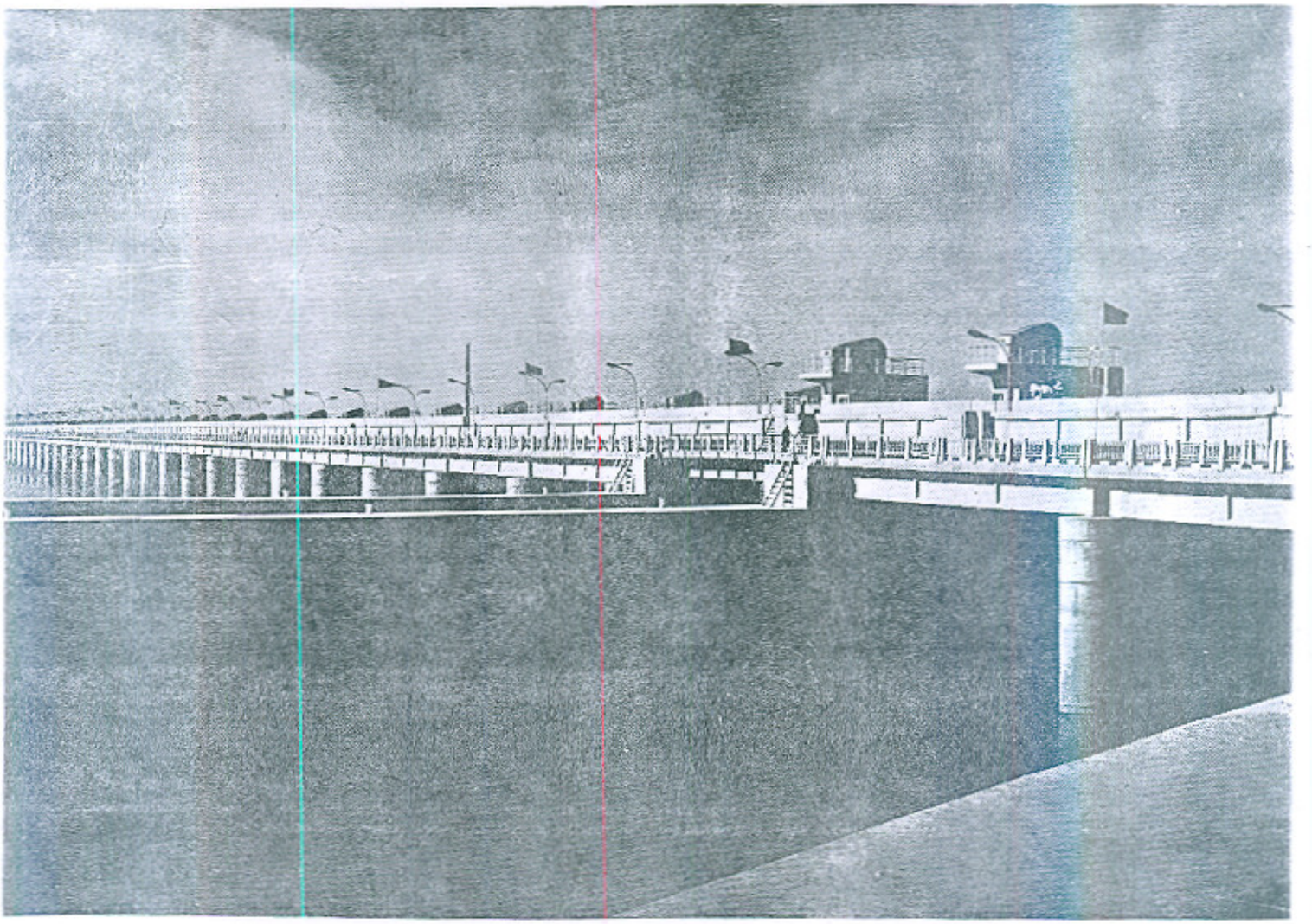
ENGINEERING NEWS

QUARTERLY JOURNAL OF THE WEST PAKISTAN ENGINEERING CONGRESS

Vol. VIII ○ March 1963 ○ No. 1



GUDDU BARRAGE HARNESSES THE MIGHTY INDUS

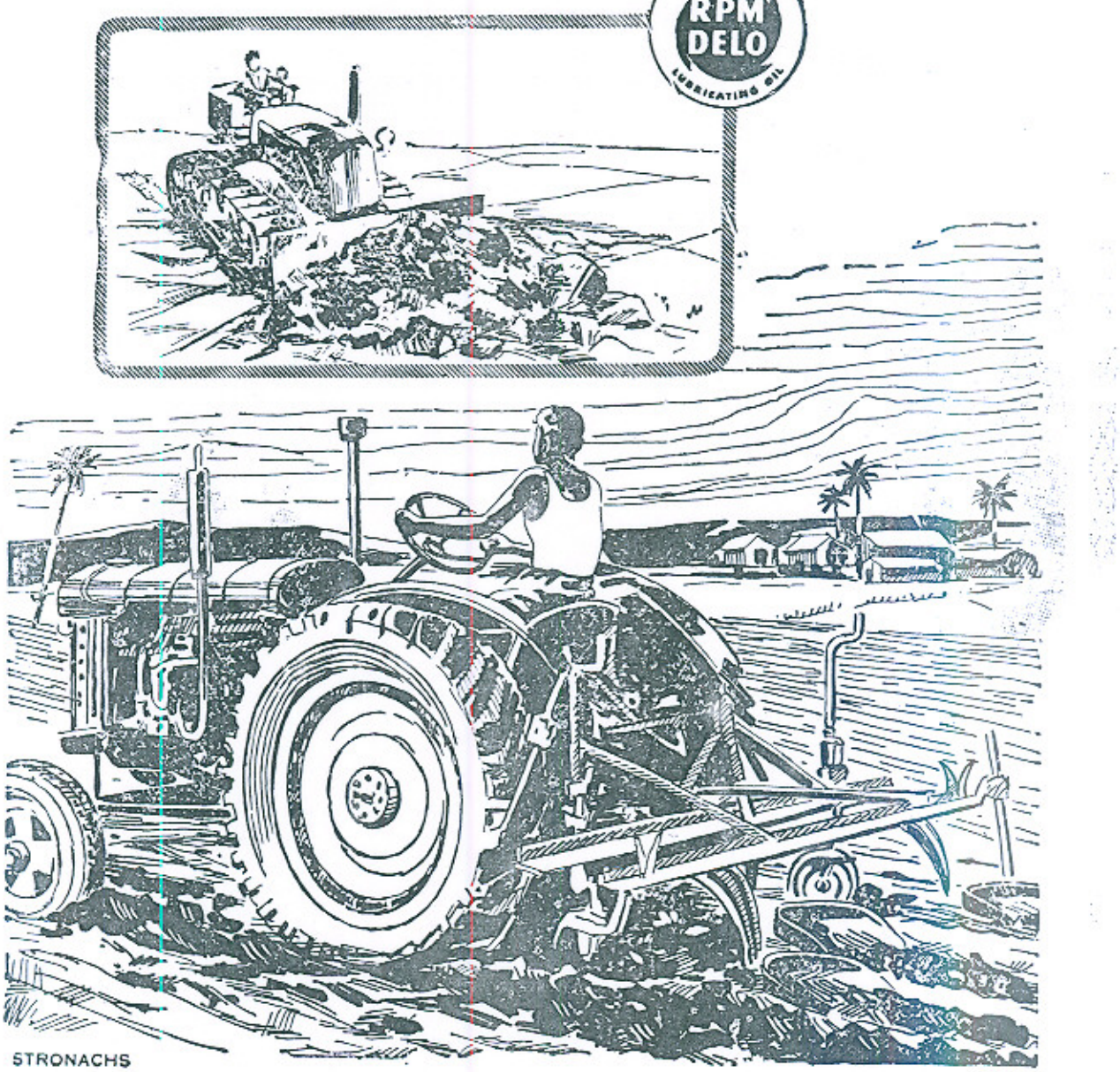
For operations to Cost a minimum

You are advised to select an oil, more refined, better designed to handle rugged operations and get all the advantages, ensure more profit and greater dependability.

HI-SPEEDOL
DIESEL FUEL

To prevent rust and minimize engine wear, specify Caltex RPM Delo—a well known name for satisfactory lubrication and performance of all diesel Engines.

DIESEL ENGINE **RPM DELO** LUBRICATING OIL



STRONACHS

G/124

CALTEX OIL (Pakistan) LIMITED

The Liability of Members is Limited

Editor :
Dr. NAZIR AHMAD
Assistant Editor :
AMAN ULLAH KHAN
MIRZA ABDUL LATIF
M. H. SAEED AHMAD

● All communications should be addressed to the Editor Engineering News, P. W. D. Secretariat, Lahore (W. Pak.)

