note. Figures have been calculated on a five year average basis.

a. Actual figures.
h. Change from 1910-11 to 1940-41.
c. Two year average figures.
d. Change from 1920-91 to 1940-41.

Source: Report on the Seasons and Crops of the Punjab.

By the turn of the century, however, the *rabi* harvest accounted for more than 60 per cent of the total harvest in all the Canal Colony Districts. Table 12 shows that in almost all the Colony Districts, the proportion of the *rabi* harvest to the total harvested areas increased till 1910-11, when apart from the districts of Gujrat, Multan, and Shahpur, it formed more than 70 per cent of the total harvested area. However, after 1910-11, in most districts, the share of the *rabi* harvest showed a decline. This can be explained by the fact that the extension of the canals and their branches had resulted in a decrease in the supply of water in the irrigation channels, as well as by the fact, that greater reliance was placed on wells after 1920-21, to supplement canal irrigation shortages, which led to an increase in the *kharif* harvest. An added factor was the extension of the area under cotton, the major *khar!* crop.

Conclusion

The role of irrigation as the major controlling factor regarding the extension of cultivation in the Punjab has been unchallenged since early times. The importance given to irrigation by the Moghuls, Sikhs and later the British, culminated in the development of the perennial canal system in the Punjab during the period 1880-1940. The availability of regular supplies of water combined with an increase in population especially in those areas where the perennial canals were constructed, demanded simultaneous changes in agricultural practices and cropping patterns.

The extension in the area cultivated reduced the area available for grazing. Similarly, the portion of land left fallow each year decreased while the double cropped area increased throughout the canal colony districts of the Punjab. Changes in crop rotation were effected as a result of the increasing cultivation of wheat, cotton, oilseeds and sugarcane as the major cash crops, while wheat also replaced many of the other foodgrains. Furthermore, their cultivation reduced the importance of *ghi,* milk and wool as the main items of exchange in the rural economy.

REFERENCES AND NOTES

1. The Canal Colony Districts include the districts of Gujrat, Gujranwala, Lahore, Sheikhupura, Lyallpur (now Faisalabad), Jhang, Montgomery (now Sahiwal), Multan, and Shahpur (now Sargodha).
2. Douie, J. M., 1908, *Punjab Land Administration Manual,* Civil and Military Gazette Press, Lahore, p. 88.
3. Govt. of Punjab, 1865, *Report on the Revision of the Settlement of the Land Tax and Tirnee Revenue, in the Cis-Indus Portion of the Dera Ismail Khan District, comprising the Leia and Bukhur Tehsils,* 1862, by H. Mackenzie, Lahore, p. 4.
4. Habib, I., 1963, *The Agrarian System of Mughal India* (1556-1707), Asia Publishing House, London, p. 21, and *Report on the Administration of the Punjab,* 1849-50, p. 7.
5. The *rabi* or spring harvest depended mainly on irrigation in the south and east of the province, while in the north-west the winter rainfall was sometimes sufficient. The *kharif* or autumn harvest depended on the monsoon rains to soften the soil and provide the necessary water. In most areas a *kharifharvest* could follow a *rabi* harvest on the same land, but not the other way around. The major *rabi* crops were wheat, tobacco, opium barley, mustard, *masur,* maize, vegetables, turnips, peas, and *tara mira.* The major *kharif* crops were, cotton,

sugarcane, rice, *bajra,* maize, *mung, mash, moth, til,* turmeric, vegeta-*bles,jowar,* gram, *churree,* and cardamom.

6. Before cultivation the land was watered a couple of times, then ploughed five to six times and then again watered before the seed was sown broadcast.. It was then repeatedly watered many times. The tail of canal was the most prized area for cultivation as here the level of the canal was above the land and !!.us_h irrigation was possible simply by making small cut or *paggu* in the sides of the canal.. (Govt. of Punjab, 1860, *Report on the Revised Settlement of the Jhang District,* 1859, by H. Monckton, Lahore, Append. B, p. 1 & 2.)
7. Govt.. of Punjab, 1860, *Report of the Revised Settlement of the Mooltan District,* 1860, by J. H. Morris, Lahore, Appen. F.
8. Govt.. of Punjab, 1866, *Report on the Revised Settlement of ihe Moo/tan District,* 1866, by G. Ousley and W. C. Davies, Lahore, p. 23. For example, in the *kharif* season if the rains came early *bajra* was planted, if not then *til, mung,* and *mash* took its place.
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18. The chief rotation pattern in the Canal Colonies was: Wheat, *toria,* cotton, or wheat, *toria,* cotton; also 1t acres of sugarcane and the same amount of maize and sone fodder.. The rotation in *chahi*

(well irrigated) area was: Wheat, maize, *senji,* sugarcane, also small amounts of tobacco, potatoes, melons, and vegetables. The rotation pattern in *barani* areas was as follows : Wheat or gram or barley in the *rabi* season, followed by *chari, moth, mash, til* or cotton in the *kharif* season, then one year fallow. (Commission on Agriculture, 1927, VIII, p. 189-190). The most common rotation pattern followed in the Punjab Canal Colony Districts was as follows:

Kharif	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*
Cotton	Fallow	Fallow	Wheat	Cotton	Fallow	Fallow	Wheat

19. Trevaskis, H. K., 1931-32, *The Punjab of Today: an Economic Survey of the Punjab in Recent Years,* 1890-1925, Vol. I, Civil and Military Gazette Press, Lahore, p. 235.

20. *Ibid,* p. 307.

21. Blyn, G., 1966, *Agricultural Trends in India,* 1891-1947: *Output, Availability, and Productivity,* University of Pennsylvania Press, Philadelphia, p.lOO.

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SLUMIFICATION IN LAHORE

DR. FARHAT GULZAR

INTRODUCTION

In the growing cities of Pakistan, millions of people are settling on public and private land and have raised temporary haphazard structures thereon popularly known as 'Slums'. Lahore is one of the fastest growing cities in Pakistan and is the provincial centre of Punjab. It received influx of immigrants at the time of Independence in 1947 which inflated its population from 6,71,659, in 1941 to 8,49,476 in 1951 recording an increase of 26.4 per cent. It increased to 8,49,476 in 1951 and 12,96,477 in 1961. By the year 1972 it rose to 21,69,742 and 29,22,000 by 1981. Thus between 1951-61 the percentage variation was 62.65 between 1961-72 it was 67.44 and between 1972-81 it was 34.65. According to the official population projection by the year 1991 the total population will reach 49,67,300 and by 2001 to 69,39,500. This increase in the population will require at least 15,000 to 20,000 house per year.

The increasing numbers of people who have taken up residence in Lahore and the large scale urbanization that has gained momentum due to the multifunctional character of the city has created serious problems in respect of urban facilities of which housing is worst affected. The heavy migration of rural population to the city is due to the pull exerted by higher average income and job opportunities, better housing, health and education facilities being the regional trade and transportation center, a provincial capital near areas of high agricultural population density, a city providing and an industrial growth centre. This accelerate pace of population agglomeration is faced with acute shortage of housing and other civic amenities in the city. A large portion of the population which falls in the low-income bracket has no alternative but to live in improvised shelters which are devoid of even minimal civic facilities. These areas, commonly known as slums, are scattered all over the city, and portray more or less characteristics of rural settlements.

Most of the slums date back to 1947 when influx of immigrants from India to Pakistan took place. Due to high demand for housing, squatting became prevalent on open lands of the city, the most badly hit being Government land. Rapid growth of population during the last 35 years further aggravated

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the problem. The quality of housing material and technology used for construction depends largely on the income and the age of the settlement.

Factors influencing the location, size and pattern of slums

The age of the settlement and location are significant variables in understanding the role of a settlement; the two variables are also related. "It is hypothesized that the older a squatter settlement, the better its location relative to employment opportunities and urban amenities, and the better its site characteristics. Furthermore, as a squatter settlement ages the potential for it to become a legal part of the city increases; once this occurs squatter residents begin to feel more secure and more a part of the city."[1] These settlements are of varying size and material.. The slums are sometimes located in areas invaded by floods and are often washed away during heavy rains. The major concentrations of slums are in the central part of the city. The older slum dwellings have the best location, they are more productive, have closer ties to the city and have fewer rural residents and thus lesser ties to rural origins. As the older slums have existed for a longer, time they have had more time to change their ethnic composition and therefore show lesser rural features than the newer settlements. They are made up of mud or brick or clay tile walls, and galvanized iron roofs. Plot sizes range from 200 square feet to 1500 squae feet. The densities of houses are high and there are almost no street patterns or open spaces. The hundred slum areas spread out within the limits of the Lahore city (Fig. 1) comprise of 35,000 households with 600,000 inhabitants. This makes up about 15 per cent of the total population of Lahore. Of the total numbers, 45 slums are situated on state land and 55 are on both state and private land (Fig. 1). Fifteen settlements, mostly on state land, have been ordered for shifting whereas the balance 85 are to be regularized as per decision of the Government.[2]

As is evident from Fig. 1 most of the slum areas are located close to one another around the old city and are widely distributed over other parts of the city. In almost every instance the areas in which these dwellings are located have extremely poor drainage conditions and are subjected to severe flooding during the rainy seasons. This, of course, aggravates the already poor sanitation condition since toilet facilities and proper methods of garbage disposal are absent or inadequate in all areas. One of the principal community needs in these areas is improved drainage and sanitation conditions. The major community need is more public faucets from which drinking and cooking water could be obtained. In general, conditions in a few of these areas can be described as subhuman and in all the areas at least as poor. This is not to say that constructive elements are poor in these areas but the fact is that

