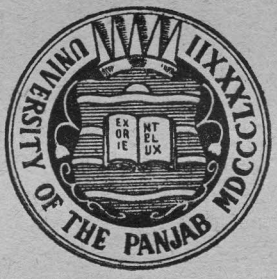
PAKISTAN GEOGRAPHICAL REVIEW



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THE AGRICULTURAL DEVELOPMENT OF THE THAL DESERT, WEST PAKISTAN*

BY

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Leader, Oxford, Cambridge and Far Eastern Expedition, 1955-56

THE story of Thal Development began in 1947, the year of the partition of Punjab and the creation of Pakistan. In that year four million Sikhs and Hindus trekked eastward to India, while back across the newly drawn frontier came six million Muslims to replace them. Thus the area which had become Pakistan gained two million starving mouths virtually overnight and her agricultural economy was strained to breaking point. Apart from intensifying agriculture on land already cultivated, new desert areas would have to be brought into use. The Thal Desert is such an area.

Thal today is the scene of the greatest development project in Pakistan, the eventual object of which is the resettlement of a quarter of a million refugees through irrigation and colonisation of a $1\frac{1}{2}$ million acre tract of land, which in its natural state is nothing more than a dreary and desolate waste. Lying between the rivers Indus and Jhelum, to the south of the Great Salt Range, it is beyond the bounds of the Punjab irrigation network and on the westerly fringe of the influence of the monsoon, which has almost exhausted itself after its 1200 mile journey up the Indo-Gangetic Plain. The rainfall is, therefore, not only low but also extremely capricious. Natural vegetation consists of a few xerophytic plants such as low brushwood and grasses and an occasional 'ber' tree. The area resembles nothing more than an angry sea of sand dunes.

The main occupation of the pastoral inhabitants was raising a few goats, sheep and camels. There was also, and still is, a certain amount of transhumant nomadism from Afghanistan by the Powindahs, who grazed their flocks in Thal during the winter and returned to the hills as soon as the hot winds and sandstorms started in March. What agriculture existed was extremely precarious, and consisted of tiny patches of irrigated cultivation around deep wells and catch-crop dry farming in the north, where the rainfall is greater and more reliable. The only masonry wells are found in the narrow bottoms of soil known as

*The paper is a precis (by P. J. H. Murphy) of the original work, which contains, *inter alia*, detailed chapters on the agriculture in Thal. The original work is available in the library of the Royal Geographical Society, London.

"pattis", which lie between the high longitudinal sandhills. These "pattis" often consist of long stretches of perfectly level ground running for many miles in a north/south direction. They are the home of nearly all the old villages. Finally, the old fort-towns on the high bank of the Indus, such as Bhakkar and Leiah, from which the various Nawabs, and later the Sikhs and British, tried to police the country, gave rise to some form of urbanism.

On the basis of soil conditions, the five million acres of Thal Desert can be divided into five distinct regions, and, since the irrigation network is to a certain degree influenced by these natural divisions, it is worth examining them.

Firstly, there is a tract sandwiched between the desert and the 1,000 foot contour of the Salt Range. This is a flat plain of hard, barren, salt-impregnated soil which has become covered with the detritus brought down by the mountain torrents, leaving a plain of gently sloping reddish clay soils on which a settled agricultural economy has always been practised.

South of the piedmont lies an undulating sand plain with low north/south dunes covering the sub-stratum of hard level clay soil. Although the natural water table is about 40 feet down, gram, with its deep root system, is cultivated extensively during the winter season.

The south-central Thal (Thal Kalan) is a vast expanse of high longitudinal sandhills between which lie the "pattis", although in the centre there is an extensive tract of loose shifting sand with no "patti" belts traversing it. Gram and water melon are both dry farmed, while occasionally one comes across a well with its tiny oasis of agriculture.

In the west, stretching for a hundred miles almost from the northern boundary of Thal to its southern limit, lies a broad strip of nearly level ground lying parallel to the Indus some 20 to 25 miles away. Its main feature is the central core, which is a narrow strip of firm flat cultivable sandy loam soil, with a high enough water table to permit well-irrigation. This strip, known as the "Daggar", is most probably an old, abandoned channel of the Indus. Fodder crops and wheat are the main winter crops, whilst the intense heat of summer, lowering the efficiency of draught animals and increasing the evaporation rate, accounts for the comparative absence of a summer crop. In the north of the area, where rainfall is higher and more reliable, there is a certain amount of dry-farming, but this decreases southwards as well-irrigation grows in importance.

The "Daggar" is bounded in the west by the "Powah", a strip of upland some three miles broad, forming the high bank of the Indus—an obvious settlement zone for the villagers whose lands lie in the riverain tract below, which forms part of the fifth and last natural region. These floodplains are marked almost everywhere by a sharp low bluff. Precarious cultivation particularly of rice-dependent on the summer floods, is the economy of these areas.

Three main soil types have been recognised in these regions. The first

includes the clays which lie in the Piedmont region, south of the Great Salt Range ; the second includes the sandy loams of the "Daggar" strip ; and the third constitutes the mainly sandy soils of the rest of Thal. Although the 1½ million acre irrigation zone includes part of the Piedmont, the whole of the "Daggar," and the undulating sand plain of northern Thal, it excludes the sandhills of Thal Kalan. Nevertheless, the most striking fact is the very high proportion of primarily sandy soils—more than a million acres, or roughly 70% of the irrigation zone. Apart from this quality, the Thal soils have three other undesirable features : namely, low, organic matter content, low nitrogen content and high pH values. Their fertility is thus extremely low and before any high crop yields can be expected, these characteristics have to be corrected.

Its inland position some 600 miles from the sea gives Thal an extreme climate with temperatures in summer reaching 120°F in the shade and in winter down to freezing point. The easterly monsoon depressions bring about three-quarters of the total annual rainfall during July, August and September. The rest of the year is almost entirely arid, with the exception of the winter rainfall of February and March, when westerly depressions from Afghanistan bring the two or three inches which are so vital to the maturing of the winter wheat and gram crops. March heralds the arrival of the hot weather with its associated dust and sand storms and the pevailing south-easterly hot winds, which cause the vegetation to shrivel up and die. These sandstorms occur up to twice a week in the harsher climate of the south but are less frequent in the north.

Total annual rainfall decreases from an average of 13″ in the north to 8″ in the south, whilst the highest variability being found in the zones of least rainfall also causes the south to be appreciably more arid, and has a consequent effect on the kind of crops grown. According to de Martonne's index of aridity the south is classified as "arid", whilst the north just manages to qualify for the "semi-arid" classification. The high insolation temperatures brought about by the usually cloudless skies cause yearly evaporation rates of 80 to 100 inches.

The Indo-Pakistan climate, characterised by its scarcity of water in winter and its very high temperatures just before the monsoon, has given rise to the classic two season system of summer and winter cropping. The summer, or "kharif" crop, is harvested in late autumn ; the winter, or "rabi", in spring. As we have seen, it proved impossible to raise a "kharif" crop in parts of Thal ; clearly the only hope for any agricultural development lay in canal irrigation, well-irrigation being too costly because of the depth of the water table and the high cost of upkeep of bullocks. A canal from the Indus was indeed one of the first to be surveyed but the other Punjab 'doabs' (interfluves) were irrigated before Thal because of the infinite superiority of their soils. It was not until the Anderson Indus Discharge Commission of 1935 awarded the Province of

Punjab the right to utilise 6000 cubic feet per second (cusecs) of the Indus flow that any development proved possible. A Thal Project was drawn up in 1936 in the form of a twenty year contract between the Punjab and Sind Governments and work actually commenced in 1939. Because of the war this work was suspended, and by 1949 half the channels which had been constructed were choked with sand, while very little land was actually being irrigated. This represented an enormous loss of productive capacity and of potential revenues, so in August 1949 the Government of Punjab, with an enormous refugee problem on its hands, set up the Thal Development Authority (T.D.A.). This autonomous body, which has a clause in its statute excluding "politicians and criminals" from the board, was empowered to buy farming equipment, level the dunes, construct roads, houses, schools, dispensaries, new towns, factories and villages, start afforestation schemes and experimental farms and, above all, to acquire and allocate land for the settlement of approximately a quarter of a million refugees.

T. D. A. can in some ways be likened to the Tennessee Valley Authority for it deals with the whole of the regional development of the area. It is not, however, responsible for the irrigation works and their maintenance, nor for the distribution of water. The Irrigation Branch of the Public Works Department builds the canals and collects the water revenue, and the jurisdiction of T.D.A. does not begin until the watercourses are completed, which actually lead the water on to the farmer's fields.

The Indus is the source of water for all this development. Its regime is characterised by a low discharge throughout the winter months, which increases with the spring snow-melt until the monsoon brings the floods of July and August, after which the discharge falls off again to the winter low. The minimum discharge ever recorded was 17,304 cusecs, the maximum almost one million. The average discharges are of course not so extreme, and in spite of violent annual fluctuations there is always an abundant supply during the "kharif" months (April to September), whilst winter and early spring are the periods of difficulty.

Because of the requirements of the irrigation canals in Sind, the Thal canals cannot draw more than 6,000 cusecs from the Indus. It is hoped that this allowance will be increased and it is to that end that the main canal from the Kalabagh barrage was built with a capacity of 10,000 cusecs. The canal network covers the northern portion of Thal south of the Salt Range right up to the River Jhelum, and also the long western strip stretching the length of the Indus down towards its confluence with the Punjab rivers. The rest of the desert is uncommanded. The main canals are lined, whilst the distributaries and watercourses have grasses planted along their banks to reduce seepage and act as a protection against blown sand. The absorption losses are nevertheless high, for the establishment of canals in sandy desert is no mean engineering feat.

The cultivable canal commanded area is almost 1½ million acres, and, calculating absorption losses at 25% on the main canals and branches, the maximum discharge capacity is 3.18 cusecs per 1,000 acres at the distributary heads. Since the intensity of irrigation is 80% this means that the duty is 1 cusec per 285 acres, which even by Punjabi standards is low (Punjab : 1 cusec per 150 to 240 acres ; Morocco : 1 cusec per 180 acres). These figures are of theoretical value but they do not show how much water actually reaches the crop roots, for the losses after the distributary heads in the unlined distributaries, minor channels and watercourses, not to mention the amount which reaches the fields but travels straight down to the water table, are considerable. It is generally considered in the Punjab that if 100 cubic feet are taken from the river into the canal, hardly 43 cubic feet will be utilised by the crops, the rest will go to increase the water table. Clearly, in Thal the associated problems are of great importance, since initial seepage is higher in sandy soils and due to summer heat and high evaporation, the crop water requirements are greater. Leaching and the rise of the alkali are likely to be speeded up.

One of the direct effects on agriculture is that there is a greater emphasis on "rabi" crops (fodders, oilseeds and wheat), which greatly assist the development of inferior lands, than on "kharif" crops (cotton, sugarcane and some fodders) with their higher water requirements. The ratio in Thal of "rabi" to "kharif" cropped land is accordingly two to one.

The plan T. D. A. has drawn up to colonise this inhospitable land with its host of environmental problems is one of overall regional development. 10% of the 1½ million acres has been set aside for afforestation, either in large blocks, or as shelter belts along the canals and roads, or as small woods attached to the villages. Experimental farms, which either carry out general agronomical studies or else have special purposes, such as the Tail Indus Sugarcane Farm, the Cotton Research Farm, and the Commonwealth Livestock Farm, have been established throughout Thal. Apart from the general research they conduct into crop rotations, irrigation and manure requirements, etc., they also produce quality seeds for distribution and act as demonstration areas to tenant farmers whose cultivations are carefully supervised. This application of science to farming can best show the peasant how to cultivate his own plot of land when he returns to his village, where it is hoped he will disseminate the knowledge he has acquired. But it is the villages, and not the demonstration farms, which are the backbone of the project, and it is here that Thal Development must stand or fall.

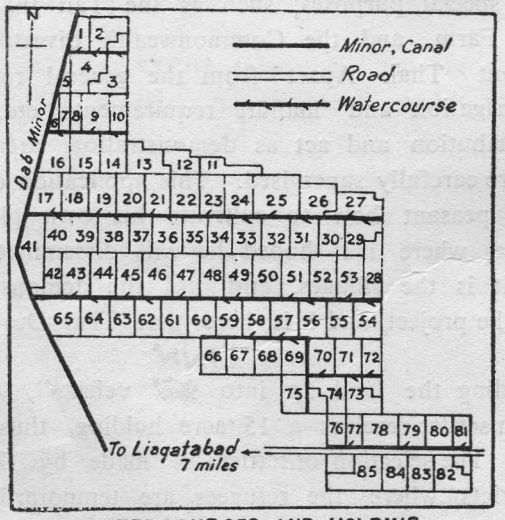
T.D.A. is dividing the land up into 900 "chaks", or villages, of about 100 acres each. Each settler receives a 15 acre holding, thus there are about 50 families to a "chak". The selection of settlers is made by the Deputy Commissioners of the districts where the refugees are temporarily settled, or, in the case of army settlers, by G.H.Q. The settlers come in groups of about 50 families under their headman, who receives a grant of an extra 15 acres. The

land has already been levelled and usually two-roomed brick houses, cattle sheds, and drinking-water pumps have been built. Loans of seeds, bullocks and implements are also available. The price of land at 150 rupees per acre (Rs. 1=1/6d.) is recoverable by instalments over the next 35 years, whilst the price of the house (about 800 rupees) and the other loans have to be paid back in 10 years. Acquisition of proprietary rights is compulsory for all allottees of land.

Each "chak" has a common grazing ground of about 50 acres, and another 50 acres set aside for afforestation. Metalled roads connect the "chaks" to the new network of main roads and neighbouring market towns. There is a school for every group of two or three villages, whilst a group of a dozen villages is provided with a dispensary. Eventually 44,000 families will be settled on these "chaks", a target which has already been more than two-thirds achieved.

There has been much debate as to whether the fifteen acre holding is an economic unit under the poor farming conditions of Thal. Many consider that 25 acres are the bare minimum. Detailed enquiries have been carried out, which show that the 15-acre plot, assuming average yields and stable prices is just economic today, but the danger lies in future fragmentation of holdings on the death of the head of the family. It is to prevent this happening that T.D.A. is building five completely new market towns, each with a local agricultural processing industry, to absorb the excess labour from the " chaks". Naturally these industries depend on the success of cotton and sugar production in the agricultural sector—and so agriculture remains the basis of the development of Thal.

In order to assess its progress we visited many of these newly irrigated " chaks " and in particular Chaks 3 and 4 M.L., which are typical of the sandy loam area at the northern end of the "Daggar". There are 122 families of farmers on these



WATERCOURSES AND HOLDINS
ON CHAK 3 M.L.

two adjacent villages and ten families of landless field labourers, making a total population of about 800 and an average of six to a family. They are nearly all ex-servicemen from the Ambala and Jullundur districts in Punjab (India). After Partition they spent two years in refugee camps and had been at Chaks 3/4 M.L. for seven years when we visited the village. During that time their land has improved greatly, but is not as good as were their old lands in Punjab (India). The first year in Thal they had to live in tents while they were building the houses, on which loans were advanced. This period was a very trying one due to climatic conditions, and eighteen families left. The land was partly levelled on their arrival and some they levelled themselves, while they also dug their own watercourses, from a plan supplied by the Irrigation Department. Each family was given seed and either two bullocks or a camel, and these have to be paid back over a period of ten years.

Today agriculture is firmly established and the population is steadily increasing. Our investigations were conducted partly on the basis of questions put through an interpreter to the village headman (an ex-subahdar-major) and a group of about forty farmers. The replies to these questions often showed a keen appreciation of the farming problems in this poor soil. The following selection will not only demonstrate this but will also given a background to farming life on a typical Thal "chak".

1. How do you pay your taxes?

The total taxes (water rates, land betterment tax, land revenue, etc.) come to about 130 to 150 rupees a year. Besides this we have to pay back the "taccavi" loans for seed, house, land, etc. This amounts to 85 rupees a year, which we pay in two instalments.