● Price Rs. 2/- per copy Rs. 6/- a year in advance. Free to members of the West Pakistan Engineering Congress. Changes of address should be intimated promptly giving old as well as new address.

● Contributions to this journal in the form of articles, news of engineering works, news about engineers, photographs and technical data etc. are cordially invited.

● Reprints from this journal be made on condition that full credit is given to the Engineering News and the author and the date of original publication is stated.

● West Pakistan Engineering Congress is not responsible for any statements made or opinions expressed in this journal.

● Advertisements are accepted at the following rates :—

	Rs.
Back Cover, Outer Page ...	300
Front Cover, Inner Page ...	250
Back Cover, Inner Page ...	200
Full Page ...	100
Half Page ...	60

PRINTED AT
RIPON PRINTING PRESS LIMITED
BULL ROAD, LAHORE

EIGHTH YEAR OF PUBLICATION

ENGINEERING NEWS

Quarterly Journal of the West Pakistan Engineering Congress

VOL. VIII MARCH 1963 NO. 1

In this issue

Foreign Consultants in Pakistan

On many occasions during this quarter of the year, the President of Pakistan, Field Marshal Mohammad Ayub Khan, had exhorted the engineers and scientists of the country to improve the standard of scientific research and technology and to make the best use of the indigenous talent and resources.

At the time of inaugurating the 15th All Pakistan Science Conference in Lahore, he strongly impressed upon the engineers and the scientists of the country to catch up with the advanced nations of the world in research and technology. He remarked that, being a new and developing country, we have to bridge efficiently and quickly the wide gulf that exists between us and the highly developed countries of the world. Education is a major factor in the economic growth of a country. In fact, scientific education and economic development go hand in hand. To build our bridges and dams, to multiply our sources of power, to build industry, to exploit natural resources, to modernise and improve the quality and quantity of our crops, to fight waterlogging and salinity, we stand in need of a large number of highly trained and qualified scientists and engineers of our own.

While opening the Guddu Barrage the President was pleased to learn that the grand project had been designed and built by the engineers of Pakistan. He praised Mr. Kazi, the brain behind the design as well as construction of the huge undertaking. Evidently, if given a chance, Pakistani engineers are capable of proving their genius. Recently, the President inaugurated the Rechna Salinity Project. When, on this occasion, Messrs Tipton and Kalmbach of Denver, the consultant firm on the design of tubewells, Messrs Minor and Minor of Greely, U.S.A., the firm entrusted with electrical transmission and Messrs Harold Smith of America, the contractors who installed the tubewells, were presented to him, he was quick to remark: "It is all very well to say that such and such contractors have done creditable work, and I congratulate them. But at the same time we must remember that we have got to train our own manpower and develop our own industry to continue this work so that they have a pride of performance and they take personal interest in these things just as was witnessed recently when the Guddu Barrage was opened. I was very happy to hear that the whole project was conceived by our own engineers, especially Mr. Kazi, and that it was executed by us is a matter of great pride. I hope and I am sure that we have the talent in the country and it is going to be well developed to be able to undertake task of this magnitude".

He further said: "We have to develop indigenous industries so that our own contractors, our own manufacturers and so on, produce the necessary gadgets and learn the necessary know-how, to ensure that the resources are kept within the country to produce the technical manpower that can handle such things; and I hope that the Wapda will always keep that in their mind".

Similar exhortations were made by Dr. Usmani in his address on "Science for Survival," although in a slightly different tone. He stated that "the administrator, to show 'achievement' and the industrialists, to make quick profit, employ foreign consultants, experts or advisers for preparing designs and specifications, calling tenders for machinery and installing the imported equipment under their supervision. Quite often the project is run by foreigners even after completion. This, Sir, not only raises the cost of the projects but at times leads to national wastage of resources and distorted development. Such wastage could be avoided if we had our own institutions for research. Very often we have paid a heavy price for depending upon these foreign "Experts" who ignored the advice of our own engineers and paid no heed to scientific research in designing and study of structures which should have preceded the construction of the projects."

The consultants, when employed, are committed to associate a certain number of Pakistan nationals with them and train them in the methods of their working, so that they may acquire the necessary know how for designing and executing engineering undertakings later on themselves.