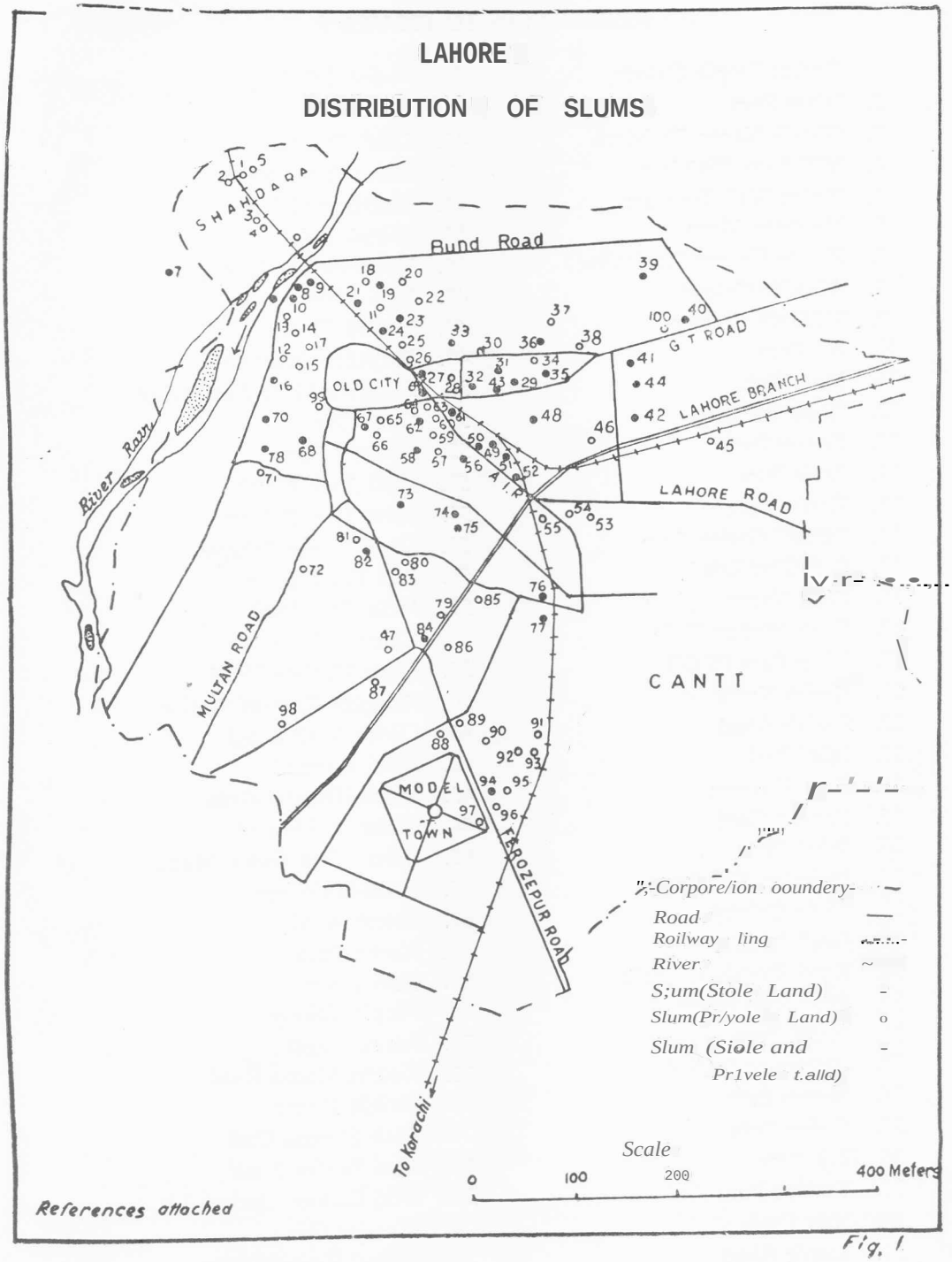
LAHORE
DISTRIBUTION OF SLUMS
SHAHDARA
Bund Road
River Ravi
OLD CITY
G T ROAD
LAHORE BRANCH
LAHORE ROAD
A.I.P.
MULTAN ROAD
CANTT
MODEL TOWN
FEROZEPUR ROAD
To Karachi
Corpore/ion ooundery
Road
Roilway ling
River
S;um(Stole Land)
Slum(Pr/yole Land)
Slum (Siole and Pr1vele t.alld)
Scale
0 100 200 400 Mefers
References attached

Fig. 1

REFERENCES TO FIGURE I

1. Barkat People Colony
2. Islam Pura
3. Gharib Nagar Shahdara
4. Mill Area Shahdara
5. Piplan Wali Shahdara
6. Maqbara More
7. Bhutto Colony (Tariqabad)
8. Albadar Colony
9. Siddique Colony
10. Ali Pura
11. Mali Pura
12. Dhoban Pura
13. Feroze Pura
14. Amir Pura
15. Karim Pura
16. Samadi Ganga Ram
17. Sher Sing Road
18. Data Nagar
19. Chah Matian Wala
20. Islam Pur a PECO
21. Karim Nagar
22. Sheikh Abad
23. Iqbal Park
24. Basti Hakeem
25. Farooq Ganj
26. Iqbal Pura
27. Ihuggian Faiz Bagh
28. Shuja Colony
29. Jamil Road
30. Katri Sheikh Mubarik
31. Jalar Sain Jewan
32. Marzi Pura
33. Muhammad Abad
34. Begum Pura
35. Gujjar Pura
36. Haji Pura
37. You nus Pura
38. New Crole
39. Tanvir Abad
40. Mujahid Colony
41. Easa Abad
42. Sansi Quarters
43. Daras Barey Mian
44. Muhammad Pura
45. Phatak No.7
46. Naqshaw Bus Stop
47. Baja Lines
48. Newan Toya
49. Barganza Quarters
50. Jhuggian Mehr-Allah Ditta
51. Gondi Pir
52. Dharam Pura
53. Basti Bhali Maish
54. Mian Mir Colony
55. Ghari Shahu Scheme
56. Bibi Pak Daman
57. Mela Ram Park
58. Chhapar Pura
59. Aqab Khaban Hotel
60. Jhuggian Railway Station
61. Choor Shah Bangi
62. Pathi Ground
63. Mayo Hospital Area
64. Mohalla Gowalan
65. Ucha Tibba Gawal Mandi
66. Habibia Colony
67. Liaqat Abad
68. Kachu Pura
69. Ravi Town
70. People Colony
71. Janak Nagar
72. Katcha Mason Road
73. Patiala House
74. Shah Shamas Qari
75. Basti Saidan Shah
76. Siraj Colony (Qurban Lines)
77. Musajar Gali
78. Mental Hospital Area

79. Ahata Mool Chand
80. Chaudry Colony
81. Chah Qurban Wala
82. Shah Jamal
83. Fazalia Colony
84. Canal Park
85. Jhuggian F. C. College
86. Main Wahdat Road
87. P. R. 1. B. Garden Town
88. Saint Maray Colony
89. Mustafa Abad
90. Guru Mangat
91. Teh Zaildaran
92. Area Charan Du
93. Nasir Abad
94. Gopal Nagar
95. Henery Key
96. China Hospital
97. Iqbal Town

the great majority of the people are better off now than before and that they do not want to leave their present communities signifies that one cannot simply evaluate the slum areas on the basis of such characteristics as housing conditions and physical site characteristics.

Preliminary analysis of reasons for migration of the low-income groups interviewed, mostly appears to be pull-oriented, i. e. most of the slum inhabitants arrived with the idea that employment opportunities were easily available or they knew some one in the city prior to their arrival. Push factors are of great importance, but the number of immigrants that entered the city in 1947 during Independence is tremendous.

Another common characteristics Qf the majority of the slum community interviewed is that place of employment and residence are highly correlated. "The low income person needs to be close to his work. He cannot afford transportation expenses which cut into his small income. He also needs to be in the city so that his family can help earn family income."3 Thus, in formulating reallocation plans for slums the Government should consider this factor carefully. The desire of most of the slum community residents is not to move from their present community of residence to other parts of city. A number of reasons account for this and one of the most important is that their jobs are presently accessible.

Slums are even found in the most sophisticated areas of the city like Gulberg, Civil Lines, Shadman etc. The increase in the number of slums is usually imperceptible over a short period. But given proper chance these go on increasing with gradual appearance of activity by way of personal services and retail business to develop them into regular neighbourhoods.

The size of the slum varies with the area available for free development. It varies from a small cluster of 65 households in Najaf Colony,

TABLE *I-List of Slums Situated on State Land (Federal Land)*

S. No.	Name of Abadi	Area *	Population	No. of House hold	Ownership	Remarks
1	Jhugian Railway Station	24 00	1540	350	Railway	In principle the transfer of the land has been agreed upon.
2	Iqbal Park	175 00	5500	800	do.	Ditto
3	Daras Barey Mian Phase-I	251 00	—	—	do.	Ditto
4	Mujahid CoJohy	37 00	1200	—	do.	Ditto
5	Essa Abad	48 00	2400	300	do.	Ditto
6	Sansi Quarters Phase-!	176 00	—	—	do.	Ditto
7	Baja Lines	28 00	2500	400	do.	Ditto
8	Qurban Lines	165 00	5000	550	do.	Ditto
9	Tariq Abad	42 00	1800	200	do.	Pitto
10	Data Nagar	60 QO	2500	—	do.	Ditto
11	Jamil Abad	42 00·	—	—	do.	Railway is not prepared to transfer the land.
12	Sansi Quarters Phase-II	111 00	—	—	do.	Ditto

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4	Mujahid CoJohy	37 00	1200	—	do.	Ditto
5	Essa Abad	48 00	2400	300	do.	Ditto
6	Sansi Quarters Phase-I	176 00	—	—	do.	Ditto
7	Baja Lines	28 00	2500	400	do.	Ditto
8	Qurban Lines	165 00	5000	550	do.	Ditto
9	Tariq Abad	42 00	1800	200	do.	Pitto
10	Data Nagar	60 QO	2500	—	do.	Ditto
11	Jami! Abad	42 00	—	—	do.	Railway is not prepared to transfer the land.
12	Sansi Quarters Phase-II	111 00	—	—	do.	Ditto

1	2	3	4	5	6	7
13	Daras Barey Mian Phase-II	41 00	7000	900	do.	Proposed to be shifted. Survey was not carried.
14	Maqbra More	250 00	—	—	do.	
15	Samadi Ganga Ram	52 00	1500	129	ETPB	ETPB has transferred some proprietary rights to the occupants.
16	Gurudat Bhavan	40 00	—	—	ETPB	A portion of land for part and school has not been handed over
17	Mauzoor Abad	94 00	3000	350	ETPB	to LDA. The case has been moved Chairman ETPB for handing over the Land to LDA..
18	Kachu Pura	110 00	—	—	ETPB	Some proprietary rights have been transferred by ETPB. LDA has no direct concern with it.
19.	Gharib Nagar	37 00	1000	150	Nazul Railway	In principle the transfer of the land has been agreed upon.
20.	Teh Zaildaran	300 00	—	—	Civil Aviation Deptt..	Land not handed over to LDA.