2. How much are the water rates on crops?

The water rates are different for each crop and are calculated on the market price, so can change, but in practice they remain fairly stable. On wheat the rate is 4¼ rupees per acre, on gram 3¼ rupees (but it is not worth irrigating gram so we pay nothing), on sugar 11 rupees, on cotton 5¼ rupees and on berseem (Egyptian clover) 2½ rupees. But we also have to pay other taxes, such as land revenue. If we grow guara and bury it before September 15th as a green manure, we don't pay the Irrigation Department any water rate on it.

3. How is the irrigation water shared out?

Each man gets his turn every seven days. In the morning it does two lots of 7½ acres on one side of the watercourse, and in the evening two lots on the other side. There is more than one outlet from the minor channels and the peasants over whose land each one operates elect a headman ("Chaudhri").

4. Do you get enough water?

We always want more water but I suppose we get sufficient considering the general shortage. We don't have any serious water disputes anyway.

(One man said he had been away for a couple of days and so missed his turn).

5. How long is the canal closed for cleaning?

From December 15th to January 31st, which is just the time would like to give the wheat crop a watering.

6. How many irrigations do you give each crop in the season?

Wheat we only give three irrigations after the pre-sowing one, but cotton must have water once a month and sugar we have to irrigate every week.

7. That's quite a lot for sugar, isn't it?

Well of course we only give sugar a little every week, not a three inch irrigation as for wheat and cotton. So sugar gets about 44 inches in the six months, cotton 22 inches and wheat 13 inches—excluding the rain of course.

8. What acreage do you have under different crops?

We usually have 5 acres in " kharif " and 12½ in " rabi ". The rest of the land is fallow. In "kharif" we have 1 to 2 acres in sugar, ¼ to ½ in cotton and 2½ in guara for green manure. In "rabi" there are 5 acres under wheat, 5 under gram and 2½ under berseem. So only half the wheat is green manured.

9. You don't seem to be very interested in cotton?

No. Sandstorm damage the plant and disease attacks it at the flowering stage. "Desi" (indigenous) is better than American but it's not worth the trouble.

10. Do you manure the crops?

We don't have many cattle and have to use the dung for fuel because there is no wood yet. Not all settlers can afford artificial manures, and ammonium sulphate has just gone up from 4½ rupees to 9½ rupees per hundredweight. The canal is closed when we would like to manure the wheat. The only crop we do manure is sugarcane at four maunds of ammonium sulphate per acre. Without this the height of the cane is only 3 to 4 ft., but with it about 10 to 12 ft.

11. What yields do you get?

On wheat about 10 maunds per acre, gram usually 7 maunds but it had blight this year and the average was only 2, "desi" cotton about 5 maunds and sugarcane 600 to 800 maunds (or 50 to 60 of "gur") if ammonium sulphate is used.

12. Do you sell the sugarcane to the mills or make "gur"?

About half and half. After transport to Leiah has been paid we get 1 rupee per maund of cane but for "gur" we get 14 rupees per maund. We can get nearly 1 maund of "gur" from 10 maunds of cane and so it's worth the extra work. But 14 rupees is not enough—18 rupees would be a fair price; but then we need the money at that time of year to pay the instalments on our "taccavi" loans, so have to take what we can get.

13. At the end of a year, assuming average yields and prices, do you have any money left over after you've paid all the taxes and the instalments on the loans?

Yes, a little, but it varies from year to year and, although it may be possible for us to live on a 15 acre farm today, it will not be economic for the next generation. You see under Islamic law the land must be divided amongst all our sons and daughters and then the holdings will be too small.

14. Can't you leave the eldest son the land and then the other sons can go and work in the new industries?

Perhaps, but we shall have to change the law.

Two significant facts emerge from these questions and answers. One is that in spite of low crop yields a family can make a living above a subsistence level. The other is the very narrow "safety margin" that exists between the amount of water available and its utilisation.

The relationship between water availability and water utilisation is the fundamental basis to any irrigation project. The water available in Thal is 1 cusec per 285 acres at the distributary heads. Allowing for the canal closure period during December and January, this means that the availability per acre per annum is 100,000 cubic feet (or 2.3 acre-feet). Now the mean water utilisation in Thal, based on Chak 3/4 M.L. cropping and irrigation practices, is 61,400 cubic feet (or 1.43 acre-feet) per annum. This ratio leaves a "safety margin" of about 39%, which would be normal on an irrigation project completely equipped with lined canals (as in Morocco), but when one considers that seepage losses on the unlined distributary channels and watercourses are about 33% it is clear that there is no real safety margin.

Such a narrow safety margin means that failure of the rains is likely to affect crop yields since no more irrigation water is available to make up the deficiency. This is one factor which makes a rapid increase in crop yields unlikely, for although yields have improved they are still low compared with those in the Punjab canal colonies as a whole. The following table will make this clear:—

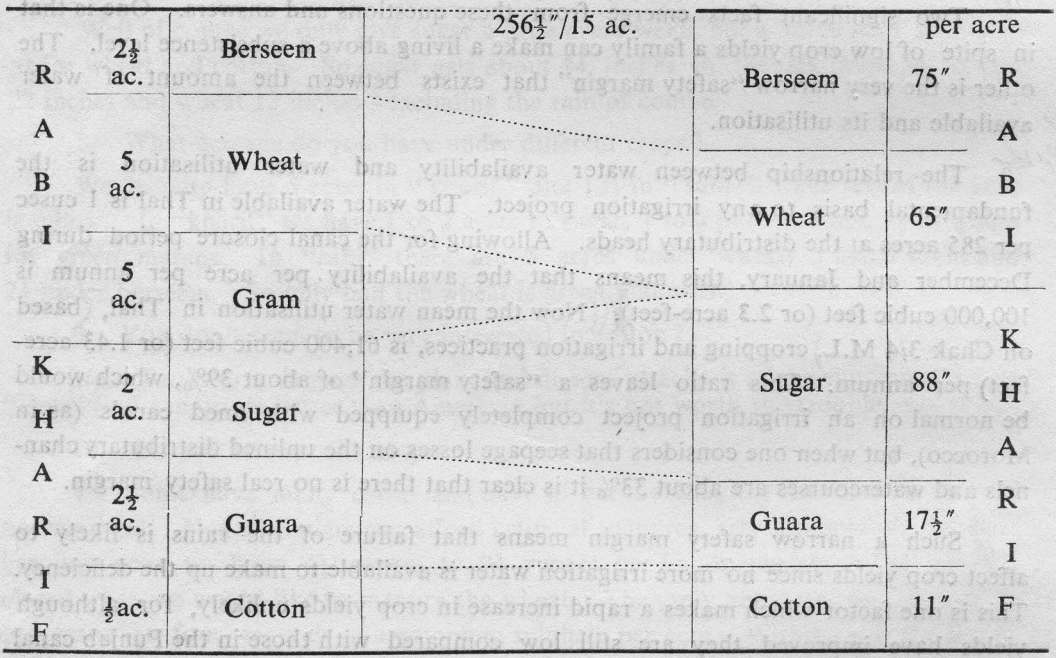
Crop	Average yield in maunds per acre. Chak 3/4 M.L.	Average yield in maunds per acre. Thal	Average yield in maunds per acre. Punjab
Cotton ...	5	4	7
Gram ...	7	8	10
Wheat ...	10	11	16
Sugarcane (gur) ...	50	22	50

(Note: 1 maund = 82 lbs. or 1⅓ bushels, *i.e.* 27 maunds = 1 ton)

The contributary factor to these low yields—the relationship between water utilisation—is illustrated graphically in the following diagram :—

WATER AVAILABILITY AND UTILISATION

Water available at
distributary head.....2.3 ac. ft.
1 cusec/285 ac.
for 320 days.
Water available
after seepage.....1.5 ac. ft.
Water used.....1.43 ac. ft.



CROPPING SCHEME

Crop yields will presumably increase as the fertility of the soil improves, but it is unlikely that they will ever equal those of the canal colonies. Furthermore, cotton, which might have been the cash crop par excellence, has not proved at all successful and the settlers do not seem to be interested in its cultivation. And yet it is most important that cotton cultivation should succeed, for without local supplies the textile mills in the new Thal towns can hardly compete with those mills in Pakistan situated at the source of production. For the same reason the practice of deducting the cost of transport to the mills before buying the sugarcane crop must cease (or else the price paid be increased) if the farmer is to find it more advantageous to sell cane rather than make raw sugar (gur). The Leiah sugar mill cannot be an economic proposition unless it has large supplies of cane, which the Tail Indus

Sugarcane Farm alone cannot supply. The industrialisation of Thal must be directly related to its agricultural development—at the moment it is outstripping it.

Cotton grown in Thal under normal agricultural practice has invariably failed, due to aridity, sand-storms and poor soils. And yet the Department of Land Reclamation has shown that bumper crops can be matured in Thal if new agricultural methods are employed. If the Thal settler is to make a success of cotton (which after all requires less water and lower costs of cultivation than sugarcane) he will have to adopt these new methods. The cotton problem, being concerned with the industrialisation of Thal, is directly linked to the problem of future population increase and the possible fragmentation of holdings.

The other great problem facing the agricultural development of this desert is one which is common to many arid zone irrigation schemes –the problem of water-logging and salinisation. We have seen how more than half of the water diverted from the Indus is added to the water table, but in Thal this addition is more serious than it would be elsewhere in the Punjab, since it is aggravated by heavy run-off from the Great Salt Range. Already patches of land have become waterlogged in north-eastern Thal, which is a region where water accumulates on the surface after heavy rainfall and where the water table is rising rapidly. Alkaline deposits brought down from the Carboniferous Salt Range have formed white alkali pans in areas which have only been under irrigation for a few years. Doubtless storm-water drains would do much to overcome this local problem.

The provision of a sub-soil drainage system throughout Thal to tap the seepage water is being held in abeyance, pending the completion of a survey of underground water resources at present being carried out. That no drainage system should have been installed as part of the irrigation network may seem unusual, but when the project was first taken up it was decided that, due to the natural slope of the land to the south and the sub-soil movement of water from the Indus to the Jhelum, none would prove necessary. After 1947 the emphasis was on refugee rehabilitation and building drains would retard this work. Yet today a serious drainage problem exists, for there has been a very rapid rise of the water-table in parts of Thal, often accompanied by a movement of salts from a great depth.

The phenomenon of the rise of the alkali through capillary action is a well known one in arid climates but it is particularly exaggerated in Thal by the presence of a hard, impervious sodium clay pan some 15 to 25 feet below the surface. The existence of this pan has only recently been discovered and its extent and depth are not yet known. It forms an artificial water table to which the seepage water is added instead of percolating down to the natural spring level, 35 to 40 feet down. Lysimeter tests at Lahore have shown that the high summer evaporation rates can attract water from a depth of 13 feet below the soil surface. Salts therefore can rise through this very deep capillary zone of the soil profile, and so the artificially high water-table caused by the impervious hard pan increases the likelihood of alkalinity.

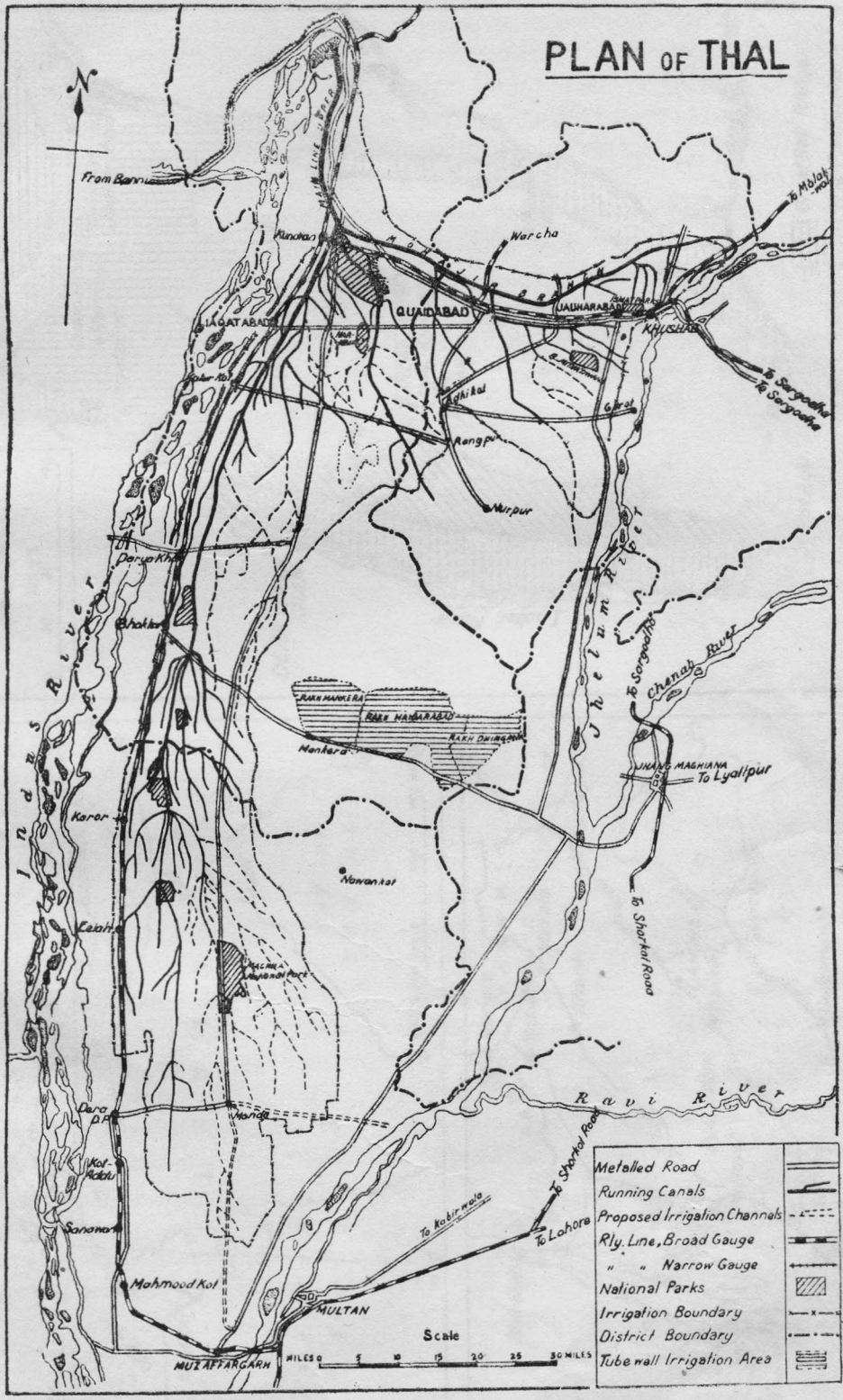
No permanent solution to this problem has yet been found, but there are plans to cope with the waterlogging problem through an installation of surface drains in north-eastern Thal, while the research farms are working on reclamation methods. Another possibility is to blast through the clay pan and thus allow percolation to penetrate down to the natural spring level. Neither of these are of course permanent solutions, since the natural spring level itself has also been rising (some 20 feet in the last ten years).

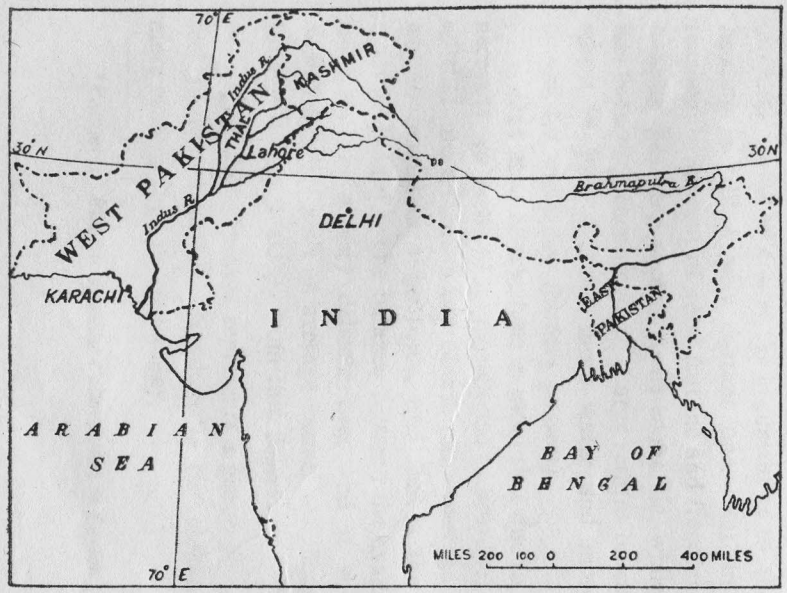
A permanent solution must lie not only in the provision of a drainage system but also in some way of combating the constant addition of water to the water table. A proposal which might meet these ends is to run the canals in summer only—possibly with a greater capacity, so that higher irrigation applications might leach the salts down, or afforestation be extended. In winter tube-wells would pump up the water, added to the water table when the canals were open, and irrigate the "rabi" crop. For this to be successful there would have to be a very high intensity of tube-wells, say five or six to the square mile. It would also be an extremely expensive project since in addition to the capital cost the recurrent costs are likely to be high, particularly since the Sui gas pipeline does not serve this area and there are no abundant supplies of hydro-electric power. It is in any case very rare for tube-well irrigation to be economic unless there is a market for some specialised products such as vegetables or citrus. It is, however, a problem which must be solved if Thal Development is to have the future it deserves.