The Warsak Dam was constructed by Canadians. Several Pakistani engineers were associated with the project but very few had any material contribution to make in the design and construction of the Mangla Dam on the basis of their previous training. Wapda has posted a number of engineers at Mangla. Are they associated with design and construction? Have they made any contribution? Have they been entrusted with jobs of responsibility and can the country expect them to acquire such knowledge as to build Tarbela or such other Dams themselves? We wish the conditions to be different from Warsak. There is one basic principle and that is, entrust a person with responsibility, give him the necessary facilities and the best in him will be brought out. When the present irrigation system was being undertaken, there were no theories, no principles and no precedents to follow while constructing these huge works, yet the engineers undertook the job resolutely and evolved the present world famous system. They did make mistakes, but they learned by experience. They succeeded in evolving new principles by which they could harness such mighty rivers as the Indus. Even after independence, when Pakistani engineers were entrusted with projects like the Ghulam Mohammad Barrage, the Taunsa Barrage, and, lately, the Guddu Barrage, they did succeed by dint of their own training and knowledge. From this it is clear that we have not only to produce capable engineers but also to entrust them with responsibility and impose full confidence in them, even if they make mistakes sometimes. Even the most experienced make mistakes. Pakistan is not yet fully developed. Its resources are limited. The standard of living of its inhabitants and their ways of working are in keeping with these conditions. Employment of a large number of

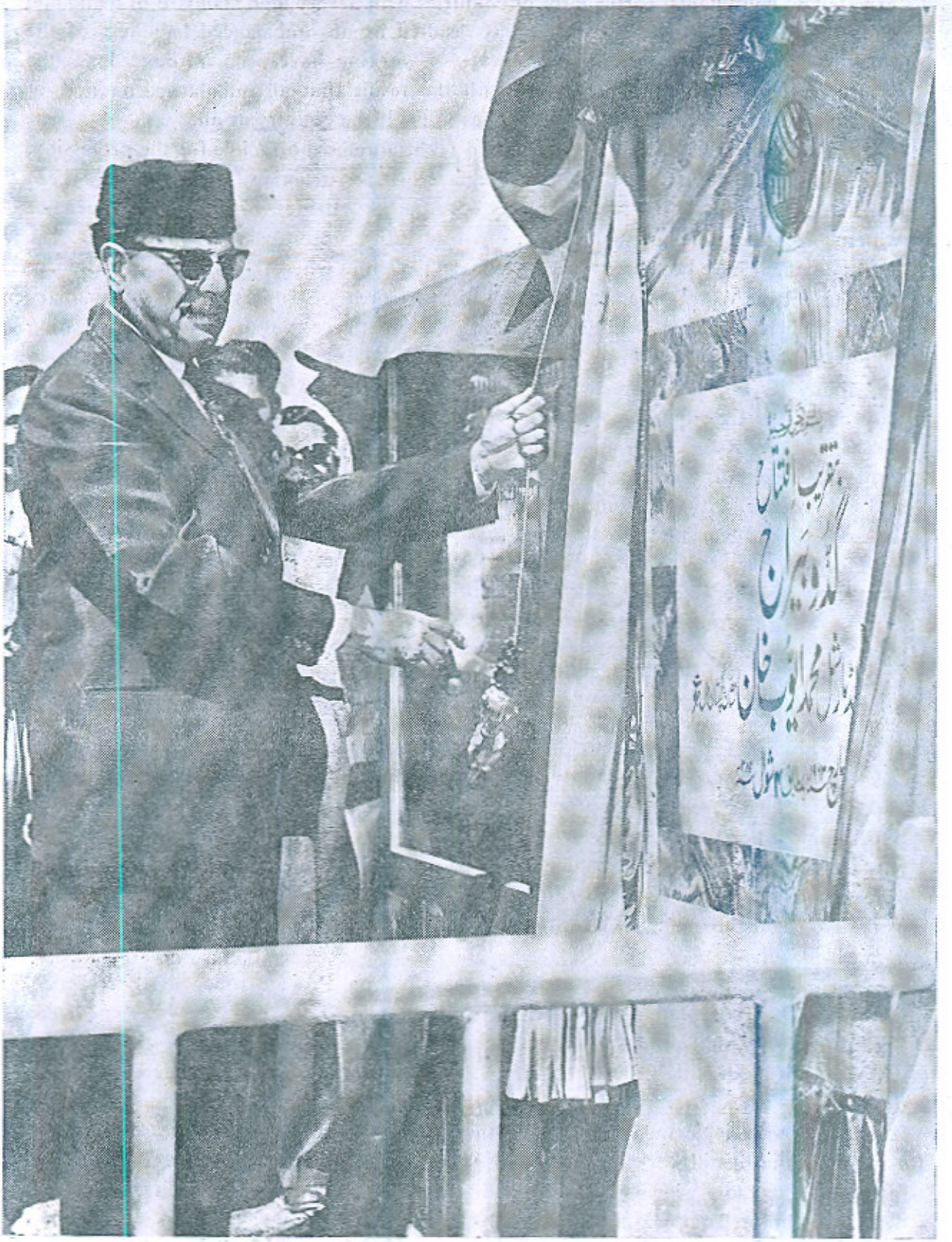
experts and consultants, particularly of countries with a very high standard of living and altogether different ways of working, has resulted in an unbalanced handling of the situation. At a few places, American ways of working have been introduced, yet the system on the whole has not changed, with the result that an unbalanced method of construction has been developed which does not suit the country at all.