*Area is given in kanals and marias.

TABLE *II-List of Slums Situated on State Land (Provincial Land)*

S. No.	Name of Abadi	Area	Population	No. of House-hold	Ownership	Remarks
1	2	3	4	5	6	7
1	Basti Saidan Shah	225 00	8000	950	LDA	
2	Nasir Abad	47 00	2500	—	do.	
3	Sheikh Aba d	74 00	1200	170	do.	
4	Gujjar Pura	65 00	950	150	LMC	In principle the transfer of the land has been agreed upon.
5	Shuja Colony	195 00	1450	29U	Nazul/Private	Proposed to be developed during the current financial year.
6	Begum Pura	84 00	1900	—	Muslim Auqaf	
7	Shah Shamas Qari	33 00	2000	250	Ditto	
8	Choor Shah Bandgi	42 00	1500	150		
9	Mela Ram Park	29 00	900	117	Settlement Department	In principle the transfer of the land has been agreed upon.
10	New Crole	48 19	20GO	325	Settlement/ Muslim Auqaf	
11	Liaqat Abad	24 00	900	140	Settlement Department	Ditto

[Table II-Contd.]

1	2	3	4	5	6	7
12	Muzafar Gali	33 12	500	120	Ditto	In principle the transfer of the land has been agreed upon.
13	Patiala House	74 00	1000	135	Ditto	
]4	Davis Road	86 00	5000	1500	Ditto	Ditto
15	Fazalia Colony	127 00	6000	900	Ditto	DItto
16	Mill Area Shahdara	107 00	2000	355	Ditto	Ditto
]7	Islampura Shahdara	392 00	6000		Ditto	Ditto
18	Katcha Mason Road	41 00	900	150	Ditto	Ditto
19	Mian Mir Colony	134 09	—	—	AuqafJPrivate Settlement	Proposed to be developed during the current financial year.
20	Najaf Colony Phase I	73 00	1115	195	LDA	
21	Najaf Colony Phase II	22 00	225	65	"	Ditto
22	Chaudhry Colony	72 00	2000	233	Nazul	Ditto
23	Awami Colony	180 00			Health (Pb) Settlement	Ditto
24	Dharampura	75 00				
25	Sukh Nehr	500 00	7000	1200	do	
26	Herbanspura	75 00	900	150		

*Area is given in kanals and marlas.

Phase II (Table 2) to almost that of 15,00 households in Agha Khan Road (Davis Road) slum area (Table 3). The largest population of 7,000 is found in Daras Barey Mian Phase II (Table I) and Sukh Nehr which also has the largest land area of 500 kanals (Table 2). The sizes of slums close to the old city due to the non-availability of large vacant tracts of land in the pre-1947 period are small whereas they are large in the new colonies.

Due to large areal expansion Lahore has become a city of long distances between its various areas and as such expensive in terms of time and money. Usually the slum dweller is a pedestrian or a cyclist and as such cannot travel long distances, he therefore chooses to live in a slum which is nearer to his place of work.

LIST OF REMAINING SLUMS

1. Barkat People Colony
2. Piplan Wali Shahdara
3. Albadar Colony
4. Almadad Colony
5. Siddique Colony
6. Mali Pura
7. Duban Pura
8. Ferozepura
9. Amin Colony
10. Karim Park
11. Sher Singh Road
12. Chah Motian Wali
13. Karam Nagar
14. Basti Hakeem Nayar Wasti
15. Farooq Gunj
16. Jhuggian Faiz Bagh
17. Katri Sheikh Mubarik
18. Jalal Sain Jewan
19. Marzi Pura
20. Muhammad Abad
21. Haji Pura
22. Younus Pura
23. Tanvir Abad
24. Muhammad Pura
25. Newan Toya
26. Barganza Quarters
27. Juggian Mehr Allah Ditta
28. Gondi Pir
29. Takia Sanaran Ghari Shahu
30. Bibi Pak Daman
31. Chappar Pura
32. Aqab Khaiban Hotel
33. Mohallah Gowalian
34. Ucha Tibba
35. Habibia Colony
36. Ravi Town
37. Janak Nagar
38. Ahata Mool Chand
39. Chah Qubran Wala
40. Katri Atta Muhammad
41. Basti Chausia
42. China Hospital
43. Ahata Chiragh Din

SLUMS PROPOSED TO BE SHIFTED

1. Ara Chanan Din
2. Saint Marry Colony
3. Bhabra
4. Mustafa Abad
5. Ali Pura
6. Pathi Ground
7. Jhuggian F.C. College
8. Shah Jamal
9. Henry Key

Charactistics of slums

The general survey of these settlements show the following special characteristics of slums:

(0 Water supply, drainage, sewerage, road and electricity are almost missing.

(ii) There are no public facilities like schools, dispensaries, health and recreation centres etc., thereby depriving children, women and men of essential social services."'

(ia) The living conditions in slums are deplorable. They are mostly made up of unbaked bricks or mud without any ventilation and proper light.

(iv) A very small percentage of children go to school and there is a high rate of drop outs.

(v) There are no maternity and child care centres. Because of poverty and illiteracy only one per cent of the expectant mothers go to hospitals and MCH Centre. The local untrained 'midwives' look after the delivery cases. On this account, it is estimated that in these areas there is higher rate of infant mortality compared to other parts of the city.

(vi) The poor living conditions can be directly attributed to low incomes of the families. There are hardly any employment opportunities available within these settlements. The male labour force comprises mainly of workers and local artisans like labourers, vendors, Government servants, rickshaw drivers, sweepers etc. Among women, some work as house-maids in well-to-do families, etc. It has been estimated that income per household ranges from Rs. 200.00 to Rs. 300.00 per month (excluding the invisible income in the form of clothing, food and other help that these people get from their place of work).

(vii) Children are mostly sent to small workshops and factories as apprentices where they earn Rs. 2.00 to Rs. 3.00 per day and thus supplement the family income. This is also one of the reasons for not sending children to schools. It is observed that there exploitation of child labour is of common occurrence.

(viii) The participation of women in economic activity is poor considering the low earning capacity of each household. Those who work as house-maids bring home some daily/monthly income to supplement

the family income while some earn by doing sewing and embroidery. Thus there is hardly any skilled labour among women in these settlements.

A general characteristics of the growth of slums is the availability of land either free of cost or at very nominal rent. The lands in the central part of the city are always expensive. As a result, the earliest slum dwellers chose such lands which were available but were either not for sale or had no owner and were not supervised. These consisted of general evacuee areas, vacant open lands and large compounds and quarters of evacuee trust properties, state lands and land held by local bodies. Most of the lands and properties occupied by slums are either evacuee, evacuee trust properties and state properties. Attempts by all concerned with such properties to recover these lands and properties vacated have been successful. A large number of slums have developed over private lands where people have purchased small plots and constructed dwellings over them. These usually occur on the periphery of the city and around such villages which have been or are about to merge with the main city. (Fig. 1). The land values in such areas are usually low and lands are purchased as agricultural lands which are generally much cheaper than urban lands. At many a place, clusters have developed over very unattractive lands or very marginal lands.

Government Policy

The present Government has laid great emphasis on the development of slum settlements, and the following decisions were taken:

(a) Priority should be accorded by the Provincial Government to the immediate conferment of provisional proprietary rights to the inhabitants of the settlements on state lands upon payment of a concessional cost by the inhabitants.

(b) January 1 should be fixed as the cut-off date regarding the regularization of these settlements on state land and conferment of proprietary rights thereon. Encroachments made after this date should not be recognised and the Provincial Governments should take appropriate steps to evict subsequent encroachers and prevent further encroachments.

(c) In case of slums on state land under the ownership of Federal Government Agencies such as Railways and the Ministry of Defence, the Provincial Governments should ensure full consultation and coordination with the Federal Agencies concerned before conferring properietary rights on the inhabitants of such settlements.

(d) Slums located on private land should be regularised through individual negotiations and compromise between the land owners and inhabitants of the slums with the assistance and close involvement of the local administration. In the alternative the interested parties may seek recourse to legal measures, if so desired.

In accordance with the aforesaid policy, the Government of Punjab has outlined strategies to solve the problems of slums on the following lines:

(i) Provision of the basic infrastructures such as street pavement, construction of drains, approach roads and disposal of sullage.

(ii) Environmental improvements whenever possible in the existing slum areas and strict check on the unauthorised encroachments.

The Government of Punjab has taken a serious note of the unauthorised constructions/encroachments on public property and unhindered growth of the slums in the province. With a view of discouraging this tendency, the following decision have been taken by the Governor Punjab:

(a) All slums which do not fall within the recognizable yard stick laid down by the Government (viz. 100 household units and existing before 1st January 1978) should be removed in a phased manner.