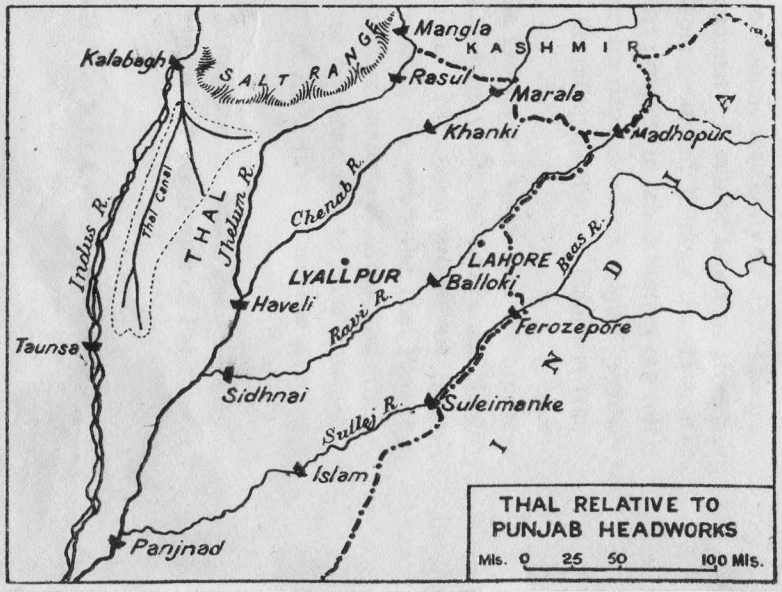
These, then, are Thal's greatest problems: salinity, waterlogging, and future fragmentation of holdings. Since reclamation costs are three or four times those of irrigation, salinity and waterlogging remain foremost. As regards fragmentation the only solutions one can see lie in the success of the newly established industries together with legislation to prevent the size of the holdings being reduced. The success of the industries depends in turn on the success of continued agricultural research to improve soils and crop yields.

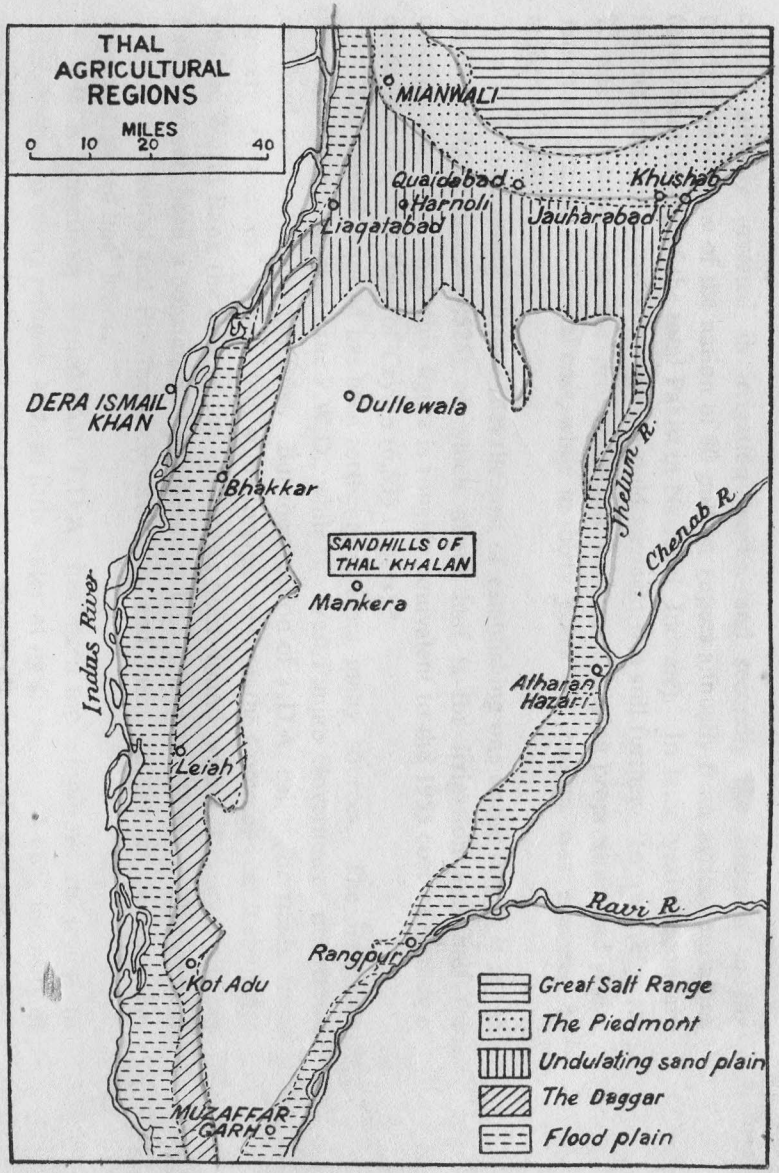
But what of the success of the whole project to date in relation to the financial outlay? Is a capital cost of 410 million rupees (£31m.) on roads, irrigation works and the T.D.A. itself justified? On social grounds there is no doubt that the settlement of a large number of refugees with a greatly increased standard of housing, health, education and farming practices can be justified, but the capital at the disposal of the state is not unlimited, so can we not find an economic justification for this immense undertaking?

The economics of an irrigation project are necessarily complex. They are particularly so in Thal, for not only is there the budget of the Irrigation Department to assess but also that of the Thal Development Authority itself. The irrigation works are expected to pay for themselves through the water rates, land betterment tax and increase in land revenues, over a period of 25 years. The financial justification of the creation of T.D.A. was first of all the avoidance of a loss on


PLAN OF THAL
N
From Bannu
Kundian
Warcha
To Mianwali
QUAIDABAD
JAUHARABAD
Khushab
To Sargodha
To Sargodha
Ghakhar
Rangpur
Nurpur
Daryakhan
Bhakkar
Indus River
Jhelum River
To Sargodha
Chenab River
RAKH MANKERA
RAKH HAIDARABAD
RAKH DHINGANA
Mankera
JHANG MAGHIANA
To Lyallpur
Korar
Nawankot
To Shorkot Road
Lakhi
Dera Din Panah
Mianwali
Ravi River
To Shorkot Road
To Lahore
To Kabirwala
Kot Addu
Sanawan
Mahmood Kot
MULTAN
MUZAFFARGARH
Metalled Road
Running Canals
Proposed Irrigation Channels
Rly. Line, Broad Gauge
" " Narrow Gauge
National Parks
Irrigation Boundary
District Boundary
Tube well Irrigation Area
Scale
MILES 0 5 10 15 20 25 30 MILES


70° E
30° N
WEST PAKISTAN
KASHMIR
Indus R.
THAL
Lahore
Brahmaputra R.
DELHI
KARACHI
INDIA
EAST PAKISTAN
ARABIAN SEA
BAY OF BENGAL
MILES 200 100 0 200 400 MILES


Mangla
KASHMIR
Kalabagh
SALT RANGE
Rasul
Marala
Khanki
Madhopur
Chenab R.
Indus R.
Thal Canal
THAL
Jhelum R.
LYALLPUR
LAHORE
Balloki
Beas R.
Haveli
Ravi R.
Ferozepore
Taunsa
Sidhnai
Suleimanke
Sutlej R.
Islam
Panjnad
THAL RELATIVE TO PUNJAB HEADWORKS
Mls. 0 25 50 100 Mls.


THAL AGRICULTURAL REGIONS
MILES
0 10 20 40
MIANWALI
Quaidabad
Harnoli
Khushab
Liaqatabad
Jauharabad
DERA ISMAIL KHAN
Dullewala
Bhakkar
Jhelum R.
Chenab R.
SANDHILLS OF THAL KHALAN
Mankera
Indus River
Atharan Hazari
Leiah
Ravi R.
Rangpur
Kot Adu
MUZAFFAR GARH
Great Salt Range
The Piedmont
Undulating sand plain
The Daggar
Flood plain

capital already invested in irrigation works, and secondly the addition to the productive income of the nation of 80 million rupees annually from agriculture alone (equivalent to $\frac{1}{2}\%$ of the total Pakistan National Income). In later years secondary income from the industrial projects would augment this still further. In twelve years it was estimated that the project would become a paying proposition and give a return of $4\frac{1}{2}\%$ on its capital cost, while in thirty years the project was expected to amortise itself.

It is interesting to note that the cost of establishing one settler family is in the region of 7,000 rupees (£525) of which about half is for irrigation and half for colonisation, and that this figure is roughly equivalent to the 1953 cost of settling a colonist in the Dry Zone of Ceylon (6,535 rupees).*

The capital required has been forthcoming from many sources. The irrigation costs are financed through the P.W.D., while the West Punjab Government undertook the road construction programme. But the creation of T.D.A. called for funds from entirely new sources. Apart from some foreign aid from the Commonwealth countries and the World Bank the bulk of the money has been found within Pakistan. There has, however, been a constant struggle between T.D.A. and the Finance Department of both the Central and Provincial Governments, and most of the expenditure has been met by 'ad hoc' loans.

It is sometimes argued that T.D.A. has been too ambitious in trying to rehabilitate so many refugees with so little water at its disposal. A 66% intensity of irrigation might have been more productive on an overall basis than the present 80% intensity, whilst of course the argument as to the economic feasibility of the 15-acre holding is still a very current one. But in summary it can be said that given a reasonable amount of good fortune and freedom from pests and diseases the 15-acre holding has been shown to be economic, while the progress in rehabilitating the soil has been very encouraging. Large returns on costs are dependent on higher yields, which in turn demand more water and more liberal application of fertilisers (the capital for which few farmers possess).

One must always bear in mind that due to the shortage of water and the urgent necessity to settle as many refugees as possible, maximum yields have to be sacrificed so that more farmers can obtain more average yields. Maximum production gives way to maximum subsistence, and that is the criterion on which the Thal Project must be judged. The balance between the availability of water resources and their utilisation is a very delicate one, and it will be no mean feat to have provided 44,000 families with an average annual net income of £130 (five times the average for the Indian peasant) from this desert.

Thal Development represents a geographical revolution of which Pakistan may feel justifiably proud. Nowhere is the slogan "Build for the people of Pakistan" more evident than in Thal today.

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*Farmer : *Pioneer Peasant Colonisation in Ceylon* (O.U.P. for R.I.I.A.)

NATURAL GAS IN PAKISTAN

BY

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IT is not known when the natural gas was first discovered, and who first found that it would burn. Before 3,000 B.C. flares of natural gas were focal points for temples of worship in the Near East. Ancient Greek literature contains references to gases coming out of the earth that would burn. Before 1,000 B.C. the Chinese are recorded to have been drilling wells to produce natural gas for heating, lighting and manufacture of articles. Its use as a fuel, however, ceased there before others could learn about it.

In U.S.A. the Indians led the early explorers to areas where the gas issued and they set fire to it. In 1815 gas was encountered by a driller in search of brine for salt near the present site of Charleston. The use of natural gas as a modern fuel, however, dates back to 1820 when in the Fredonia village of New York a local gun-smith, Hart, drilled a well near a gas seep to secure a large flow.

Natural gas is generally associated with rocks ranging from Tertiary to early Palaeozoic. In fact it seems to be found where decomposition of vegetable and animal matter has occurred. Commercial quantities, however, depend upon the trapping of gas. It is found more or less under the same conditions as petroleum, and occurs with it or separately. Its distribution in the world, therefore, corresponds to that of petroleum belts to a very great extent. Four of the six continents (excluding Africa and Australia) as well as many islands in the seas produce gas. There has been only a small production of gas in Egypt and Morocco in Africa, and some natural gas has been found in Australia, but there has been no commercial production. The following figures show the production of natural gas in principal countries:

Million c. metres (1 c.m.=35.314 c.ft.)

Countries	1954	1955	Countries	1954	1955
U.S.A.	247,563	263,658	Indonesia	1,582	1,908
Canada	3,419	4,069	U.S.S.R.	8,783	10,355
Trinidad	515	498	Italy	2,967	3,622
Venezuela	2,443	2,749	Hungary	556	543
Colombia	454	539	Pakistan	59.1	120
Brunei	1,098	741			

Except Pakistan the table includes the countries where the annual production of gas is about or over 500 million c. metres.

PAKISTAN

The geological history of the two wings of Pakistan and the adjacent areas and the geophysical surveys have suggested the presence of oil, and with it of natural gas, in both the areas. The oil-gas belt in West Pakistan occupies the large re-entrant between the Himalayas in the north and the mountains bordering the Indus plain on the west. It is said to have been formerly occupied by a gulf and later by a valley along which a river drained toward what is now the Arabian Sea. The gulf was filled up by a thick series of Mesozoic and Tertiary sediments folded into structures suitable for containing oil and gas fields.

East Pakistan lies in the petroliferous belt running from Assam through Burma to Indonesia. A series of low ridges rise from the plain on the eastern border. There are many thousands of feet of rock belonging to the Sylhet sandstones and the Surma series of the Miocene age. Anticlinal structures suitable for oil and gas traps, oil seepages and gas shows are common.

Vigorous search for oil after partition has led to the discovery of important gas-fields at Sui (Dist. Sibi) in West Pakistan and in Sylhet in East Fakistan. Gas has been produced with petroleum at Dhulian (dist. Rawalpindi) since 1949.

SUI

Oil seepages occur at several places in the Mari-Bugti country (dist. Sibi) in the Lower Tertiary, and geological structures exist which are favourable to the accumulation of oil and gas. Geologists explored the country in the last quarter of the 19th century and found oil-gas leaking at the surface of the ground at Khattan. Here, shallow wells were dug near the seepage and over 800,000 gallons of crude oil were obtained between 1886 and 1894; since then no drilling had been carried out in eastern Baluchistan till after the partition. In undivided India there was the difficulty of obtaining oil concessions in tribal areas.

On the basis of geological investigations there was a good chance of finding oil and natural gas in commercial quantities in the Sui area. Sui lies in the Mari-Bugti country, about 50 miles north of Jacobabad. The Burma Oil Company (PPL) obtained permission from the Government in the later part of 1950 to start drilling for a test well at Sui, and drilling began in October, 1951. At a depth of 400 ft. the well reached a thick porous limestone which contained natural gas. The limestone is of Eocene age, folded into an anticline. Map No. 1 shows the contours on top of the main gas-bearing region. Drilling was continued in the hope of finding oil and the well went to a depth of 10,700 ft. by July, 1952. No oil was, however, found. But proper tests confirmed the presence of a large volume of gas. A second well was drilled five miles away from the first, and it showed that the gas field was very large. Since then four more wells have been drilled, making them six in all, which are enough to ensure the continuous production of 70 million c. ft. of gas per day.

The estimated reserves of gas are four million c. ft., which is equivalent to approximately 2 hundred million tons of coal or about three times the total known coal reserves of Pakistan. It is expected to meet the estimated consumption of Sind and Karachi region for 200 years. The proved reserves of Sui gas are enough to meet whole of West Pakistan's fuel requirements for well about a hundred years. It is one of the largest fields in the world.