(b) Housing and Physical Planning Department and Local Councils should immediately prepare new schemes for low income groups. These colonies should be established in the peripheries of big towns, especially near the industrial areas.

(c) Big villages around major cities should be provided with electricity and other basic civic amenities.

(d) Small industrial units should be established in the rural areas to check the migration from rural to urban areas.

(e) All open spaces of plots belonging to Government Departments/ Autonomous Bodies/Auqaf etc., should be properly guarded and cleared of all types of encroachments All such open plots which are not required by the Departments/Organisations for their use in the near future should be considered for transfer to the Development Authorities/Improvement Trusts/Local Councils concerned for maintaining as open plots.

(f) All encroachments on Government properties, roads, streets and public places should be removed, if and when necessary by force.

Role of LDA in the Development of Slums.

The Lahore Development Authority carried out a comprehensive programme for the development of slums by carrying out physical surveys through private consultants and development plans in accordance with the principles of town planning specifying the width of the streets etc. The Engineering Wing was assigned the execution of work in accordance with the development plans. The civic amenities being provided by the LDA, are paved streets, open drains, water supply, street lights and development of open spaces into parks on the available sites.

While undertaking the development activities, the first priority was assigned to those slums which had cropped up on state land. Second priority was assigned to the development of those which were established on the land under the federal agencies, and the third priority was given to those which were partially under the state land.

LDA has made achievements in the development of slums by providing paved streets. open paved drains, water supply, disposal of sullage, street lights, parks wherever sites are available. In few slums the plots for the construction of mosques, schools, churches, community halls have been given by the LDA. Slums situated on Federal Government land are partially developed by Lahore Municipal Corporation and those situated on Provincial Government land are partially developed by the Lahore Development Authority.

LDA has constructed 3,558 one room quarters opposite the Packages Industries at Kot Lakhpat for the rehabilitation of those persons whose houses were demolished due to r.:alignmeiit'af streets/roads, or of those who were shifted from some slums i.e. Shah Jamal, Mayo Hospital, Punjab Road Transport Board Premises, Wahdat Road etc. The gigantic and most difficult process of development was completed with the active assistance and cooperation of the residents in general and the Development Committees in particular. About 35 slums have been developed during the last four years at the cost of Rs. 13.12 crore. In addition to this water supply will be provided to 10 slums. The LDA aims at commencing these works as early as possible so that these areas are handed over to the LMC for maintenance.

UNICEF indicated its desire to provide assistance in the field of social and economic development of the low income people residing in slums. A workshop was organized by UNICEF in collaboraiion with Planning and Development Department in November 1979 which attended by the re-

presentatives of related agencies i.e. LDA, LMC, Social Welfare Department, Pakistan Family Welfare Council,, Pakistan Medical Association and representatives of the slum settlements. Second workshop was held from 2nd October to 5th October 1981 for the preparation of a detailed Action Plan. This Project will deal with only eleven such areas.

Slum clearance or improvement and amelioration involves physical as well as special and economic considerations: The Government has been aware of the gravity of the problem and accordingly schemes have been prepared to rehabilitate the slum dwellers' The biggest housing project for these people is the Lahore Township Scheme near Kot Lakhpat which makes a provision of 35,580 quarters over an area of 41 marlas each for the low income people. Out of the completed units a large percentage has been allotted to the low income groups of Government servants and a few hundred to the slums dwellers from whom the land was got vacated.

Conclusion

In conclusion, slums is a term used essentially to mean areas with cluster of temporary tenements whereas certain section of the population is forced to live in a squalid environment, devoid of the barest facilities and services. Slums located around the old city are old belonging to the pre-Independence period and those in the fringes belong to the post-Independence time and are fairly scattered. The age of a slum settlement is an important variable in determining the role of the settlement, the oldest settlements have the highest socio-economic status as regards education, income levels, occupational structure, and housing conditions. The newer and more pheripheral settlements hav.e residents who are less educated, have less skilled occupations, income is low and housing conditions are poor. The inhabitants of the slums live in all sorts of make-shift arrangements using any kind of building material which they can lay their hands upon. Their dwellings are made ofkatcha bricks, mud, wood, straw. bamboo and pacca bricks. Some live in dilapidated abandoned Hindu temples. The common amentities like drinking water, sewerage, electricity, latrines and bath rooms virtually do not exist. Most of them live under subhuman conditions. A large number of workers in the slums are unskilled or semi-skilled workers.

In order to provide them with the basic amenities of life the Government is taking all possible measures to provide them with pucca houses. The Town Planning Department has already developed a housing scheme called the Lahore Township near Kot Lakhpat, which is primarily meant to cater to the housing of the low income group.

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Abbreviations

M. C, H.	=	Mother Child Health Centres
L, D.A.	=	Lahore Development Authority
L.M.C.	=	Lahore Municipal Corporation

SETTLEMENT SYSTEM AND CENTRAL PLACE ANALYSIS IN CHASHMA RIGHT BANK CANAL PROJECT AREA DERA ISMAIL KHAN (D. I. K.)

ABDUL WARTS KHAN*

Introduction

A human settlement is like a living organism which passes through several stages of growth or decay. There may be unifunctional settlements and multi-functional settlements. Generally larger settlements perform more functions and are les sin numbers and smaller settlements perform less functions and are more in numbers. Functions performed by settlements are categorised as ;-

1. Lower order functions, which are used by people more frequently and need smaller number of Customers (People). 'As such this type of functions locate either in ev~rysettlement or in maximum number of settlements.
2. Higher order functions, which are used by the people infrequently and need larger number of customers. This type of functions therefore, tend to locate in bigger settlements with high accessibility from the surrounding settlements.

There is functional interaction between various settlements due to which a mutual functional relationship is established. This helps in establishing a system in which settlements tend to become mutually interdependent.

Within the over all system sub-system emerge which tend to *pe* self-sufficient to certain degree. The components of the system/sub-system of the settlements interact through the means of transport and communication and, therefore, the efficiency of the system of settlements becomes the function of the efficiency of transport and communication system.

Witnin the system, the settlements form a hierarchy. At the 16west end of this continum is found the smallest settlement having a few households. The smallest settlement may be purely agricultural settlement which hardly offers any service and depends upon the higher order settlements for service. At the other end, we have the largest settlement which offers waximum variety of service for the entire system and is located at the most accessible point within the system.

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Settlement System in CRBC Project Area

The settlement system in CRBC project area is dominated by rural settlements. Out of 138 villages only two settlements D. I. Khan and Paharpur is classified as urban settlements in 1972 census. The rest are classified as rural settlements.

Central Place Analysis

The concept of central place function was developed by Walter Christaller which provides a theoretical framework for study of the distribution of settlements. The essence of the theory is that "a certain amount of productive land supports the service centres exist because essential services must be performed for their surrounding areas (hinterland). It was argued that higher order services function exist in centrally located (most accessible) settlements which perform these services for their own population as well as that of surrounding smaller settlements. Thus each central place has a certain amount of nodality and a hinterland associated with it. The size of hinterland in terms of area and hinterland in terms of area and'population would depend upon the order of function.

Different methods have been used for measuring the centrality of settlements. Some of these are based on rating of functional equipment e.g. goods and services offered by a settlement, the number and type of shops, banks, post offices, educational institutions and health facilities etc. present in them. Others are based on assessing the; nature and extent of hinterland or market area of a settlement.. In this study we will use the former method.

Objective

The main objective of the central place analysis, in the CRBC project area is to identify the area with inadequate coverage of services of various levels. For this purpose reliable information on the functions/services having centrality is vital

For this purpose a detailed field work was done (in 138 villages of CRBC project area) by administring a questionaire.

Methodology

A selected number of services/functions were used for this purpose. These include educational institutions, health facilities, agricultural extension offices, fertilizer outlets, livestock health facilities, periodic livestock markets. number of shops by type, number of Banks, machinery repair facilities, cottage industries by types and agro-based industries by types. Another

important activity; economic activity and accessibility playa very important role in the centrality of settlements.

In the first stage presence or absence of different services/facilities were tabulated by each settlement and therefore, each service/function was assigned a value/score or point as shown in Annex-I..

It can be seen that lower order function (function having less importance) e.g. Primary school was given low weightage, whereas specialized or higher order function (Hospital, High School) which serve larger hinterland, was given higher weightage.

Existence of a banks was also given higher weightage because it was also an indicator of good commercial activity existing in the settlement..

In the next stage total scores for each settlement were added, and the score of each settlement were plotted on a graph. Break or discontinuities in the diagram helped in classifying various grades of centres. By this method 6 grades of centres were identified in the project area with the respective frequency of L 2, 7, 5, 35 and 75 from highest to lowest order centres (see Annex-II and III).

D. I. Khan city was excluded for analysis because it serves as the primate city of the region and was placed in category I. Three other settlements Dewala, Muryali and Ratta Kulachi were also excluded because these were located in urban fringe of D. I. Khan. The remaining central places have been grouped according to their status (see Annex-II).

Findings:

Category 1. *Highest Order Central Place*

Dera Ismail Khan city was placed in Grade-I because it is the highest order central place for the region. It has divisional, district and tehsil head-quarters and also various Provincial Government and Federal Government offices are located here providing administrative services to the region.

Dera Ismail Khan city also serves as local and regional marketing centre both for whole-sale and retail.. It has firm economic base due to presence of various financial institutions like banks, co-operatives etc. A firm marketing society exists here which regulates the marketing activities.

Alongwith socio-economic services Dera Ismail Khan also provides health facilities to the region due to existence of District Headquarter Hospital.. T B. Hospital, various dispensaries and private clinics.

Dera Ismail Khan also serves as educational centre for the region having varions schools, colleges and a university. Some vocational centres also exist here e.g. Polytechnic, Technical Training Centre, Vocational Training Centre for women etc.

Category II. *Second Order Central Places*

Two settlements Paharpur and Paroa fall in this category. Paharpur has a town committee and plays the role of a central place for its surrounding settlements. We can call in the secondary status marketing centre because it provides marketing facilities to the surrounding settlements. It also provides social services for the surrounding settlements, having a Civil Hospital, Veterinary Hospital and a boys and girls high schools.

Paroa is located in the southern part of the project area on Dera-Multan Road. Its importance is also backed by its location. It provides marketing faciliti~s to the s~rrqunding settlements by presence of a shopping centre and bank,. Alongwith economic services it also provides some social services for the surroundihg settlements by presence of schools and hospital..

Category III. *Lower Order Central Places*

This category consists- of 7 settlements: Ramak, Machora Shumali. Kech, Mahrah, Band Korai, Multan Isa and Dhakki. These are lower order centrat places. These settlements offer some services for their surrounding settlements.

Category IV. *M ediocess :*

15 settlements fall in this category. These settlements provide services to their own population but hardly for their surrounding settlements.

Category V. *Lagging Central Places*

35 settlements fall in this category. These settlements are defficient in services and depend on other higher order settlements for services.

Category VI. *Lowest Order:*

75 settlements fall in this category. These are at the lowest position in the system. These a,re purely agricultural settlements which depend on higher order settlements for services.

ANNEX I

SCORE FOR VARIOUS SERVICES

	Scores
Connectivity and Transportation	
(a) Road Connectivity	
Connected by metalled	=4
Connected by Shingled	=2
Connected by Cart Track	=1
(b) Connectivity with D.I. Khan, Paharpur, Parva and Ramak	
Connected with DJ. Khan	=4
Connected with Paharpur	=2
Connected with Paroa	=1
Connected with Ramak	=0.5
(c) Aceessibility of Settlement	
Bus operating to village	=2
Final Bus stand in village	=4
Bus stop	=2
(d) Frequency of Bus Operation	
Upto 5 times	= .25
5-10	= .50
10= 15	= .75
15-20	=1.00
20-25	= 1.25
25-30	=1.50
30 =35	=1.75
35 - and above	=2.0Q
(e) Agricultural Offices	
Agricultural assistant office	=3
Agricultural Officer	=5
(f) Agro based industrial units	
Flour mills	= .5
Oil Ext units (Bullock Drive)	= .5
,, " (Elect)	=1.5
Husking mills	=1.58
Cotton jenning	= 1,5
Ara machine	=2.5

	Scores
(g) Mechinery Repairs	
Cycle repair shop	= .5
Ekct. appliances	= 1.00
Welding	= 1,5
Battery charging	=2.0
Auto/tractor repair	=2.5
Social Services:	
(a) Education Institutions	
Primary school boys	= .5
Primary school girls	= 1,0
Middle School boys	= 1,5
Middle school girls	=2.0
High School Boys	=2.5
High School Girls	=3.0
(b) Health Facilities	
Dispensary	=1
Sub Health Centre	=2
Basic Health Centre	=4
Rural Health Centre	=5
(c) *Animal Husbandry*	
Veterinary Centre	=2
Veterinary Dispensary	=3
Veterinary Hospital	=5
(d) Postal Facilities	
Branch Office	=1
Sub Post Office	=2
Post Office	=4
(e) Telephone and Telegraph	
Telephone	=4
Telegraph	=6
(f) Economic Activities	
(a) Shops	
Karyana	=0.5
Tea Stall	= 1,0
Meat	= 1,5
Cobbler	= .5
Tarkhan	= .5

	Scores
Lohar	= .5
Cloth Merchant	=2.5
Tailoring Shop	=2.5
(g) Banks	
One Bank	= 1,0
2 Banks	=2.0
3 Banks	=3.0
More than 3	=4.0
(h) Shoper Movement for Consumer goods	
Shopper coming to village	=4
,, and going to other village	=2
Not coming nor going out	=1
Going out to other villages	=0

ANNEX II

S. No.	Name of village.	Score	S. No.	Name of village	Scores
	Grade-I		6	Miran	52.50
	Dera Ismail Khan		7	Dhalla	51,75
	Grada-II		8	Lar	50.25
1	Paharpur	224.50	9	Said Alian	9.75
2	Paroa	171.00	10	Dir-Khan	47.50
	Grade-III		II	Kotla Lodhian	45.25
1	Ramak	97.00	12	Mitta pur Kallan	44.00
2	Machora Shumali	93.50	13	Thatta	34.50
3	Kech	90.00	14	Musa Khar	40·75
4	Mahreh	89.25	15	Malana	4'050
5	Band Korai	79.75		Grade-V	
6	Mulla Isa	72.00	I	Khaliq Shah	40.00
7	Dhakki	62.25	2	Korai	40.00
	Grade IV		3	Kot Butta	40.00
1	Katgarh	59.75	4	Shor Kot	39.50
2	Malli Khel Kaccha	58.50	5	Bigwani Shumali	39.00
3	Daraban Khura	58.00	6	Zandani	38.75
4	Rakh Band (Korai Civil)	58.00	7	Awan	38.25
			8	Kotla Saidan	37.25
5	Mandrah	52.50	9	Shah Dau	36.75

S. No,	Name of village	Scores
10	Haji Mora	36.50
11	Noorpur Shumali	36.50
12	Gara Ashiq Khan	34.50
13	Chahkan	33.00
14	Khutti	32.50
15	Girsar	32.00
16	Gara Tahir Khan	32.00
17	Amir Shah	31.00
18	Hissam	30.25
19	Gomal	30.00
20	Lang Khair Shah	30.00
21	Tirgarh	27.75
22	Kala gorth	27.50
23	Sikandar Janubi	20.75
24	Hayat Korai	26.00
25	Fateh	25.50
26	Nawab	25.50
27	Lundah	23.50
28	Rakh Zindani	23.50
29	Tikan	23.50
30	Gara Haji Hussain	23.50
31	Butaisar	23.50
32	Saiduwali	23.50
33	Dmer Khel Kacha	23.03
34	Singar	22.00
35	Rakh Mangan	21.50
	Grade-VI	
1	Diyal	20.00
2	Daraban Kalan	20.00
3	Gara Ghulam Ali Shiri	19.75
4	Jara	19.50
5	Rakh Ghas	19.50
6	Mahmooda	19.50
7	Shala	19.00
8	Lachrah	19.00
9	Miani	19.00
10	Budhan	18.75
11	Jatta	18.50
12	Mukin Shah	18.50
13	Thattal	18.50
14	Ranjpur Janubi	18.50
15	Rakh Band Korai (M)	18.00
16	Gara Noor Khan	18.00
17	Noon	18.00
18	Ghaunsar	17.25
19	Ghamsan	17.50
20	Shah kot	17.50
21	Ghaus Shah Janubi	17.50
22	Rajanpur	17.50
23	Khanu Khel	17.25
24	Adii Sepra	17.00
25	Bali Shumali	17.00
26	Khana	16.50
27	Rakh Mandra	16.00
28	Bilot Kacha	16.00
29	Kulachi wala	16.00
30	Bochra	16.00
31	Ara	15.50
32	Ghabi	15.50
33	Sagu Janubi	15.50
34	Gara Bakhsha	15.50
35	Segra	15.50
36	Rakh Bibi	15.50
37	Rashid	15.00
38	Mubarik Shah	15.00
39	Mianwada	14.50
40	Kirri Khaisor	13.50
41	Had Isra	13.50
42	Rora	13.50
43	Lund Pahar	12.75
44	Qazi	12.50
45	Mathwala Shah	12.50
46	Khanpur Janubi	12.50
47	Kangpur Janubi	12.00
48	Rakh Lakri Jalala	12.00
49	Dhap Shumiili	12.00

S. No.	Name of village	Scores	S. No.	Name of village	Scores
50	Thowa	12.00	63	Makkar	9.50
51	Rakh Shah Kot..	12.00	64	Rakh Khona	9.50
52	Kotla Habib	11.50	65	Lok	9.00
53	Sigwani	11.:0	66	Gara Jamal	9.00
54	Gama, Balu, Nihal..	11.50	67	Hamu wala	9.00
55	Malekhy	11,00	68	Jalwala Chamali	9.00
56	Bali wala	11.00	69	Ghulam Koti	8.50
57	Chira Polad	10.50	70	Qila Qaim Shah	7.50
58	Sheikh Raju	10'50	71	Patel Jai Gharhi	7.00
59	Ubha	10.50	72	Rakh mahrah	7.00
60	Ruknu	10.00	73	Hiram Jai	5.50
61	Bachri	10.00	74	Umar Baba	5.00
62	Lodrah	9.50	75	Dewan Sahib Wala	5.00

ANNEX III

TABLE No. -*Number of Settlements by Grade*

Grade	Number of settlements	Names of Settlements
I	1	D. 1. Khan
II	2	Paharpur and Paroa
III	7	Ramak, Machora Shumali, Kech, Machora Shumali, Mulla Isa Dhakki.
IV	15	See Annex I
V	35	See Annex II
VI	75	See Annex III
Total	135	

URBAN REGIONS OF FAISALABAD

DR. M. H. BOKHARI

A study of the fast expansion of Faisalabad reveals that industries, commerce, administration and education-have been developed in certain appropriate districts according to their particular requirements. The different areas which are related to the aspects of the townscape, functions and form, produce variations which provide a basis for the recognition of urban regions.[1] In this article these problems have been examined with respect to their spatial characteristics for the delimitation of the distinctive parts of the city, the urban regions. These may be defined as those portions of the city which possess the same type of townscape, serve comparable functions, and within which development has been similar. It is the nature, relative disposition and social inter-dependence of the various parts which determine the form and the geographical structure of the city, making it a distinctive entity.[2]

To appreciate the total environment in the context of its regional differentiation, the delimitation of such regions is essential for urban geographers as suggested by Professor Emrys Jones. 'The description of such regions, however, does not carry the urban geographer very far unless he is able to delimit them, for only then will a real differentiation of the region be revealed.'[3]