The discovery of Sui gas is of great economic significance to West Pakistan. Its geographical location in the Lower Indus basin, where alternative conventional sources of power are practically negligible, is extremely important. Though the Sui gas-field, located as it is in a remote thinly populated, undeveloped region, cannot attract any important industries to its vicinity, it will greatly promote the development of Karachi-Landhi industrial region, which is already the greatest in West Pakistan, but which has depended so far upon imported fuel. The extension of its gas-line to Multan and later to Lahore will industrialise along its way an important cotton area for which a large quantity of cheap and easily available fuel was needed. The availability of gas will remove the uncertainties of price levels associated with the use of imported fuels. It will contribute a great deal to the economic stability of the country by making it to a large extent independent of foreign fuel. It will not only reduce the cost of production in the existing factories but will also facilitate the creation of new factories. It is bound to change the pattern of distribution of industry according to the area commanded by gas. While the problem with oil is to continue to produce as rapidly as we consume, the problem with natural gas is to develop useful ways and means to consume it as rapidly as we produce. More and more uses of the gas are to be found, and more and more industries are to be established and dispersed along the pipeline. Industrial progress will not be held up owing to the scarcity of fuel. As a raw material it will help in the manufacture of fertilizers and the solution of our food problem. In the domestic sphere it will offer a cheaper and easily available fuel, and a cleaner house. It will, therefore, add to general social welfare of our people by making life more comfortable in small, medium and large towns.

Another very important aspect is that it will save for the country large sums in foreign exchange. In 1956, Sui gas brought about a saving of nearly 160,000 tons of imported furnace oil, costing about Rs. 15,000,000. In 1957, the Karachi Gas Co. and the Indus Garlo sold 6,415,469 m.c.ft. and 3,826,120 m.c.ft. of Sui gas respectively (10,242,089 m.c.ft. in all). It is equivalent, in heating value, to 289,460 tons of oil, the import of which would have cost the country Rs. 22,500,000 in foreign exchange.

The production of Sui gas during the triennium 1955-57 is as follows:

Year	Production (c.ft.)	Gas sold to pipeline (c.ft.)
1955	1,323,316,000	912,492,000
1956	8,025,207,000	7,422,825,000
1957	11,837,860,000	10,874,981,000

The Sui gas-field is connected with Karachi by a 347-mile long pipe-line, and a 217-mile pipe-line to Multan is almost complete and the gas is expected to start flowing into the latter pipe-line by the middle of this year (see Map No. 2).

The transmission line to Karachi constructed by the Sui Gas Transmission Company is in operation since October 1955, supplying gas to Rohri, Khairpur, Hyderabad and Karachi. In 1957, it supplied gas to nearly 350 industrial, commercial and domestic consumers.

At Karachi a large number of industrial and commercial consumers, including all major industries, are using Sui gas. Some of these using gas are aircraft, automobiles, bakeries, brick kilns, chemical, confectionery, cement and cigarettes, dairies, electrical engineering, electric supply company food products, furniture, iron and steel, laundry, metal treatment, radio and rubber, ship-building, textiles and clothing, tobacco, and vitreous enamelling and wire. It is also being supplied to an increasing number of domestic consumers in various areas. The impact of Sui gas in the expanding economy of Karachi can be gauged from the fact that in 1955, when gas was first piped to Karachi, the local industries' fuel demand was for about 325 tons of furnace oil a day, but now Sui gas is supplying daily approximately 20 m. c. ft. of gas, equivalent to more than 450 tons of oil.

During the year ending 31st August, 1957, Karachi Gas Company sold 5,741 m. c. ft. of gas which in heating value is approximately equivalent to 134,000 tons of furnace oil, the import of which would have cost about $1\frac{1}{4}$ crores of rupees in foreign exchange. The following table gives the consumption of the Sui gas by various industries in Karachi in August 1956 and 1957.

Type of Industry	AUGUST 1956		AUGUST 1957	
	No. of Consumers	Consumption (in millions of cu. ft.)	No. of Consumers	Consumption (in millions of cu. ft.)
1. Electric Power Station ...	1	256	1	298
2. Cement ...	1	67	1	121
3. Textiles (Silk Cotton and Woollen) ...	9	60	30	109
4. Iron and Steel ...	4	8	15	25
5. Chemical ...	1	3	7	8
6. Oil and Soap ...	nil	nil	10	10
7. Glass ...	1	1	4	5
8. Miscellaneous	3	4	24	5
Total ...	20	399	92	581

On the 31st December, 1957 Karachi Gas Company was supplying the gas to 120 factories, with a further 27 awaiting connections. The sale of gas during December, 1957, was 617 million cu. ft.

Outside Karachi the Indus Gas Company distributes more than 11 m.c. ft. of gas (equivalent to about 235 tons of oil) daily to about a dozen companies including Associated Cement Company, Hyderabad Electric Corporation and Zeal Pakistan Cement Factory.

Sui gas had replaced oil to such an extent that more gas was being sold to the manufacturing industries in these areas than the total amount of furnace oil consumed by industries in the whole of West Pakistan. It was obviously due to the fact that the price of gas was 5-10% lower than that of furnace oil. Besides being cheaper the operating efficiency of gas may be as much as 40% more than that of oil in certain heat treatment processes such as glass manufacturing industry. There are other economies as well; the use of gas saves fuel losses and the storage and transportation charges.

The construction of Sui gas pipe-line to Multan is of vital importance to the industrial development of Bahawalpur and Multan divisions. It skirts about 80 villages. Among the major undertakings to be served as an immediate objective, are the proposed electricity power station and iron and steel works near Multan, the Gudu Barrage Scheme, and textile and oil mills at Rahimyar Khan.

DHULIAN

Dhulian (dist. Rawalpindi) is located in the Potwar plateau north of the Soan syncline. In this area the structure is generally anticlinal and oil and gas have accumulated in anticlines and domes. The geological structure of the Dhulian oil and gas field is accordingly a gentle anticlinal dome. The gas is found from the Ranikot limestone of Eocene age and is in solution with oil. Here oil was first found in commercial quantities by the Attock Oil Company in 1935, and the production started in 1939. The production of gas has been reported since 1950, when it amounted to 7.1 million c. ft. The production figures for the last three years are:

Year	Production (c.ft.)
1955	2,293,783,000
1956	2,415,765,000
1957	3,560,869,000

The gas produced in 1957 was consumed as follows :

Morgah Refinery	..	515,100,300
Rawaldindi Elec. Supply Co.	..	280,399,200
General Mfg. Co. Ltd.	..	2,292,300
For Pet. Production	..	881,817,500
Other than for Pet. Production	..	31,687,600
Surplus flared up	..	1,849,573,100

The gas which was formerly wasted is now of great importance to the industry in Rawalpindi and its importance is increasing.

ZIN

After the discovery of gas at Sui, another test well was drilled in its neighbourhood at Zin in the Mari-Bugti country in 1953. The drilling went down to a depth of 638 ft. in 1954. A large reservoir of very low pressure natural gas was met but due to a high proportion of non-combustible impurities utilization of the gas was found to be uneconomical.

UCH

In 1955, another gas field was discovered by deep exploratory drilling at Uch near Sui. The well was drilled to 1,100 ft., and proved the presence of natural gas in the same geological horizon as that of Sui. The importance of this discovery was offset by the presence of a very high percentage of carbon dioxide in the gas and more so by the enormous quantities of gas which became already available from the Sui field.

SYLHET

Search for oil in the Patharia Hill Tract of East Pakistan began in 1917, and the Burma Oil Company drilled two wells in that area. Some oil was recovered but the geological structure of the area was found to be very complicated. After the establishment of Pakistan it was decided in 1950 to make a further test boring in the area. The well was spudded in March, 1951, and drilled to a depth of 5,411 ft. but it proved a failure. Geological informatory borings were carried out in Sylhet in 1951 and 1952. In 1955 Pakistan Petroleum drilled their first test well at Sylhet. When the drilling had gone to a depth of 7,800 ft., high pressure gas was discovered. It broke through the surface of the ground in several craters, about 200 yards from the well, one of which caught fire, resulting in the loss of much valuable and expensive drilling equipment and industrial and residential establishments. Drilling of a second well to a depth of 9,245 ft. in 1956 confirmed the presence of the gas. After collecting more information about the underground structure Pakistan Petroleum began drilling in My, 1957, to develop the gas resources of the area and to estimate the size of the gas-field. Its objective was to produce gas from proved horizons and to get further information on the value and extent of the gas-bearing strata. It is located on a small hillock near Haripur village on the bank of the Kapna River, less than a mile from well No. 1 and 14 miles from the Sylhet town. The drill reached the gas at a depth of 4,000 ft. It became a producer on 20th July, 1955. The production from the oil 2″ tubing gave a flow of nearly 15 million c. ft. of gas per day. The open flow potential is calculated to be more than 100 m.c. ft. per day and is, therefore, comparable with the Sui wells. It is ready for the supply of gas when the gas line is constructed.

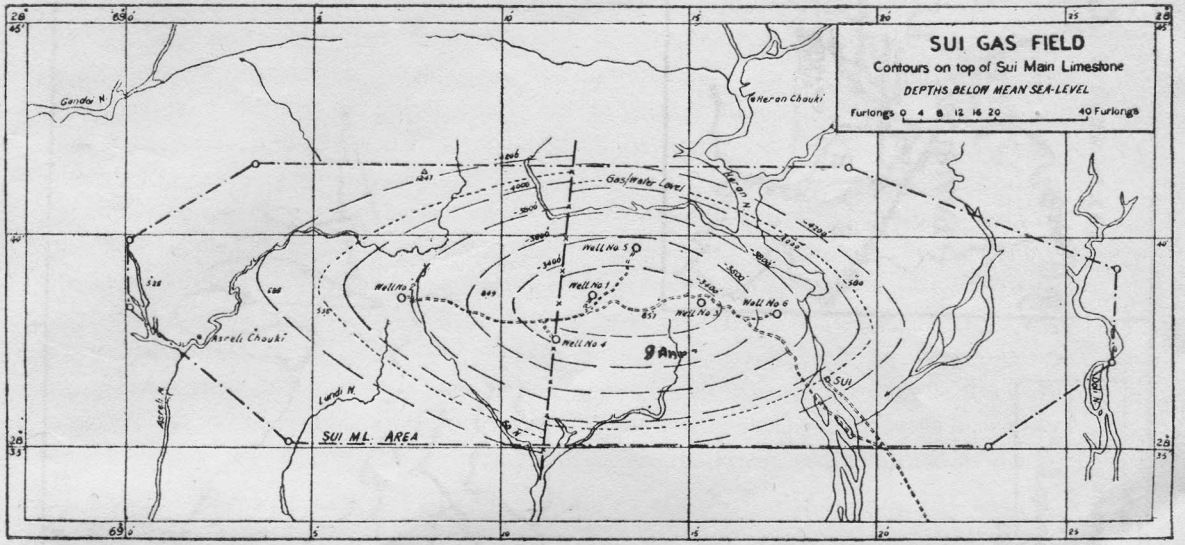
The Sylhet gas-field provides the first potential source of indigenous fuel now existing in East Pakistan. According to the latest estimate there is a proved reserve of 150,000 million c. ft. of gas while the possible reserves are estimated at 280,000 million c. ft. of natural gas, having a heat content of about 1,000 British

Thermal Units per cubic foot. The gas is purer than that of Sui and will, therefore, not require the complicated and expensive purification system which had cost in Sui about 15 million rupees. The amount of gas estimated as probably recoverable is equivalent to nearly five million tons of oil. Considering the fact that East Pakistan so far entirely relied on imported fuel, the Sylhet gas is bound to reorientate and recast the economic structure of East Pakistan. It will not only save large amounts in foreign exchange but will also facilitate the implementation of the development plans of the Government. No coal or oil is produced in East Pakistan, and the hydro-electric sites are far removed in the Chittagong Hill Tracts. The discovery of gas is, therefore, a great blessing and it will play a great part in the industrial development of East Pakistan. Nature has been bountiful to maintain a parity of gas fuel between the two wings. Among the projects and industries which the Sylhet gas could serve are thermal power stations, cement factories, glass works, brick kilns, synthetic fertilizer and miscellaneous factories.

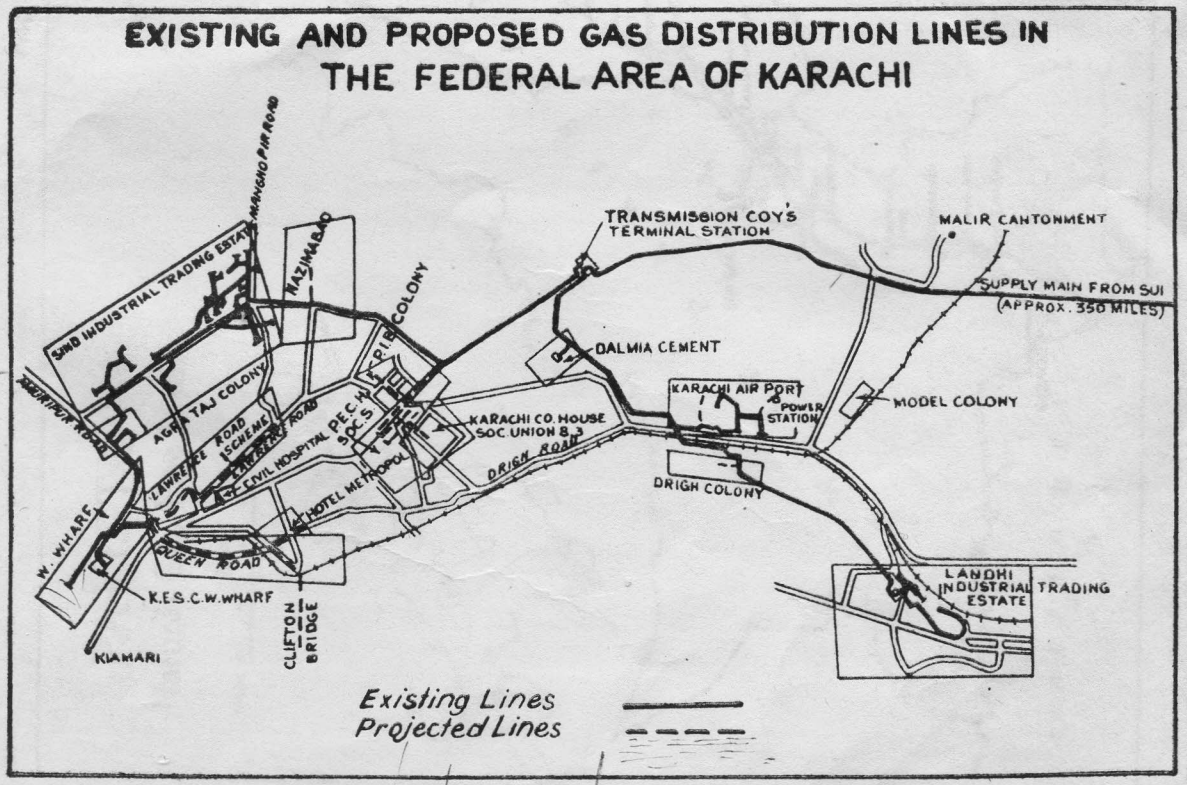
The present scheme for the development of Sylhet gas has been limited to Dacca-Narayanganj region, as the industrial expansion in any other part of East Pakistan in any foreseeable future is not sufficient to justify the construction at present of additional pipe-lines in a difficult country of numerous shifting rivers. It is extremely doubtful if it will ever be practicable to supply gas to the Khulna or any other industrial area west of the Padma (Ganges) or Jamuna rivers because of the formidable water-barrier presented by them. It is, however, proposed to take the gas to Chattak for producing cement.

In order to transport the gas from Sylhet to Dacca, it is proposed to construct a high-pressure pipe-line of 8″ diameter, 145 miles in length. On account of the flooding of the many rivers the construction work is to be confined to winter months and the route is to be carefully chalked out making use of the existing road and the railway bridges. The scheme envisages a headquarters station at Sylhet and terminal station at Dacca, with a repair station at Itakhola. The price of gas in Dacca would be Rs. 2/3 per 1,000 c. ft. upon the completion of the project in 1959, which is equivalent to furnace oil at Rs. 93 per ton, whereas the prevailing price of furnace oil per ton in Dacca is Rs. 156. As the bulk of the industry in East Pakistan is located in the Dacca-Narayanganj region the gas will greatly help in reducing the cost of production and expanding the industry.