Since Faisalabad was a planned city, therefore, provision was made for certain sectors in the original plan to accommodate specific functions and accordingly their appropriate buildings were constructed. In the old plan of the city such sectors were marked for the following purposes.[4]

1. *The Administrative Sector.*
2. *The Residential Sector.*
3. *Commercial Centre.*
4. *Industrial Centre.*
5. *Educational Centre.*
6. *Open Spaces and Recreational Parks.*

Prior to independence of 1947 the buildings of the administrative section were mostly of single storey construction, having no plaster on their outer walls, so that a light reddish complexion was given to this area. Apart from these Government and District Board Offices the residential bungalows in this area were also provided on a similar pattern. In other parts of the residential sector,

the exteriors of the two-storeyed indigenous houses were either white-washed or painted grey. The relatively even roofline of the majority of the buildings in the area was punctuated at irregular intervals by domes and pinnacles. The reIail shopping areas were developed on both sides of the eight roads radiating from the central Clock Tower, whereas the wholesale businesses in grains, hide and skins, salt, wood and ghee were established in various sections of the inner and outer ring roads. The industrial sector remains confined to the south of the city where it is encircled by the railway tracks on the east and the south. The western side was blocked by a road joining the city centre to the Sammundri road, whereas the northern side was bordered by the Sirwala distributary. The buildings of the schools and hospitals, single or double storeyed indicate clearly the area they are situated within is residential.. A number of open spaces with a few recreational parks were provided within the city corporation limit.

The Partition of the sub-continent in 1947 has completely disrupted the planned development because of the abnormal expansion of the city in many directions. This unexpected increase through the influx of population to this city has extended it almost equally on all sides of the original planned city, regardless of the previous planning. In the absence of controlled development during this new era of expansion, Faisalabad has lost the old systematic arrangements of its functional structure. "As a result, new urban regions have been added and the majority of the older ones have expanded and also been modified internally."5 (map 1).

The Present Urban Regions of Faisalabad

The present general aspects of townscape, its functional structure, morphology and demographic analysis provided the basis for the demarcation of the following urban regions of the city.

(I) The Commercial Core

(II) The Administrative Quarters

(III) The Agricultural University Campus

(IV) The Old Factory Area

(V) The Inner Residential Areas

A. The Detached Bungalow Area.

B. The Semi-Detached Bungalow Area

C. The Indigenous House Areas

D. The Terraced Quarter Areas

E. The Hovel and Hut Areas

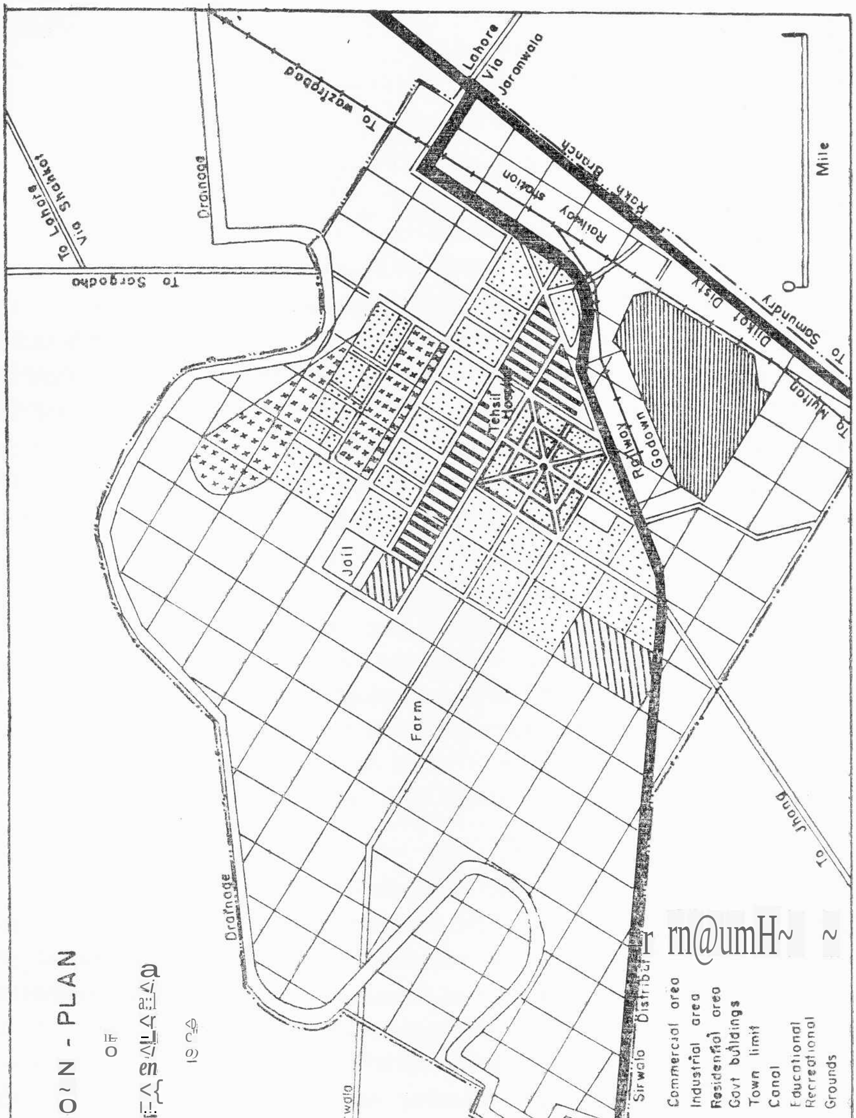
PLAN
To Wazirabad
Lahore Via Jaranwala
Raka Branch
Railway station
Mile
To Lahore Via Shahkot
Drainage
To Sargodha
Pilot Disty
To Samundry
To Multan
Tehsil
Railway Godown
Jail
Farm
To Jhang
Drainage
Sirwala Distribut
To Narwala
Commercial area
Industrial area
Residential area
Govt buildings
Town limit
Canal
Educational
Recreational
Grounds

Fig. 1

(VI) The Suburban Areas with Industrial Satelites and Colonies

A. The Semi-Detached Bungalows.

B. The New Terraced Quarter Areas.

C. The Private Localities with Indigenous Houses.

D. The Huts of Suburban Areas.

(VII) The Outer Fringe of the Open Country

Now each of these regions is examined in turn.

I. The Commercial Core

The radiating road plan of the city is the most striking feature. The administrative area, bordering the commercial core on its north-eastern and south-eastern sides enjoys less advantage from the road system than the commercial core. These radiating roads (locally known as bazars) are like the spokes of a wheel which radiate from the Central Clock Tower on all sides. A number of through roads connect this core with other urban centres. The Sargodha Road from the north, Lahore and Satiana Roads from the east, Sammundri Road from the south, Jhang and Aminpur Roads from the west approach the city centre. The inner and outer circular roads inter-connect all these other roads. The Ring Road has separated the commercial core from other regions of the city. Within the commercial core the segregation of functions is well marked and there is a clear pattern-the radial roads are the bazars for retail business; the inner ring road is the place for wholesale business; and the triangular sectors formed by the radial roads are residential along the main roads was commercial, with the first and second floors being planned for purely residential use.

Since the commercial activities increased after the birth of Pakistan in 1947, naturally the demand for their accommodation increased. The influx of refugees immediately afterwards was responsible for the great boost in commercial activities within this part of the city. They were further supported by the establishment of a number of huge cotton textile mills around the city peripheries, which stimulated wholesale activity, especially in cloth, at Faisalabad. Many houses along these radiating bazars have been replaced by the new multi-storey structures, where ground floors are being used for the wholesale cloth markets, the first and second floors for the commercial offices, the rest for residential purposes.

The great pressure upon space within this region increases the land value. The land which was once priced barely at Rs. 1,200/- (£100) per acre; in 1946, now has risen to Rs. 70,000/- (£3500) within a period of Therty-five years.[6] To gain advantage from the high price of land most of the needy inhabitants

have migrated from the city centre to the outer residential areas. This created a two-fold effect. First was the tendency for commerce to spread horizontally outwards and secondly for it to extend vertically, expressed in the construction of multi-storeyed buildings, for it see ns that "th ~growth of every town is a twin process of outward extension and internal reorganization."7

II. The Administrative Quarters

The administrative area lay adjacent to the commercial hub of the city, which joined it from the north-east, east and south-east. . In 1904, when Faisalabad became the district headquarters, soon after its establishment, the administrative activities were enlarged and therefore this entire region was occupied by various administrative offices. The selection of this quarter as an administrative centre was most appropriate because of its proximity to the city centre, as well as its direct approach from all the tehsil headquarters administered by Faisalabad.

This urba:l region was planned as a grid. Both sides of its roads are provided with thick shady trees, which thus clearly differentiate it from other areas of the city. The police barracks are situated in the north-western part. . They are all single-storeyed, with spacious compounds, and are mostly built with baked bricks. Each compound is well shaded by trees so that even these bui~dings are partly hidden. Further north is the Faisalabad District Jail with its administrative offices. The huge mud walls of the jail give a foreboding air to this locality.

The other Government administrative offices and district courts are situated east of the Kutchary Bazar. Structurally they are also single-storeyed buildings, mostly with red brick exterior walls. They are located within a huge compound enclosed by a small boundary wall known at 'Kutchary'. Within this compound a number of large rooms are built in the shape of the letter 'H'. These rooms are used as court-cum-offices for the Deputy Commissioner, magistrates and session judges. It also contains small prison for the temporary incarceration of accused persons awaiting trial and criminals. Within the compound the thatched huts formerly used by the lawyers have now been replaced by single room offices built of baked brick. A large number of people may be seen within this area during office houn, but during the rest of the day the place is absolutely deserted.