Map No. 1



Map No. 3



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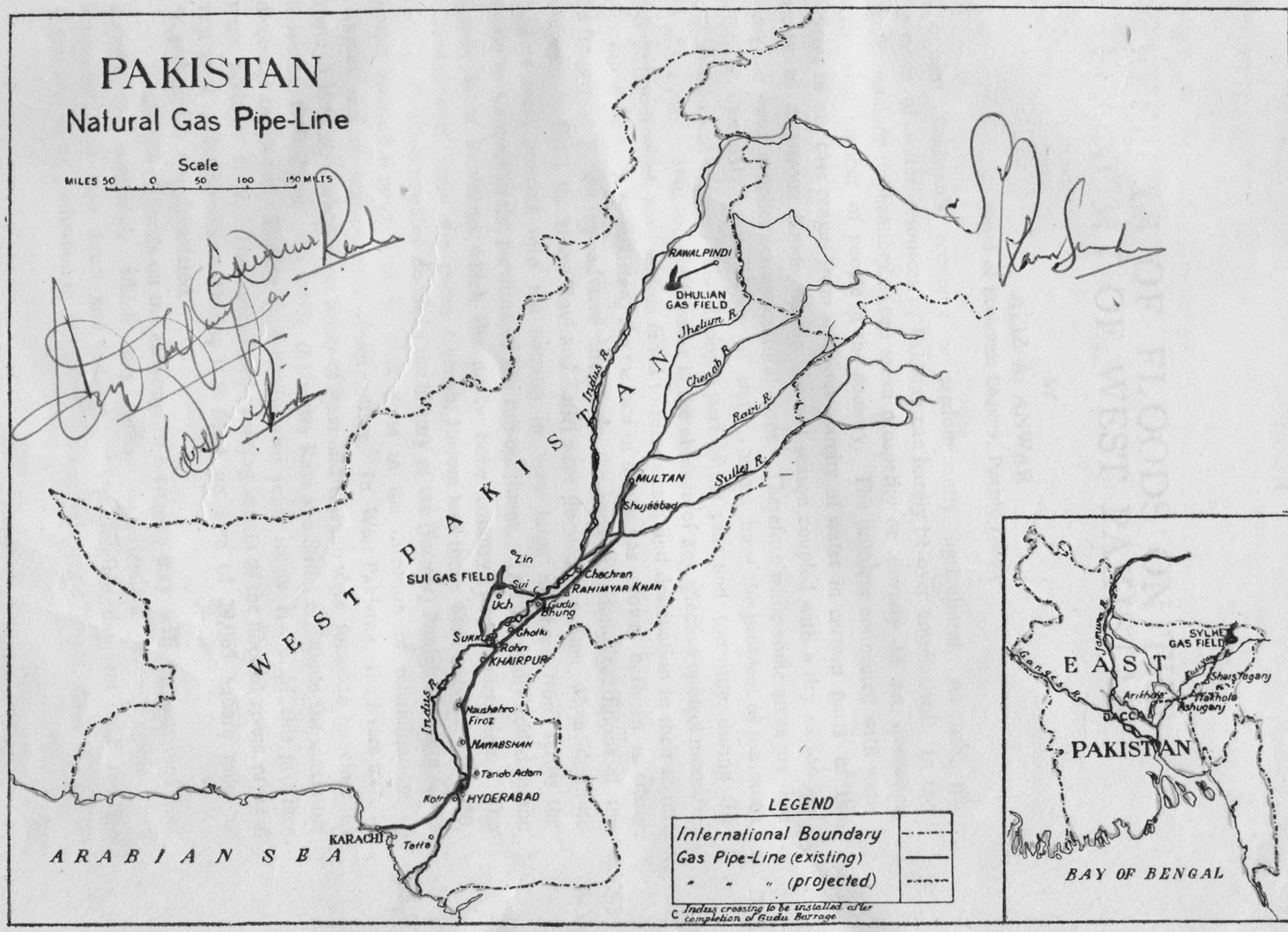
Map No. 2



PAKISTAN
Natural Gas Pipe-Line
Scale
MILES 50 0 50 100 150 MILES
RAWALPINDI
DHULIAN GAS FIELD
Jhelum R.
Chenab R.
Ravi R.
Sutlej R.
Indus R.
MULTAN
Shujabad
WEST PAKISTAN
Zin
SUI GAS FIELD
Sui
Chachran
RAHIMYAR KHAN
Uch
Gudu
Bhung
Gholki
SUKKUR
Rohri
KHAIRPUR
Naushahro Firoz
NAWABSHAH
Tando Adam
Kotri
HYDERABAD
KARACHI
Tatta
ARABIAN SEA
LEGEND
International Boundary
Gas Pipe-Line (existing)
" " " (projected)
C Indus crossing to be installed after completion of Gudu Barrage
EAST PAKISTAN
SYLHET GAS FIELD
Jamuna R.
Ganges R.
Arikhola
Shaistaganj
Takhola
Ashuganj
DACCA
BAY OF BENGAL

EFFECTS OF FLOODS ON THE ECONOMY OF WEST PAKISTAN

BY

AZIZ A. ANWAR

Board of Economic Enquiry, Punjab, Lahore

AT present Pakistan's economy is predominantly agricultural. As such, the importance of water resources to Pakistan can hardly be over emphasised. In fact in its far-reaching implications, it can mean prosperity or poverty to an overwhelmingly large number of people in the country. The problem connected with water resources in our case ranges from a serious scarcity of water in certain parts of the country to disastrous floods during the wet season coupled with a dry season and inadequate water supplies for agricultural crops. Therefore while some areas are less productive due only to deficiency of water, others have the problem of too much water in the form of heavy rains during a part of the year and too little during the rest of the year. Thus too much water in the absence of any effective control measures leads to floods which have seldom failed to bring death and destruction in their train.

Since the birth of Pakistan, the menace of floods has grown both in intensity and frequency, producing adverse effects on the socio-economic conditions of the country. In 1947, the rivers Ravi and Sutlej were flooded at a time when destitute refugees were pouring into the country in very large numbers from across the border as a sequel to the partition of the sub-continent. This naturally added to the already great hardships which the newly born country was undergoing. The following year again the rivers Chenab, Jhelum and Indus were swollen. In 1950, there came unprecedented floods in the history of the (former) Punjab Province which almost nullified a good deal of work done in the direction of rehabilitation of refugees and of improvement of agriculture. In West Pakistan, the rivers were in spate in 1954 also, when water levels of Ravi and Chenab were found to be close to those of 1950 floods. In 1955, the rivers Ravi and Sutlej registered the maximum discharge on record. During the following two years many rivers of this province were again in spate. The furious and sweeping waters of the flooded rivers ravaged vast areas of the province. During 1956 flood, an area of 29,065 square miles of West Pakistan was devastated.

The effects of floods on the economy of a country may well be classified into harmful and beneficial, which may further be classifed into tangible and intangible, and into direct and indirect. While tangible damages tend to lend themselves to an evaluation in terms of money, intangible losses do not. Direct

damages are witnessed mostly in the flooded areas, while indirect losses are not confined to the flooded localities alone.

The nature of losses suffered varies widely depending upon factors like intensity of the flood, topography of the area affected, time and conditions prevalent in a particular area. In some cases indirect flood damage may be larger than direct damage and *vice versa*. In case of Pakistan, being a land of villages, direct damage is invariably always higher in rural areas than in urban areas.

ADVANTAGES OF FLOODS

Though highly destructive, in the absence of effective flood control measures, floods are not altogether without their salutary effects. Gushing waters of a flood reach out to areas suffering from acute scarcity of water and contribute to the richness of crops to be raised, particularly those crops which demand abundant supplies of water to mature. Flood water also brings silt with it which is deposited on the land when the water recedes. This silt helps raise certain crops more quickly than the normal time. Saline areas in particular benefit from the flood waters which wash away a good part or the whole of salinity from the barren lands, making them productive at least for a certain period. Besides, flood water wash away refuse and filth of areas where the drainage system is not complete or is defective.

DISADVANTAGES OF FLOODS

On the whole the flood damages are so numerous, heavy and varied compared with flood benefits that these advantages do not have any special significance. For the purpose of this paper, the harmful effects of floods have been studied under the following five main broad heads :

1. Agriculture and Irrigation.
2. Industry and Trade.
3. Transport and Communication.
4. Public Income.
5. Miscellaneous.

1. Agriculture and Irrigation.

Since independence, West Pakistan has witnessed seven floods of varying intensity. As a result thousands of villages were inundated and millions of people rendered shelterless during flood days. Vast areas of cultivated lands and standing crops were devastated. Thousands of maunds of foodgrains and fodder were destroyed. Large numbers of cattle-head were washed away. Nearly all the wells, tubewells and irrigation works in the affected areas were more or less damaged. The result was a drop in the production of processed food no less than in livestock and farm production. Disruption of marketing facilities and disorganisation of cooperative societies were also caused. In short, the village economy of the affected areas was badly shaken during each flood.

(*a*) **Villages Affected.**—Rural areas, especially those lying low on either side of the rivers, had to bear the brunt of the wrath of floods in this province, which suffered maximum direct destruction. The number of villages affected, damaged or destroyed at the time of each flood is recorded in Table 1.

TABLE 1*

No. of Villages Affected, Damaged and Destroyed by Flaods

Flood Year	Number of Villages		
	Affected	Damaged	Destroyed
1948	5,000**	3,456	122
1950	10,000	4,538	1,100
1954	3,747	2,000	600**
1955	6,945	2,913	500
1956	11,609	4,000**	400**
1957	4,498	2,000**	300**
Total	41,799	18,907	3,022

The figures show that during the last six floods about 18,907 villages were damaged while 3,022 were destroyed. In 1957, the estimated extent of damage to private property (excluding houses) was put at Rs. 17 million. The corresponding estimates for the last six floods amounted to Rs. 142 million.

(*b*) **Damaged to Cultivated Area.**—Great damage was done to the cultivated areas, and standing crops were destroyed by rushing flood waters as shown by the Table 2. Stagnation of water in the cotton fields had adverse effects on the plant as well as on the yield. The sugarcane plants cultivated in low lying areas also suffered seriously notwithstanding the fact that this plant can stand abundance of water.

TABLE 2

Cultivated Area Affected and Destroyed and the Value of Crop Destroyed

Flood Year	Area in Acres		Value of Crops Destroyed (In rupees)
	Affected	Destroyed	
1948	1,000,000**	754,000	75,000,000**
1950	1,765,544	700,724	70,611,317
1954	1,587,177	308,810	30,000,000**
1955	1,711,952	990,121	80,482,020
1956	2,180,489	798,956	79,290,108
1957	2,085,883	635,997	66,832,871
Total	10,331,045	4,188,608	402,216,316

*Statistics for the year 1950 to 1957 given in this and subsequent tables (excluding estimates) were obtained from the office of the Flood Relief Commissioner.

**Estimates.

The above table shows that during the last six floods 4,188,608 acres of cultivated area were destroyed. The estimated value of crops destroyed amounted to Rs. 402 million. The cause of recurring food deficits in the country is also partly accounted for by the flood havoc caused to food crops.

(*c*) **Foodgrains Destroyed.**—In addition to the damage to the standing crops, stocks of foodgrains (government as well as privately owned) kept for future use were either swept away or were spoiled by the standing water. Table 3 gives the quantities of foodgrains lost to the country since 1948:

TABLE 3

Quantity of Foodgrains Destroyed in Floods

Flood Year		Foodgrains Destroyed (in Maunds)
1948	...	50,000*
1950	...	14,25,253
1954	...	54,392
1955	...	14,28,496
1956	...	12,28,164
1957	...	2,42,556
Total	...	44,28,861

*Estimates

4.4 million maunds of foodgrains so urgently needed for the teeming under-nourished millions of the country, were destroyed during the last six floods. In 1957, the estimated value of foodgrains destroyed by floods was Rs. 2.9 million and the total estimate for last six floods puts it at Rs. 48.7 million.

(*d*) **Destruction of Fodder.**—Standing fodder crops as well as large quantities of stored fodder totalling about 10 million maunds were destroyed as is shown in Table 4.

TABLE 4

Quantity of Fodder Destroyed (in maunds)

Flood Year		Fodder Destroyed (in maunds)
1948	...	1,000,000*
1950	...	3,525,571
1954	...	1,500,000*
1955	...	1,788,016
1956	...	1,074,284
1957	...	1,134,749
Total	...	10,022,620

*Estimates

The maximum destruction was caused in 1950 when 3.5 million maunds of fodder were washed away. In 1957, the estimated value of fodder destroyed was Rs. 2.8 million, and the estimate for the total loss was stated to be in the neighbourhood of Rs. 25 million.

To get fodder supplies from the surplus areas, concessional rates were introduced for the carriage of fodder by rail. The consigner was to pay only 40% of the ordinary freight and the rest was to be debited to the Provincial Government. An amount of Rs. 34,000 was set apart for this purpose during the 1950 flood. Fodder scarcity, however, did not last long as adequate quantities of fodder crops like *Shaffal* and *Berseem*, which flourish very well on the moisture provided by the floods, were available to meet the demand.

(*e*) **Loss of Cattle Heads.**—The main cattle problems created by the floods were in regard to (*i*) transporting the animals from the affected areas to high level places, (*ii*) checking the high mortality rate among the cattle during the flood days, (*iii*) providing the needed quantity of fodder, (*iv*) opening veterinary centres to treat animals from minor ailments and for inoculation against diseases and (*v*) burying the dead animals with disinfectants.

The Provincial Veterinary Departmant opened a large number of centres during each flood where animals were treated and also immunised against contagious diseases. But in spite of all the efforts to bring the stranded animals to the cattle concentration camps a large number of cattle heads were lost, as is revealed by Table 5.

TABLE 5

No. of Cattle Heads Lost during Floods

Flood Year		Cattle Head Lost
1948	...	2,877
1950	...	41,662
1954	...	5,135
1955	...	36,985
1956	...	2,500
1957	...	4,050
Total	...	93,209

The flood years of 1950 and 1955 were the most destructive for the livestock wealth of the country. Taking the average value of an animal at Rs. 100 per head for forming an estimate of the financial loss sustained by the province on this account, a figure of Rs. 9.3 million is arrived at.

(*f*) **Damage to Wells.**—A large number of irrigation wells, including tube-wells, were swamped in water and the masonry work either cracked or collapsed. During 1957, more than 5,337 wells were damaged, and the estimated cost of repair worked out to Rs. 1.4 million.

(*g*) **Supply of Seeds.**—Great shortage of seeds is experienced in the post-flood days on account of sudden displacement of population and the washing away of foodgrains or due to the damage done to the stocks by the flood waters. The Agricultural Department organised a large number of seed agencies (400 in 1950) in view of the fact that it would be very difficult for cultivators to travel long distances to get seeds. These agencies distributed 300,924 maunds of seeds in 1950 with the help of manpower, pack animals, boats, etc. The Government issued *taccavi* wheat seeds at a price of Re. 1/- less than the prices of wheat seeds prevailing in the various *tehsils*, and in 1950 a sum of Rs. 500,000 was earmarked by the Government for this purpose.

(*h*) **Canals Damaged.**—Canals were also breached and damaged at several places during the floods on the repair of which the Irrigation Section of the P.W.D. had to spend huge amounts. It was estimated that the total damage to the canals in 1950 amounted to about Rs. 7 million.

2. Industry and Trade.

(*a*) **Industry.**—Several towns and urban localities situated near the rivers were also more or less flooded. Low lying industrial areas in the suburbs of cities and towns were particularly hard hit. Whole or parts of industrial centres, namely Sialkot, Nizamabad, Gujranwala, Shahdara and Badami Bagh of the (former) Punjab Province were under flood waters. The factories remained submerged under water for days together and the water damaged machinery, equipment, buildings, raw material and finished products in many of the industrial concerns. There were cases when the raw material and other stores were also washed away by angry waters.

In September, 1954, the N.W.R. Carriage and Wagon Shops, the Loco Shops and the Moghalpura Power House were heavily flooded, and water was reported to be knee-deep at certain places and waist-deep at others. Working of about 200 mines was suspended during 1956 in the Quetta and Kalat Divisions.

Some factories located at a safe distance from the flood water were also forced to suspend operations because of the lack of raw materials due to disruption of means of transportation. All this led to the closing down of factories for days together even after the recession of the flood waters thus resulting in fall in income and employment level and in higher cost of production.

(*b*) **Labour.**—Floods also caused displacement of labour by driving them out of their places of work to those of safety. The closure of several factories and smaller concerns rendered a large portion of labour force unemployed for periods ranging from days to weeks, and in some cases where the damage was serious even for months together. All this brought suffering and distress to the workers, especially those employed on daily wage basis. The loss of wages was a cause of much hardship, especially to low-paid labour. The loss of working days taken collectively had its adverse effects on the economy of the country as a whole.

(*c*) **Prices.**—The price structure of the flood-ravaged areas in particular and of other areas in general did not remain unaffected. The prices prevailing in

consumption centres rose and those in the production centres fell. But where the raw material supplies were cut off or supply of electric power discontinued, the production centres also experienced a rise in prices. Table 6 shows the percentage change in the wholesale prices of certain commodities due to floods at Lahore.

TABLE 6

Changes due to Floods in Wholesale Prices, Lahore, 1950.

Commodity		Percentage change due to floods 1950
Gram	..	+ 1·2
Barley	..	+ 8·5
Rice Basmati	..	+ 18·3
Moong whole	..	+ 12·5
Chillies Dry	..	+ 12·4
Mash Whole	..	+ 28·4
Onions	..	− 24·0
Potatoes	..	− 5·6
Gur Desi	..	+ 26·2
Salt Rock	..	+ 2·4
Firewood	..	+ 1·6
Cotton Desi (unginned)	..	+ 9.7
Toria	..	+ 1·4
Sarson Oil	..	+ 4·6
Cement	..	+ 31·4

Prices per maund for September and October 1950 were obtained and the percentage increase of prices in October, 1950 were worked out. Then normal percentage changes during these months (average of 3 years) were calculated. Finally the percentage changes due to 1950 flood were worked out and are given in Table 6. It is clear that the prices changed in varying proportions depending upon the supply and demand position of the commodities concerned. In the case of items appreciating in prices, the percentage rise ranged between 1·2 and 31·4. Cement recorded the highest percentage increase in prices because its supplies were brought into Lahore from Wah and other producing areas which were cut off due to disruption of transport system which pushed its prices up at the consumption centres. Almost similar was the case with various other commodities which were brought into Lahore from outside. In the case of potatoes and onions although the price recorded a rise in October, 1950, yet when the percentage change due to flood was calculated it recorded a fall in the case of these two commodities. The reason was that the environs of Lahore being one of the surplus production areas of these items, these could not be transported to other consuming areas leading to a relative percentage decrease in their prices. Almost similar was the position in the case of retail prices of several commodities.

3. Transport and Communications

Direct as well as indirect damage was caused to the communications of the Province. Railway and road tracks were breached at several places, resulting in the contraction of commodity and passenger traffic, decline in earnings of rail and road transport, and in curtailment of employment and business activities connected with the transport industry.

(*a*) *Railway.*—Battered by the flood waters, some parts of the tracks were either washed away or were found hanging in the air. Some railway bridges were also breached by swollen flood waters.

During the course of the 1954-floods, more than 100 breaches occurred on the railway tracks of Lahore and Multan Divisions covering more than 26,000 ft. of broad gauge track. Apart from these breaches, several other sections of tracks were affected, and many railway stations and godowns flooded with water. Narowal-Sialkot section was the worst affected. There were 25 breaches on this section covering an aggregate length of about 18,000 feet. The largest single breach recorded was 6,100 feet. The depth of the water varied at various places. The maximum depth of 27 feet was recorded on the Chiniot and Lalian section.

In addition to permanent gangmen, 4,060 temporary workers were employed in Lahore Division and 1,600 in Multan Division in 1954 for carrying out repairs to breaches and other damaged sections of the track and for protection works. Through communications in all the flood damaged sections was restored after 16 days of disruption.

The estimated total cost of flood repairs and other damages to railway property in 1954 amounted to Rs. 1 million. In the year 1957, flood damages to railway tracks and structures was estimated at about Rs. 6 million. The estimated cost of flood prevention and protective works exceeded Rs. 10 million.

(*b*) *Roads.*—The floods breached many important highways at several places and many culverts and bridges suffered serious damage. The Building and Road Section of the Public Works Department was charged with the responsibility of closing small breaches, erecting temporary bridges on long deep breaches, making diversions in the flooded areas and restoring through traffic immediately. It was not possible to start the restoration work till the floods had sufficiently subsided. It was estimated that during the 1950-floods, damage to roads, bridges and railway lines amounted to Rs. 10 million.

(*c*) *Communications.*—In the case of telegraph and telephone communications, however, there was only a brief interruption of a few hours, as otherwise the system kept functioning throughout the flood periods. Wireless equipment was also used to remain in touch with the people in affected areas. The postal arrangements, however, were seriously upset during the flood days. Through communications, except by air for certain urban places, was nearly impracticable.

4. Public Income.

The Central as well as the Provincial Government sanctioned large sums of money as extra expenditure on the provision on relief measures and on rehabilitation schemes. The Government revenues also shrank due to fall in land revenue and *abiana* (water rates) collections. The Government was, however, prompt in advancing large sums as *taccavi* loans for various purposes to enable the flood-stricken people to tide over the difficult period. Flood relief cess was imposed on land revenue and the Flood Relief Committee was organised to collect donations from the public for the help of flood affected people.

(*a*) *Government Grants.*—The Central as well as the Provincial Governments made substantial monetary contribution to alleviate the distress of the flood-stricken people of this province as is clear from Table 7.

TABLE 7

Central and Provincial Government Grants for Flood Relief

(In Rupees)

Flood Year	Central Govt.	Provincial Govt.
1950	20,000,000	535,000
1954	..	971,000
1955	12,500,000	2,000,000
1956	6,700,000	3,000,000
1957	..	1,000,000
Total	39,200,000	7,506,000

(*b*) *Taccavi Loans.* Advancing large sums as *Taccavi* Loans was an important step to rehabilitate the flood stricken cultivators. These loans which were advanced under Agricultural Loan Act XII of 1884 and Land Improvement Act of XIX of 1883, provided the farmer with the necessary means to resettle himself on his land. The following amounts were sanctioned by the Provincial Government for *Taccavi* Loans :

TABLE 8

Amount of Taccavi Loans Sanctioned

Flood Year		Amounts (in Rs.)
1950	...	5,343,000
1954	...	2,200,000
1955	...	12,100,000
1956	...	8,000,000
1957	...	3,000,000
Total	...	30,643,000

Out of the total amount, about half was interest free. The amount of loan for the year 1955 included Rs. 10 million from the Central Government. The balance was contributed by the Provincial Government.

(*c*) *Remission of Land Revenue and Abiana.* As the damage caused to the standing crops was great and the cultivators were not in a position to pay for the crops which had been destroyed, the Government remitted the land revenue and *abiana* at places where the crops had failed. This was a relief measure which by implications was an indirect financial help to the affected people. The total remission and suspension of land revenue and *abiana* during *kharif* 1950 amounted to Rs. 2.6 million.

(*d*) *Relief Cess and Fund.* Flood Relief Cess was levied in 1950 at the rate of 2 annas per rupee or part of a rupee of the land revenue assessed and occupiers' rates payable during *kharif* 1950. The total estimated realisation of this cess was expected to be of the order of Rs. 4.6 million.

A sum of Rs. 1.7 million was sanctioned for flood relief from the Quaid-i-Azam Relief Fund in 1950. In 1955, about 800,000 rupees were collected, and during the next two years 225,000 rupees were collected for relief fund. These amounts were utilized for providing relief measures in various shapes. In 1957, Provincial Flood Relief Committee collected Rs. 230,000.

5. Miscellaneous.

(*a*) *Loss of Human Lives.* Sweeping flood-waters spared nothing and human life was no exception. Maximum loss of life was reported during the 1950 floods, when people were taken quite unaware and, men, women and children were known to have been drowned or washed away by hundreds. Table 9 gives the number of human lives lost or missing in floods :

TABLE 9

Human Lives Lost or Missing in Floods

Year		Lost or Missing
1948	...	150
1950	...	2,910
1954	...	630
1955	...	679
1956	...	160
1957	...	83
Total	...	4,612

The loss of 4,612 souls was an irreparable one. It was reported that on 27th September, 1947, about 1,000 Muslim evacuees from East Punjab were swept away by the flood in the Beas.*

**Civil and Military Gazette*, 30th September, 1947.

(*b*) *Diseases and Epidemics.* The health problems of the flood-affected areas consisted in the prevention and/or treatment of the following diseases :

(*i*) Cholera

(*ii*) Malaria

(*iii*) Bowel diseases like Dysentery and Diarrhoea

(*iv*) Pneumonia and other chest diseases.

Even when the flood receded, all the water did not subside, and stood for days together at many low lying areas. These places and other soft-marshy grounds tended to become the breeding places of different disease-carrying germs. The Government not only provided relief to flood evacuees and flood affected villages but also took measures for the prevention of cholera.

The incidence of malaria was very high in the flood affected villages and the position was made worse by relapses. The spread of bowel diseases like dysentery and diarrhoea and chest diseases was also reported.

It was estimated that more than 75% population of the flood-affected villages had suffered from one disease or another and at least one member of every family was bed-ridden throughout the coming season. This situation gives some idea of the number of working days lost to the nation and its adverse effects on the economy of the country.

To cope with the health problems so created, the Health Department organised Mobile Medical Units consisting of doctors, sanitary and anti-malaria staff, increased the existing hospital accommodation, established temporary hospitals and dispensaries and procured essential medicines in large quantities. The staff disinfected wells, carried out anti-malaria inoculations, distributed anti-malaria drugs and other medicines for diarrhoea and dysentery. D.D.T. was sprayed over the flood affected areas from the air with the help of the Pakistan Air Force.

(*c*) *Houses Damaged and Destroyed.* A very large number of residential huts, houses and other buildings in low lying areas were damaged or destroyed as shown in Table 10.

TABLE 10

Number of Houses Damaged or Destroyed

Flood Year		Houses Damaged	Houses Destroyed	Total
1948	...	91,502	87,000	178,502
1950	...	167,331	269,108	436,439
1954	...	23,552	41,215	64,767
1955	...	183,247	139,431	322,678
1956	...	89,565	75,033	164,598
1957	...	90,499	52,412	142,911
Total	...	645,696	664,199	1,309,895

As many as 1,309,895 houses and huts were either damaged or destroyed during the last six floods. The estimated value of damage done to houses was of the order of Rs. 25 million during 1957, and the total loss due to damage and destruction during the last six floods amounted to about Rs. 231 million.

Great damage was also caused to some buildings belonging to Government and Local Bodies. During the 1950 floods the Tehsil buildings at Daska, Pasrur, Shahdara, Kabirwala and Chiniot were seriously damaged, besides those of the Government College at Jhang and of various police stations. The buildings of schools and hospitals belonging to the District Boards also suffered extensive damage. When the 1950-floods receded, the District Boards approached the Government for an assistance of Rs. 7 million to repair the damaged buildings and to reconstruct the demolished ones.

(*d*) *Government Action.* As floods are in the nature of a national calamity with widely dispersed adverse effects, the resources of almost all the Government departments were mobilised and so coordinated as to achieve the maximum result in minimum time.

During the floods of 1950, a portion of the Army was immediately mobilised to assist civil agencies. Pakistan Air Force also played a prominent part in these operations by dropping thousands of maunds of food supplies to the marooned people.

Information and relief centres were established to render assistance to those affected by the flood. Evacuation of inhabitants of low lying areas was undertaken. Tens of thousands of human beings rendered homeless and stranded were picked up by workers of these agencies and brought to the temporary relief centres. 'Rescue Units' were mobilised to bring to safety persons trapped, far enough, on the top of trees and houses. The Government also granted relief money to each destitute family having lost its earning member. In 1956, the West Pakistan Government installed more than 75 wireless sets for flood warning and reporting at several places near the rivers Sutlej, Ravi, Chenab and Jhelum.

(*e*) *Flood Commission.* After the 1950 flood had receded, the Central Government appointed a Flood Commission to investigate into and report on the causes that contributed to the flood disaster, and to suggest measures to prevent and control such causes. The Commission submitted its report in June 1951, which is still being kept as a secret document, and no decision has yet been taken in this respect. Flood Protective Measure Committee was appointed in 1950 by the Provincial Government to recommend the type of equipment required at various places in the flood affected areas to meet any such emergency in future.

TOTAL DAMAGE

The Provincial Flood Relief Commissioner's office estimated that in 1957 the total loss due to floods, excluding cost of restoration of Government works of public utility, was of the order of Rs. 120.7 million. This estimate includes damage to private property and houses, value of foodgrains, fodder and crops damaged, cost of repairs to wells, cost of cattle-head lost and other miscellaneous damages. On the

same basis, an attempt has been made in the Table 11 to evaluate, in terms of money, the total damage done and loss caused by other floods, excluding cost of restoration of Government works of public utility.

TABLE 11

Estimated Value of Loss Suffered due to Floods in West Pakistan

Flood Year		Loss (Million Rupees)
1947	...	100
1948	...	128
1950	...	212
1954	...	72
1955	...	185
1956	...	166
1957	...	121
Total	...	984

The figures given above reveal a very dismal picture of the economy of West Pakistan having sustained a colossal loss of Rs. 984 million during the last seven floods. If these floods could have been prevented or made less destructive the amount thus saved could well have been spent on the development projects with tremendous results.

There are certain losses due to floods which make themselves felt only after considerable time has elapsed and which at any rate do not lend themselves to an immediate assessment in terms of money. They lead to holding up of some or all of the development projects which might have long been under way by necessitating diversion of Governmental machinery to the urgent task of combating flood and adopting flood control and flood relief measures. The delay in the implementation of some of the development projects already under way was its repercussion development in other sectors too.

It is to be noted that in a growing community, even if the intensity and magnitude of floods remain the same, the direct and indirect damage increases with a rise in the population. The great flood of 1849 in U.S.A., for example, washed through the unsettled Kansas River Valley without material damage, while in 1951, flood in that valley caused damages approaching one billion dollars.*

CONCLUSIONS

The flood problem is becoming increasingly acute and is exhibiting the dangerous tendency to become more or less permanent. The general optimism regarding the food position of Pakistan, witnessed at the time of Independence, drawing its full justification from the historical fact that this sub-continent, had enjoyed the reputation of being called the "granary of India," did not endure

**Flood Control Journal*, January 1953, pages 32-33.

long. Since 1953, Pakistan has been struggling hard to feed its population from its own food resources, without any marked success. Among the host of reasons responsible for bringing about near reversal of the once happy food position, floods coming with tenacious regularity are the one. Large amounts of precious foreign exchange worth tens of millions of rupees have been spent every year on import of food stuff which in its economic implication is an entirely non-productive expenditure.

To provide for food requirements of a growing population and to alleviate the present food shortages in the country, additional agricultural production is essential. For this purpose, further irrigation and power development which depends to a great extent on the storage of flood water now wasted, and on the carry-over of these waters from one season to another, for release in dry months, is essential. In the U.S.A., a good deal of success has been achieved in devising methods for delaying the flows by resorting to what is known as water control through Watershed Management also called Drainage Basin Management. The effects of such a control on water yields, flood control and soil conservation are tremendous. But in our country very little has so far been done in this direction.*

*Water Resources Development in West Pakistan, by K. A. Ghafoor.

AN ANALYSIS OF THE CIVILIAN LABOUR FORCE IN ITS BEARING ON THE GROWTH OF URBAN POPULATION, WEST PAKISTAN, 1901—1951

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IT was decided to analyse the labour force of West Pakistan and trace its relationship to the growth of urban population over the period 1901-1951. The choice of the period, 1901-1951, was made primarily for the following two reasons:

1. Comparable data of civilian labour force are not available for earlier decades.
2. Urban progress was more marked during the present century than during the decades 1881-1901. Authentic census data are not available for our region of study as a whole prior to 1881.