The district courts and the police lines are separated by the buildings of the pest and telegraph offices. Recently this block has been renovated and a couple of new blocks have been added to their compounds. These additional buildings are the telephone exchange-a double storeyed stucture with cemented

outer walls, painted white and cream. These buildings have given a new look to this part of the region and have broken the former monotony of the dull reddish colour of the brick buildings.

The tehsil headquarter, P. W. D. and the canal irrigation offices are also located in a compound with its small boundary wall adjacent to that of the district courts towards the southeast.. These buildings are also single-storeyed with brick walls. Opposite the irrigation offices in the north is the building of the State Bank of Pakistan. The other buildings attached to this bank in the south are the railway offices. They are all single-storeyed buildings, with baked brick coloured walls. The flatness of the skyline of this region is broken only by the church, the water storage tank and a few small towers of the newly erected District Board Hall..

The city Municipal Corporation and their other office buildings are located to the south-east of the city centre. The main block of these buildings, including its hall, was built only recently and is quite different from the other buildings around this block. This new block has cemented outer walls painted cream. Most of the Corporation offices are located within this building.

After the Independence of 1947, rapid expansion took place in the city and a number of new Government offices consequently had to be established to meet the immediate need for accommodation pending the construction of new buildings. Large bungalows, especially in the Civil Lines, were used, and even now a number of offices for the Taxation, Settlement and Rehabilitation, Labour and Town Planning departments still occupy such buildings. Most of them are in the new residential localities such as Jinnah and People's Colonies.

m. The Agricultural University Campus

The Faisalabad Agricultural University Campus is third in relation to the commercial core and the administrative regions as the most striking feature Situated in the northern portion of the city, it lies to the west of the main Faisalabad-Sargodha Road. The Jail Road in its south joined this part by the College Road to the city centre.

There are three prominent building blocks within this region. The central one consists of the University building itself, with its large halls and teaching departments. A number of building corridors are being used for the laboratories attached to their respective departments. These are all two-storeyed buildings of dull reddish colour. By the side of this block, the students' hostel is situated. Most of these buildings are shaded by the growth of large trees which line both the sides of the streets laid out in a grid. Further to the north-west are a number of vast sports grounds, with adjacent swimming pool

and a gymnasium. These grounds are beautifully maintained with trimmed boundary hedges. South of these grounds is the main workshop of the University, where the agricultural machinery may be repaired and renovated.

The second block is situated west of the university building. It consists of residential bungalows occupied by teaching staff. All these bungalows are enclosed separately by green hedges. Structurally they are all single-storeyed, with outer walls of red brick. There is an exceptionally large bungalow in their vicinity known as the Circuit House, which is mostly used as temporary accommodation of high Government officials while they are paying an official visit to this city. Some new buildings have been added recently to provide extra accommodation for students and staff residences. A beautiful double-storeyed modern hostel has been constructed by the side of the staff houses block. These new buildings in the area have mostly consumed the agricultural land which was previously used for the experimental farms. These buildings are quite different from the old University buildings by reason of their modern architecture and this part of the region also lacks shady trees. Some of the open lands between these buildings and the Narwala Road to the north-west are still used as experimental farms. Throughout the year these farms are utilized for the cultivation of a succession of crops by the University research departments. A small dairy farm is also attached to the north, and here cattle are kept in proper sheds, built of baked bricks with tin roofs. Some of the research laboratories for the dairy products lie alongside.

The third portion is situated north-east of the main University block along the Faisalabad-Sargodha Road. This block consists entirely of the huge experimental farms for the University students, except for a few seed-storage rooms and some open sheds for the temporary rest of the students during the summer eason. Recently this agricultural land was acquired by the university from the private farmers whom the University have compensated either by money or by providing an option to acquire an equal amount of land within the city urban areas. This site has been developed form establishment of a most modern Medical College known as the Punjab Medical College in Faisalabad.

The fruit research section of the University has been separated from its parent body, and has been established about 7! miles south-west from the University in Risalawala rural area along the Faisalabad-Jhang Road. This section is named after the Ex-president of the country as 'Ayub Agricultural Research Institute'. Here large tracts are used for a variety of fruit growing experiments.

Recently a number of new blocks of buildings were erected with the latest equipment for their research laboratories, and big halls for the d~monstration

of fruit to the stt:dents. The constructional work has teen completed for the staff residential bungalows and their servant quarters within this area.

V. The Inner Residential Area

The5e r;„:sidential quarters are located mostly on the eastern and western parts of the city central area. A small portion in the south is also occupied by such residences. Although this entire belt is residential, as pointed out earlier there are also at some places within this region concentrations of activities like administration, education and transport. . In places too retail businesses are found along the main thoroughfares.

An a matter of fact individuals tend to live in areas inhabited by others of similar culture, interests and economic status.[8] Residential segregation is also reflected in building practice, for houses of exactly the same type are built in groups or in large estates for people with the same economic status.[9] Thus the region consists of five sub-regions characterised by different categories of dwellings, each provided for the occupation of residents of a certain income and economic status.

A. The Detached Bungalow Area

This entire block of detached bungalows is situated to the east of the city's administrative zone. The bungalow area of the Civil Lines, Canal colony and Railway colony belongs to the highly placed Government officials. This area is regularly planned, with tree-lined avenues inter-secting at right angles. All the bungalows are single-storeyed, similar in design and exclusively "pucca" constructed with thick walls, high ceilings and a wide varandah. Each bungalow has much open space around it, and the large trees conceal the buildings giving a general landscape like that of a large plantation rather than an urban area.

B. The Semi-Detached Bungalow Area

This area is situated west of the city centre. The double-storeyed semi-detached bungalows of the Jinnah and Gulberg colonies were established after the Partition of 1947. They are mostly occupied by the people from the rich business community who can afford to pay the very high prices of the plots which are a result of their close location from the city centre. Both colonies are planned on the rectangular pattern, with broad straight roads provided with cemented pavements. The bungalows are constructed on small plots which are arranged with their boundary walls in back-to-back fashion, so creating great congestion. They have plastered walls mostly whitewashed or painted in cream colour. There are, however, a few small parks for the children, but they are not "Jell kept.. These colonies with their regular layout and absence

of trees with new and beautifully designed modern architecture impart a uni=J.ue townscape compared with other urban regions of the city.

C. The Indigenous House Areas

These old residential 'mohallas', with their indigenous type of double-storeyed houses, at present exist in all the three parts of this region. The localities of Tariqabad, Abdullahpur and Mansurabad are on the east, Dauglaspura, Santpura, Partapnagar, Gronankpura, Dhobi-ghat and Mohdpura on the west and only Jhal Khanuwana on the south. Their houses are old, double-storeyed, and mostly dilapidated. They are occupied by middle class people of a variety of professions. These localities are planned in chequer-board fashion, with rows of double-storeyed back-to-back houses constructed with brick and mortar, without any plaster on the outer walls. The lanes are narrow and filthy and the whole area represents a typical Indian environment. In spite of their planning, they are not provided with open spaces or children's parks within the locality.

D. The Terraced Quarter Areas

The civi: quarters of the west and the railway quarters in the east are the only two such areas within the Inner Residential Urban Region. There are mainly two-room single-storeyed terraced houses built on the rectangular street pattern. Their baked brick exterior walls are mostly painted WiUl mortar, which gives these areas a dull colour. They are mainly occupied by the lower staff of the Government offices and the railway employees. Public amenities such as open spaces and children's playgrounds are lacking.

E. The Hovel and Hut Areas

These localities are established in the east as well as on the west side fo the city centre. Tney have mallly been created by the poor fa..tory and other city labourers, and cunsist of one room mud-walled huts, with taatened ru0{s, crowded together.. As they have been developed on the unauthorized areas, there are no proper sanitary arrangements or other public facilities. Actually these "kachchi-abadies" have produced most unhealthy living environments, rentable slum conditions, and gave a filthy squalid appearance to this part of the city.

IV. The Old Factory Area

The old Factory Area of Faisalabad was laid out to the south of the city centre in the original planning. It is surrounded by the Sirwala distributary in the north, Dijkot canal in the south, with the Jhal Khanuwala Road on tne east and the City Factory Area Road on the west. The main rl1acts in the area

are quite broad, mostly straight and fully metalled, whereas the side-streets are kachcha (unmetalled), crooked and narrow. This entire area was marked by the planners for the development of factories owing to the proximity to the Railway Goods Station and its location side of the commonly prevailing north-easterly winds.

At the time of Partition, there were a limited number of factories in cotton ginning, pressing, oil crushing and flour mills. Each factory had a large compound giving the impression of a Western industrial estate. The chimneys of the Faisalabad Cotton Textile Mills, Ganesh Flour Mills and such others stood out from a considerable distance. Within their compounds there were also the residential bungalows for the industrialists, as well as living quarters for their employees. Mostly these factories are single-storeyed, with brick wall exteriors, and therefore of a dull colour.

The rapid industrial expansion has disrupted the entire planning of the industrial region. A large number of industries have been established, and there is now considerable congestion of factories, particularly in this area. Apart from industrial development, thousands of factory workers, who could not get proper accommodation in other residential parts of the city, have erected their unauthorized mud houses and huts alongside the factories where they work. These self-created unplanned houses have now developed this whole region into a big slum. Here one can observe the mud wall houses and huts. The drains are all kachcha, mostly passing alongside the centre of the crooked streets. Parks and playgrounds, even schools, are lacking.

VI. The Suburban Areas with Industrial Satellites and Colonies

This urban region is mostly residential, with a concentration of newly established large-scale industries along through roads. Within these areas a few Government offices and public institutions are aso located. Although there are sections which are strictly suburb within the real connotation of the word, most of the residential areas are actually industrial satellites with an element of industrial suburb in them. This entire region originated through the industrial development of the last decade. Thus it introduces a quite new appearance. For the most part it consists of single-storeyed bungalows, but regional differentiation in the type of housing again creates four sub-regions or types of suburb.