Table 1 gives the population recorded as urban in West Pakistan at the censuses, 1901 to 1951. The period under review is characterized by a large increase in the volume of population returned as urban. The total increase from 1901 to 1951 was 4,301,800—more than 2½ times the initial urban population in 1901. The increase in the recorded number of urban dwellers has been a progressive one from decade to decade, starting with 1901. The percentage increase of urban population for the several decades is given in Table 2.

Urban population of West Pakistan expressed as a percentage of the total population, 1901-1951, is given in Table 3. The figures indicate a steady increase of urban population in relation to total population from 1921 onward. The low percentage figures in 1911 were the outcome of a widespread plague epidemic. Large number of persons dwelling in towns had temporarily shifted to safer places. "... the decline in 1911 is accidental, since a plague epidemic in that year caused many cities to be temporarily evacuated."[1]

[1] K. Davis, *The Population of India and Pakistan*, Princeton, 1951, p. 127.

The remark refers to the towns of the sub-continent of India and Pakistan as a whole. The areas now constituting West Pakistan were also affected by the plague (see *Census of India*, 1911 *Bombay*, Vol. VII, Pt. I, p. 26; *Census of India*, 1931 *Punjab*, Vol. XVII, Pt. I, p. 6 under the heading (1901-1911).

The general increase in the percentage figures was largely the result of an increasing volume of emigration from the rural areas to the towns. The rate of natural increase of urban population in West Pakistan is lower than that of rural population. The rate of natural increase of larger towns is still lower, owing to the generally lower fertility, as measured by child-woman ratio (number of children under 5 years per 1,000 women aged 15-49 years, at the time of the census)[1] in those urban agglomerations. The rural-urban migration was largely due to economic conditions in operation both in towns and in the country. The towns of West Pakistan did not have much to offer to the village dwellers by way of cultural and social amusements, so abundantly available in the urban centres of many Western countries. The economic progress of West Pakistan is studied here by analysing the variations of the civilian labour force, and a correlation is established between these variations and the growth of urban population.

Civilian Labour Force

Data relating to the civilian labour force, by districts and states, are contained in the several provincial census volumes of West Pakistan. The data in the census volumes of Punjab prior to 1951 are available for the old districts of the undivided Punjab. Two of the old districts (Sialkot and Lahore) of undivided Punjab, now forming part of West Pakistan, have been reconstituted as a consequence of the Partition. As the occupational figures are not given in the census tables for territorial units smaller than the district, no allowance was made by the present writer in the calculation of the data for the addition of, or severance from, the two districts of undivided Punjab of *tahsils*, and parts thereof, as a consequence of the Partition. However, such areas are small and their exclusion in the calculation of economic divisions will not materially affect overall figures for West Pakistan. The civilian labour force of West Pakistan calculated for the period 1901-1951, and economic divisions expressed as percentage of the civilian labour force calculated for the period 1911-1951, are given in Table 4. Percentages of the several economic divisions to the civilian labour force were not calculated for 1901, as the figures of the economic divisions of that census are not comparable with those of the later censuses.[2] The census volumes of 1911-1931 have the same system of classification. The census volumes of 1941 do not contain the data of civilian labour force. The treatment of the data under the heading of 'economic divisions' in the census volumes of 1951 is different from the classification of 1911-1931 in some respects. In the previous censuses the economic activities of the working population were dealt with in a table which analyzed "earners" according

[1] K. U. Kureishy, *Urban Development in West Pakistan*, London University Ph.D. Thesis, 1 57, p. 166, and conclusions.

[2] " . . . The classification adopted for the purpose of the present operations (1911 census) has been a different one from that employed in 1901. As a result, in many cases, the figures included in one group in 1911 formed in 1901 a part only of one or more groups ; and it is matter for estimate only what proportion of them should be attributed to the head with which we were concerned on the present occasion" (*Census of India*, 1911, Vol. XIII, N.W.F.P., Part I, p. 251).

to "Means of livelihood." The classification was largely based upon the industry, service or other economic activity from which persons derive their income or means of sustenance, although to some extent the classes were subdivided according to the kind of work which the persons performed. In the census of 1951 the working population was classified, following the recommendations of the United Nations, according to the three concepts of Occupation, Industry and Status,[1] signifying respectively, the kind of work performed, the nature of the business or service in which the work is done, and the relationship of the person to other workers in the same organization according to whether he is an employer, one of the employees, or a man working alone on his own account. In view of the narrow meaning which the word 'industry' has acquired in Pakistan, the classification system uses the expression 'economic groups', associated groups being built up into 'economic divisions' such as agriculture, industry, domestic service. The 1951 census, thus, gives some information additional to what was contained in the earlier census volumes. The grouping of the economic divisions in the census of 1951 is also not quite the same as the one followed in the censuses of 1911-1931. However, regrouping, wherever necessary, by the present writer of the 'groups', 'orders', 'sub-classes' and 'classes' of occupations in the previous censuses, according to the 1951 scheme of economic groups and divisions of the labour force, could make the data of the several censuses approximately comparable. The comparability is approximate because of the following:

1. as stated above, no allowance is made in the pre-1951 figures for the transfer of areas smaller than a district as a consequence of the Partition;
2. there have been some minor changes in the 'classification policy' of the several censuses in the treatment of groups and orders, for example, that of 'unclassified'.[2]

In the census tables of 1931 the figures of labour force in each group are split into two sub-heads, (*i*) 'Total earners principal occupation', and (*ii*) 'Total working dependents'. The requisite figures of labour force are obtained by adding the numbers in the two columns.[3] Persons employed in defence forces and those returned as 'persons living principally on their income' are not counted in the labour force of the enumerations 1911-1931, as these are not included in the civilian labour force in the 1951 census, but are registered separately as 'Self-supporting persons not in Civilian Labour Force.'

1 *Census of Pakistan*, 1951, Vol. VI, p. 6.

2 *Ibid.*, p. 108.

3 The percentage figures of economic divisions for 1931 given in statement 6-F, Vol. I, *Census of Pakistan*, 1951, are calculated on the same lines. Explanatory note No. 2 of Provincial Table X, Vol. XVII, Part II, *Census of India*, 1931, clarifies the point. It reads "Working dependents engaged in each occupation, who were included in actual workers at the last census have been shown separately."

Remarks in the several census reports indicate that owing particularly to the complex nature of information recorded, the data on economic divisions of the civilian labour force are less reliable than most of the remaining census statistics.

Data of economic divisions expressed as percentage of the civilian labour force, 1911-1951, are illustrated in Fig. 1. From a study of the figure and the data in Table 4 the following conclusions seem valid :

(1) The civilian labour force generally increased from decade to decade over the period 1901-1951; a small decrease is noted only in the 1921 figures as compared with those of the preceding census (see Table 4). The increase is more marked in the later decades. This would seem to suggest an increased economic activity of our region of study in the later decades. The higher rate of increase of urban population of West Pakistan in the later decades seems to be related to this increased economic activity.

It may be noted that the general increase in the civilian labour force over most of the decades may not necessarily imply an amelioration of the employment situation of the population in the several categories of labour taken together, unless the rate of this increase is greater than that of the growth of total population. The compound rate of increase of civilian labour force of West Pakistan over the period 1901-1951 was 0.9 per cent per annum, while that of the total population was 1.4. It indicates that, in spite of a generally increased economic activity of West Pakistan from decade to decade, the employment situation of the population in the several categories of labour taken together deteriorated over the period 1901-1951. Immigration from other parts of British India over the period seems largely to account for the rate of increase of total population greater than that of the civilian labour force.

(2) There was a marked increase in the percentage of the agricultural labour to the total civilian labour force over the period 1911-1951. It seems to be related to an increase in the irrigated and cultivated acreages (see Table 5). The percentage of the agricultural to the total labour force decreased from 1911 to 1921 to increase over the subsequent decades. The rate of increase of agricultural labour, expressed as a percentage of the total civilian labour force, was the highest during the decade 1921-1931. It slightly slackened over the period 1931-1951. The slightly lesser rate of increase of agricultural labour during the period 1931-1951, as compared with that of the decade 1921-1931, deserves special attention, because the irrigated and cultivated acreages returned an unprecedented increase during the last 20 years (see Table 5). The slightly smaller rate of increase of agricultural labour over the period 1931-1951 seems to be related to the general decrease over the period in the cultivated acreage per head of rural population in most of the political divisions of N.W.F.P. and Punjab (see Table 6 and Fig. 2). The decrease in the cultivated acreage per head of rural population signifies an increasing pressure of rural population on soil, and partly accounted for the balance of rural-urban migration in West Pakistan.

It may be pointed out that the smaller rate of increase of agricultural labour force, expressed as a percentage of the total civilian labour force over the period 1931-1951 does not seem to suggest that the law of diminishing return became increasingly operative in the agricultural sector of the economy in recent years. There was no remarkable improvement during these years in the fertility of the soil, and the methods of cultivation remained practically the same but the yields per acre increased.[1] The increase in the yields per acre seems to suggest that the law of diminishing returns was not increasingly operative in agriculture. The increase in the yields is mostly the outcome of an increased use in West Pakistan of better varieties of seeds.

(3) The percentage of industrial labour to the total civilian labour force was variable over the several decades. It decreased from 1911 to 1921 to increase in 1931 and to decrease again in 1951. On the whole the industrial labour force, expressed as a percentage of the total civilian labour force, decreased over the period 1911-1951. The decrease over the period 1911-1951 was not only relative to the total civilian labour force but was also absolute. The total number of workers engaged in industry registered a decrease of 404,000 from 1911 to 1951.[2] The varying percentage of the unclassified labour to the total civilian labour force, from decade to decade, seems partly to explain the variations in the percentage of the indurstrial labour to the total. The deduction seems to be borne out by the divergent trends of the graphs representing industrial and unclassified labour over the several decades. The percentage of the industrial labour to the total was lower in 1921 and 1951, as compared with that of 1911 and 1931, while the percentage of the unclassified to the total civilian labour in 1921 and 1951 was higher than that of 1911 and 1931. It seems possible that owing to the changes in the classification policy, referred to earlier, a large proportion of such unskilled labourers, whom it was "impossible to allocate to a definite economic division"[3] might have been returned as 'unclassified' in 1921 and 1951. The recorded number of persons under the division 'unclassified' might have, thus, been unduly swollen at the expense of the industrial labour force in the censuses of 1921 and 1951.

The graphs of agricultural and industrial labour, expressed as percentage of the total civilian labour force, are approximately parallel over the period 1911-1931. But the decline of the graph of industrial labour is steeper during the decade 1911-1921, while its rise is gentler during the subsequent decade. The position of the graph of agricultural labour in 1931 is higher than that of 1911. On the other hand, the position of the graph of industrial labour in 1931 is lower than that

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1 K. S. Ahmad, 'Agricultural Development of West Pakistan', *Pakistan Geographical Review*, Lahore, Vol. XI, No. 1, pp. 12-14.

2 The number of workers in the several economic divisions are not given in Table 4 but constitute the basic data (obtained from the census volumes) on whch the percentages given in that Table were culculated.

3 *Census of Pakistan*, 1951, Vol. I, p. 108.

of 1911. The trends of the two graphs are divergent over the period 1931-1951, that of the industrial labour being downward. The trends of the graphs of agricultural and industrial labour force, and an absolute decrease from 1911 to 1951 in the number of workers engaged in industry, seem to suggest that the former labour force increased partly at the expense of the latter over the period under review. This tendency seems to have been more marked during the period 1931-1951. Industrial labour includes workers in manufacturing (including cottage industries, and small and large scale industries), building and construction, utilities (including electricity and water supply), transport (including road, sea and river, air and railways), and post and telecommunication services. It is difficult to assess which of the several constituents of the industrial labour force contributed more to its decline, absolute as well as relative to total civilian labour force, during the period 1911-1951. But the number of workers in Large Industrial Establishments registered a large increase (see Table 7). The increase was more marked during the period 1931-1941, and also probably after 1941 ; the available later data are incomplete. It is not possible for want of data to ascertain the distribution in rural and urban areas of the workers in the several industries. But it is known that most of the large Industrial Establishments are located in towns, and an increase in the number of workers in them partly accounted for an increase in the urban population of West Pakistan.

(4.) The percentage of the workers in trade and commerce underwent slight decennial variations during the period 1911-1951, but it was practically the same in 1951 as it was in 1911. It signifies that the increase in the number of workers in trade and commerce over the period 1911-1951 was proportionate to the increase in the total civilian labour force. Towns are the important centres of trade and commerce. Therefore a fraction of the progress of urbanization is attributable to an increase in the number of workers in that economic division.

There was a general increase over the period 1911-1951 in the domestic and pesonal service workers, expressed as a percentage of the total civilian labour force. It seems to be associated with the general deterioration, referred to earlier, in the employment situation of West Pakistan over the period under review. Domestic and personal services are generally less remunerative than many other sources of employment.

(5) The labour force recorded under the economic division 'unclassified' expressed as a percentage of the total civilian labour force, fluctuated from decade to decade, but it improved over the whole period 1911-1951. As expressed earlier, the fluctuations were partly owing to the changes in the classification policy. An overall improvement in the graph of that economic division over the period under review might have been partly due to the inconsistency of the classification policy, and partly to a real increase in the number of such unskilled labourers and other persons whom it was "difficult to allocate to a definite economic division".

The graph of the economic division, 'public administration, professions and arts', shows small variations. Fishery, mining and quarrying, each formed small proportions of the total civilian labour force, and underwent extremely small variations.

6. As stated earlier, the civilian labour force does not include the defence service employees. But cantonments have played an important role in the progress of urbanization in West Pakistan. Cantonment population which, among others, includes defence service employees is, by census definition, urban. The available census data show a marked increase in the cantonment population over the period 1901-1951. The cantonment population was 12.9 per cent of the total urban population in 1951.

The progress of the cultivated and irrigated acreage, the increase in the number of Large Industrial Establishments and the employment in these establishments, and variations of the civilian labour force by economic divisions, give a picture of an overall economic development of our region of study. The urbanization of the region seems to have had a definite relationship with this overall economic development. The tempo of urbanization seems to have synchronized with the pace of economic progress. Broadly speaking, the rate of growth of urban population and the pace of economic progress increased during the later decades.

The growth of urban population is largely a function, among other factors (for example, the increase in the strength of troops in the several cantonments, and long-distance migration, which may occasionally attain greater importance, as, it did during the decade 1941-1951, as a consequence of the Partition), of the rate of natural increase and the rural-urban migration. The rate of natural increase of urban population is universally lower than that of rural population. The greater rate of increase of urban population as compared with that of the rural population is, therefore, associated with rural-urban migration. It has been shown that the balance of rural-urban migration is not entirely due to the economic attraction offered by the town but partly results from the adversity in the rural areas. The factors contributing towards economic adversity in the rural areas are, for example, the high pressure of rural population on the soil, the generally decreasing acreage of cultivated land per head of rural population, inefficient means of cultivation, subdivision and fragmentation of holdings, water-logging in large parts of the canal-irrigated zone, and rural indebtedness. It, therefore, seems essential, in order to relieve the under pressure on the agricultural sector of our economy, to increase further the industrial basis of urbanization in future. The industries to be established should preferably be able to absorb unskilled and semi-skilled labour, together with the skilled labour.

TABLE 1[1]

Urban Population of West Pakistan, 1901-1951
(*Figures in thousands*)

1901	...	1,715.6
1911	...	1,830.8
1921	...	2,140.5
1931	...	2,920.7
1941	...	4,169.2
1951	...	6,017.4

TABLE 2[2]

Percentage increase of urban population of West Pakistan for 5 decades, 1901-1951.

Decade		Percentage increase
1901-1911	...	6.7
1911-1921	...	16.9
1921-1931	...	36.4
1931-1941	...	42.7
1941-1951	...	44.3

TABLE 3[3]

Urban population of West Pakistan as percentage of total population, 1901-1951

Census Year		Percentage
1901	...	10.4
1911	...	9.5
1921	...	10.2
1931	...	12.3
1941	...	14.8
1951	...	17.8

[1] *Census of India*, 1911—*N.W.F.P., Baluchistan, Punjab and Bombay*, Part II, Tables, Table IV; *Censuses of India*, 1921—*N.W F.P., Baluchistan, Punjab and Bombay*, Part II, Tables, Table IV; *Census of India*. 1931—*N.W.F.P., Baluchistan, Punjab and Bombay*, Part II, Tables, Table IV; *Census of India*, 1941—*N.W.F.P., Baluchistan, Punjab and Sind*, Table V; *Census of Pakistan*, 1951, Bulletin No. 3, Tables I-A of the provinces of West Pakistan.