VI-A. The Semi-Detached Bungalows of the Sub-Urban Areas

The sub-urban, semi-detached bungalows of the People's and Batala colonies are situated to the south-east of the city. These residential townships consist of single storeyed bungalows planned on the rectangular pattern. They

are fully cemented and mostly whitewashed and have spacious grassy lawns within their small boundary walls. They have been constructed by rich people, particularly industrialists, businessmen and professionals. Money has been spent by those persons quite lavishly on their constructional work. Each bungalow is of a modern architectural design. The regular layout of the colonies with their beautiful buildings, along with the open spaces and children's parks, present a distinctive townscape as opposed to the other regions of the city. A number of Government offices have been established temporarily in some of the bungalows within these areas.

VI-B. The New Terraced Quarters of the Sub-Urban Areas

These single-storeyed terrace colonies are established on the rectangular plan by the Government for the rehabilitation of the refugees created by the Partition of 1947. The Ghulam Mohd Abad colony is alone in the west, whereas Nazimabad, Samanabad and D-Type colonies are on the south side. Two-room quarters are provided in all the colonies, with the exception of the **D**-Type, where only single room quarters are built.. They are constructed of baked bricks, with cemented pointings. Some of them are whitewashed but the majority are left with their red brick exterior walls, presenting a mixture of red and white colouring. The suburban quarters are entirely different from the quarters of the Inner Residential Region by reason of their proper planning and the presence of public facilities such as parks and open spaces. They are mainly occupied by the low income group.

VI-C. The Private Localities with Indigenous Houses of the Sub-Urban Areas

In this part of the city, a few private residential localities have been established in the vicinity of the huge industrial areas. The presence of the Crescent Factory Area, in the north, Kohi-Noor Factory Area in the east, and the Rahmania Cotton Factory Area in the south-west gave incentive to development. Therefore, most of the factory employees along with other low income group people of the city, reside here.

VI-D. The Huts of the Sub-Urban Areas

The *'Kachchi a' adies'* (localities with mud huts) of the sub-urban areas are mostly developed around the large factories in the area. These localities of ~ingle room mud huts are found by the side of the Koh-i-Noor Cotton Textile Mills, Crescent Textile Mills and in the proximity of the Oil and Soap factories of the Ghulam Mohd Abad colony. The mushroom growth of these slum tracts has given a filthy appearance to this urban region.

VII. The Outer Fringe of the Open Country

The city is surrounded on its outskirts by open country with fields, gardens and agricultural villages. At present the villages of Sidhupur Noorpur in the north, Malikpur, Santpur, on the east, Malkhanwala, in the south, Chak Foujian and Chunianwala on the west lie closely to the city limits. These villages mostly supply vegetables, fruits, milk and ghee to the city. The agricultural farms, fruit gardens and some of the buildings of the research department are situated here. This area also supplies bricks to the city and a number of kilns scattered throughout this region are one of its characteristic features.

The present trend of the city development indicates that in the near future most of the area within those villages will be taken over by the city. Most probably the chances are that the existing villages will act as the nuclei for further expansion of the built up area of the city in those directions. (map 2).

The Nature of the Urban Boundaries

From the foregoing discussion of the various types of the urban regions it has been seen that there is no very clear-cut, physical separation of the one region from another.. The only physical boundary which exerts some influence is the presence of the Rakh canal.. Its presence in the southern part of the city separates the new residential townships of the People's, Batala and D-Type along with Koh-i-Noor Factory Area from the main city centre.

The main roads normally form the centre line and not the boundaries of regions, but for some areas they do act as demarcation lines, e.g. the central commercial core delimited by the Ring Road and similarly the Old Factory Area by a number of roads and the Sirwala distributary. In the north Crescent Factory Area is separated from the Agricultural University Campus by the Sargodha Road in the west and from the Inner Residential Areas by the Sheikhupura Road in the south. The administrative region in the east is also separated from the Civil Lines by the College Road. In the entire western portion of Faisalabad some of the roads conspicuously separated the Inner Residential region from the Sub-urban residential townships.

The urban regions are mainly distingulished by a change of function or of building types or both. In most cases in fact the change in form and functions go together. The morphological feature's of different functional areas are so conspicuous in themselves that the delimitation of the urban regions is not difficult. The high multi-storeyed buildings in the city centre indicate the commercial activities of the city. The extensive buildings with their tall chimneys mark the Factory area. The buildings of the administrative quarters are highly distinctive amidst the surrounding detached, residential bungalows.

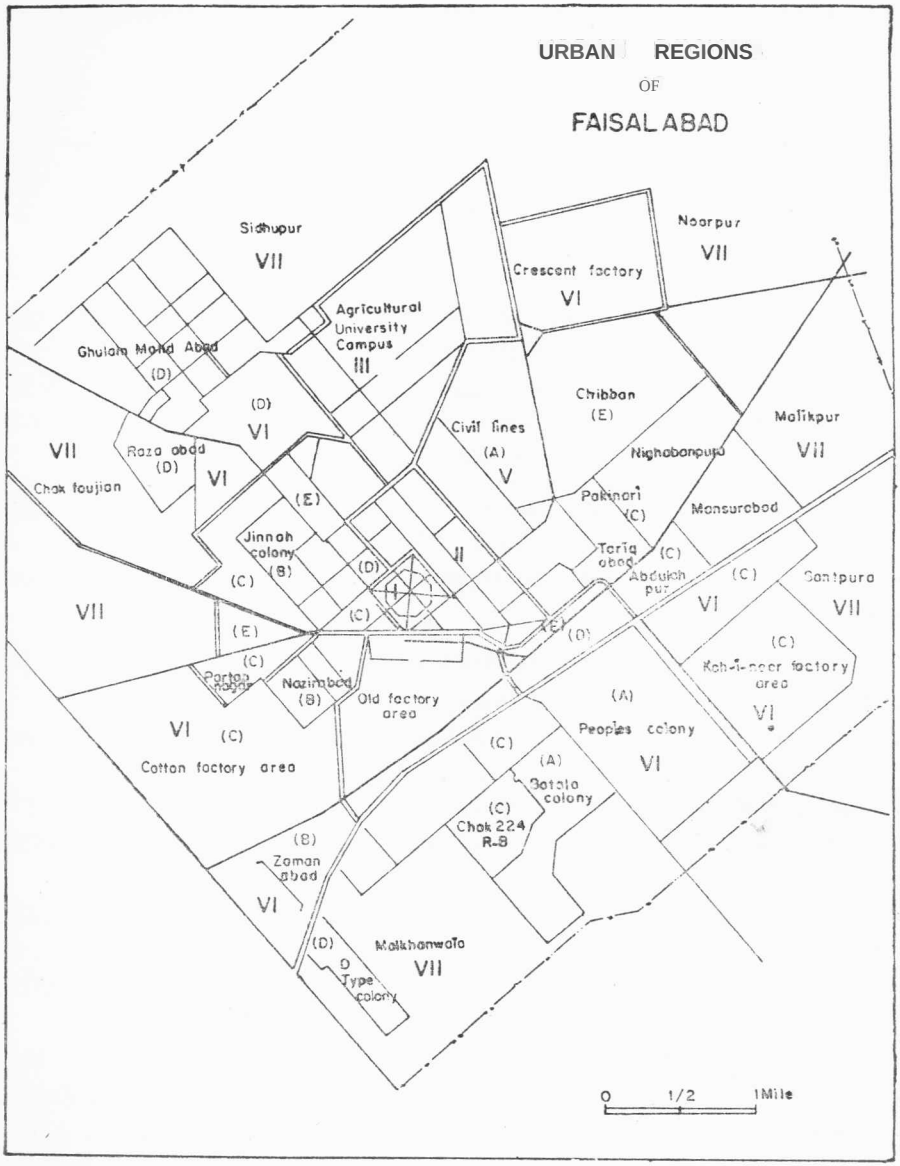
URBAN REGIONS
OF
FAISALABAD
Sidhupur
VII
Noorpur
VII
Crescent factory
VI
Agricultural University Campus
III
Ghulam Mohd Abad
(D)
(D)
VI
Civil lines
(A)
V
Chibban
(E)
Malikpur
VII
VII
Chak foujian
Raza abad
(D)
VI
(E)
Nighabanpura
Pakinari
(C)
Mansurabad
Jinnah colony
(B)
(C)
(D)
II
Taria abad
(C)
Abdulah pur
(C)
Santpura
VII
VII
(E)
(C)
(C)
(E)
(D)
Kohi-noor factory area
VI
Nazimabad
(B)
Old factory area
(A)
Peoples colony
VI
VI
(C)
Cotton factory area
(C)
(A)
Batala colony
(C)
Chak 224 R-8
(B)
Zaman abad
VI
(D)
D Type colony
Malikanwala
VII
0 1/2 1Mile

Fig: 2

The semi-detached double-storey bungalows of the Jinnah colony are quite different from the Ghulam Mohd Abad, Nazimabad, Sammanabad quarter areas, and similarly the old indigenous houses are different from the new houses of the same type.

After thoroughly examining the forms and functions of the city we have seen that there is a central commercial core, largely consisting of high buildings with a belt of administrative officers blocks on its east.. The huge buildings of the factories enclose it on the south. The indigenous houses and semi-detached bungalows of the Inner Residential region are separated by the Ring Road on the west, whereas the detached bungalows of the Civil Lines along with indigenous houses and huts of their localities are on the east.. The Agricultural University campus, with its thick vegetation, borders the city centre at its north. Farther away around this city, some areas have been developed as suburban residential townships and industrial satellites, whereas the rest of the open land is dominated by the landscape of the old villages.

Apart from the originally planned functional areas there has not emerged any new tract of special concentration or functional segregation. There is still no zone of cultural activities, no region which can be called an amusement area in the entire city.

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