Figures of urban population were calculated from the above census tables.

[2] K. U. Kureishy, *Urban Development in West Pakistan*, London University Ph.D. Thesis, 1957, p. 439.

[3] K. U. Kureishy, *Ibid.*, p. 165.

Fig.1

PERCENTAGE VARIATION OF CIVILIAN LABOUR FORCE, BY ECONOMIC DIVISIONS, 1911-1951.

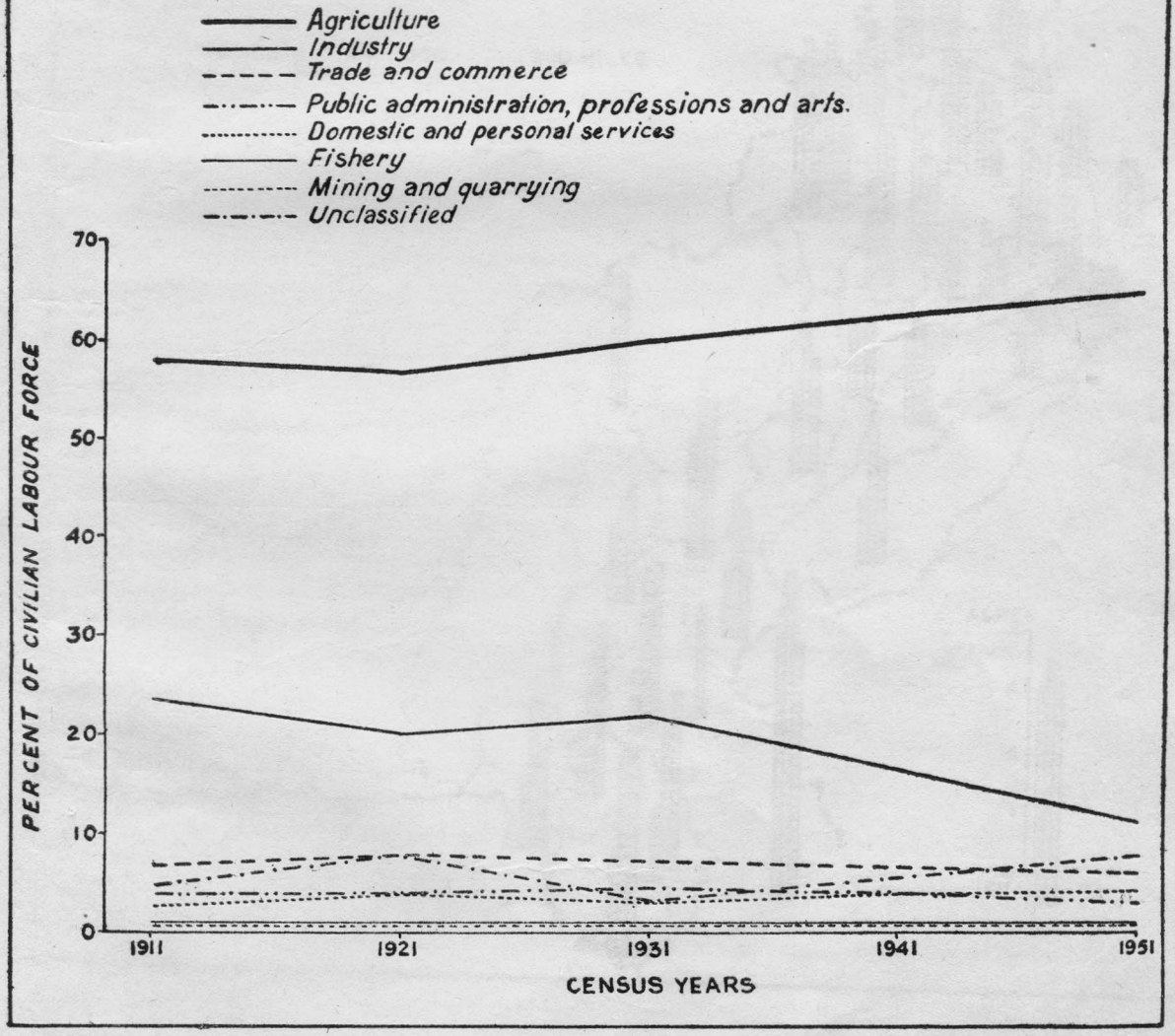

Fig. 2

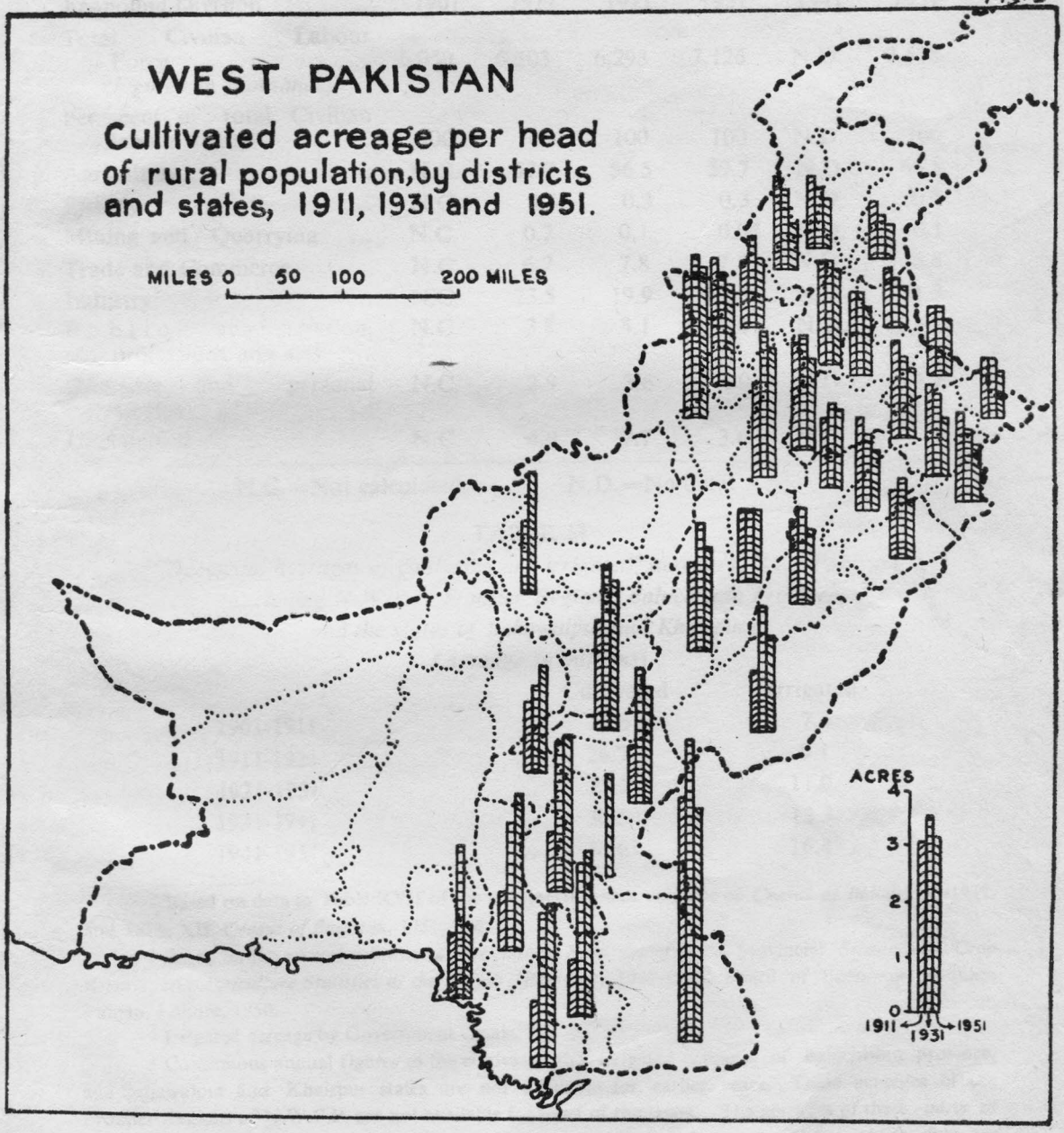
WEST PAKISTAN
Cultivated acreage per head of rural population, by districts and states, 1911, 1931 and 1951.
MILES 0 50 100 200 MILES
ACRES
4
3
2
1
0
1911
1931
1951

TABLE 4[1]

Number of persons in the civilian labour force, 1901-1951, and economic divisions xpressed as percentage of civilian labour force, 1911-1951.

Economic Division ...	1901	1911	1921	1931	1941	1951
Total Civilian Labour Force ... (*Figures in thousands*)	6,050	6,303	6,293	7,126	N.D.	9,538
Per cent of total Civilian labour force ...	100	100	100	100	N.D.	100
Agriculture ...	N.C.	57.7	56.5	59.7	N.D.	65.8
Fishery ...	N.C.	0.3	0.3	0.3	N.D.	0.2
Mining and Quarrying ...	N.C.	0.2	0.1	0.04	N.D.	0.1
Trade and Commerce ...	N.C.	6.7	7.8	7.5	N.D.	6.8
Industry ...	N.C.	23.5	19.9	21.8	N.D.	11.3
Public administration, professions and arts ...	N.C.	3.8	4.1	4.4	N.D.	3.5
Domestic and personal service ...	N.C.	2.9	3.6	3.0	N.D.	4.9
Unclassified ...	N.C.	4.9	7.7	3.6	N.D.	7.7

N.C.=Not calculated. N.D.=No data.

TABLE 5[2]

Decennial averages of cultivated and irrigated[3] acreages, West Pakistan (excluding N.W.F.P. Frontier Regions, Baluchistan Province, and the states of Bahawalpur and Khairpur)[4]

(*Acreage in millions*)

	Cultivated	Irrigated
1901-1911 ...	25.6	7.1
1911-1921 ...	26.7	9.1
1921-1931 ...	27.2	11.0
1931-1941 ...	30.5	13.3
1941-1951 ...	35.6[5]	16.4[5]

[1] Based on data in Table XVII of the provincial census volumes of *Census of India*, 1901-1931, and Table XII, *Census of Pakistan*, 1951, Vol. I.

[2] Based on the several volumes of *Agricultural Statistics of India*, provincial *Seasan and Crop Reports*, and *Agriculture Statistics of the Punjab* (*Pakistan*) 1901-1947, Board of Economic Enquiry, Punjab, Lahore, 1950.

[3] Irrigated acreage by Government canals.

[4] Continuous annual figures of the cultivated and irrigated acreages of Baluchistan province, and Bahawalpur and Khairpur states are not available for earlier years. These acreages of the Frontier Regions of N.W.F.P. are not available for most of the years. The acreages of these parts of West Pakistan are excluded from the figures given in the Table even for the years for which data are available. This is done in order to make comparable the data for the several decades.

[5] Averages for Sind were calculated on the figures of 1941-1946 as no later figures are available.

TABLE 6[1]

Cultivated acreage per head of rural population by districts and states, 1911, 1931 and 1951

District or State		Cultivated acreage per head of rural population		
		1911	1931	1951[2]
Hazara	...	0.8	0.7	0.6
Mardan	...	1.3	1.1	1.0
Peshawar	...	1.3	1.1	0.8
Kohat	...	1.4	1.7	1.4
Bannu	...	2.4	2.3	2.0
Frontier Regions of N.W.F.P.	...	N.D.	N.D.	N.D.
Dera Ismail Khan	...	2.7	3.1	2.9
Rawalpindi	...	1.2	1.1	0.9
Attock	...	1.9	1.9	1.8
Jhelum	...	1.5	1.5	1.2
Shahpur	...	2.1	2.2	1.8
Gujrat	...	1.2	1.2	1.0
Gujranwala	...	1.7	1.5	1.3
Sialkot	...	1.0	1.1	0.8
Sheikhupura	...	1.6	1.5	1.1
Lahore	...	1.5	1.3	1.1
Montgomery	...	1.4	1.7	1.1
Lyallpur	...	1.7	1.5	1.0
Jhang	...	1.4	1.6	1.4
Mianwali	...	1.7	2.8	2.6
Dera Ghazi Khan	...	1.6	2.4	1.8
Muzaffargarh	...	1.3	1.3	1.3
Multan	...	1.4	1.6	1.2
Bahawalpur	...	1.1	2.2	1.7
Upper Sind Frontier	...	2.0	2.9	2.7
Larkana	...	1.2	1.5	1.9
Sukkur	...	1.0	2.2	1.9
Khairpur	...	N.D.	N.D.	1.8
Nawabshah	...	1.1	2.6	2.7
Dadu	...	1.1	2.2	2.6
Hyderabad	...	1.1	2.6	2.8
Thar Parkar	...	2.3	5.4	4.2
Tatta	...	1.1	2.7	2.8
Karachi F.C.A.	...	1.1	2.7	1.2
Baluchistan Districts	...	N.D.	1.4	2.3
Baluchistan States Union	...	N D.	N.D.	N.D.

N.D. = No data.

N.B.—The new districts formed after 1911 were carved out of the larger old districts. For such districts the data in the Table for the dates prior to their formation are of the parent districts. In case the new district was carved out of more than one original district the acreages given in the Table for the dates prior to its information are the averages of the figures of the parent districts.

[1] K. U. Kureishy, *ibid*, p. 391.

[2] Total cultivated acreage from which cultivated acreage per head of rural population was calculated for the districts of Baluchistan refers to 1949, and for those of Sind to 1946.

TABLE 7[1]

Large Industrial Establishments of West Pakistan (excluding Baluchistan province, and the states of Bahawalpur and Khairpur), and the number of workers in these Establishments, 1901-1955

Year		Number of establishment	Average daily number of workers in all the establishments taken together.
1901	...	74	10,407
1911	...	203	24,485
1921	...	306	48,485
1931	...	483	49,063
1941	...	760	102,021
1955	...	1,049[2]	87,184[2]

[1] K. U. Kureishy, *ibid.*, p. 455.

[2] Data of Punjab Province alone.

GEOGRAPHICAL RECORD

THE tenth annual session of the Pakistan Science Conference was held at the University of the Panjab, Lahore, between 10-15 March, 1958. The University Department of Geography was the venue of the Section of Geography, Geology and Anthropology. The office-bearers of the Section were:

President : .. Dr. E. R. Gee, Director, Geological Survey of Pakistan, Quetta.

Sectional Secretary : .. Dr. K. U. Kureishy, University Department of Geography, Lahore.

Local Secretary : .. Dr. (Miss) M. K. Elahi, University Department of Geography, Lahore.

The presidential address of the Section was entitled "The role of Geology and the Allied Sciences in the Economic Development of Pakistan."

Over 25 papers were read in the Section on geographical, geological and geophysical aspects of Pakistan. The geographical papers included:

(*i*) Kazi S. Ahmad .. Natural gas in Pakistan.

(*ii*) M. I. Siddiqui .. The study of settlements on the Karachi coast.

(*iii*) Mubashir L. Khan .. A preliminary study of the atmospheric temperature in West Pakistan.

(*iv*) Mubashir L. Khan .. Secular and periodic variations of precipitation in West Pakistan.

(*v*) M. M. Memon .. Al-Beruni and his contribution to the Mediaeval Muslim geography.

(*vi*) I. H. Zaidi .. Muslims in the Philippines.

(*vii*) A. Ullah .. Irrigation in the Malir Basin.

(*viii*) A. A. Bahadur .. A geographical analysis of the problem of water supply to Greater Karachi.

(*ix*) Asrar Ullah .. A geographical survey of Parachinar area.

(*x*) A. R. Khan .. River piracy and diversion in the Karachi Basin.

(*xi*) Miss M. K. Elahi .. Development of factory industries in Lahore.

(*xii*) K. U. Kureishy .. Some aspects of urbanization in West Pakistan.

Two symposia were held on (1) "Mineral resources of Pakistan" and (2) "South East Asia", the latter under the auspices of the Pakistan Geographical Association. A public lecture was delivered by A. E. Day on "World Oil potentials with special reference to Pakistan."

KUK