Economy in Engineering construction is the foremost principle for the profession. During the last one hundred years of engineering construction, it has always been felt that departmental construction is very economical. Bringing in highly paid persons with much higher standard of living has considerably upset balanced economy. The works executed have become costlier. There was a time when the Government did not agree to get the Warsak Dam constructed for 14 crores of rupees but the Canadians constructed it at a cost of about 33 crores. Another recent example is the installation of 1800 tube wells at a cost of about 15 crores, so that each tube well has accounted for about Rs. 90,000/- and the tube well component alone has cost Rs. 50,000/- per well. The Irrigation Department could instal such a tube well for Rs. 30,000/-. We have to pay Rs. 20,000/- more per tube well only because we got them installed through a foreign firm of constructors. The designer of the tube well Messrs Tipton and Kalmbach, 'the consultants', had taken their consultation fee separately. Consultant to a 'consultant' combined has accounted for about 1.0 crore of fee in one form or another, While this project was in fact based upon investigations conducted by the Ground Water Organization, an American aided project, working more or less on American standards, has since 1954 spent about Rs. 10.0 crores. The share of expenditure on this project may thus be another 2.5 crores. The readers can work out the cost of Rechna Salinity Project No. 1 themselves.

قرض کی پیتے تھے مے اور جی میں کہتے تھے کہ ہاں
رنگ لائے گی ہماری فاقہ مستی ایک دن

The foreigners are here only for a short time. They are to finish the works and go, and the conscquences are to be borne by this country. Very often the constructional methods employed are unsuitable for the country. The failure of out-fall of Gujranwala Hydel fortunately took place when the consultants of this work were still here. Otherwise this failure would have been ascribed to the incapability of the Pakistanis to maintain the Project and a maintenance foreigner would have been called out.

The second example is that of the Rechna Project tube wells. Recently there have been some failures and Mr. L. B. Riggins, who worked as Manager of the Rechna Project with Tipton and Kalmbach has pointed out many defects which he said were not heeded to during his tenure with the consulting firm and which are bound to affect the efficient working of these 1800 tube wells. Can Pakistan afford the failure of even a single tube well costing more than Rs. 100,000/- and installed on the assumption that it will work for 40 to 100 years? Can these remarks not furnish food for thought to those who have given up the old tried system of entrusting work to a department in preference to a new untried one and are depending more on short staying consultants rather than their own nationals?



GUDDU BARRAGE
Its Engineering Features

by **A. RASHID KAZI**
Secretary, Irrigation and Power, Government of West Pakistan, Lahore.

Guddu Barrage is the third major irrigation work completed during the recent years to provide weir controlled supplies to extensive culturable lands in the ex-Sind area. It is the fifth barrage on the mighty Indus. The construction of this barrage at an extremely difficult site is another instance of the leadership of Engineering perfection of the country to construct barrages on sand foundation and to harness mighty rivers such as Indus. It is one more example of the talent of Engineers of the country where without foreign help, both technical and financial, a barrage has been completed from its design stage to the finish by Pakistani Engineers within a record period. In the central and final diversion of the river an engineering history was created in this country. In this article specially prepared by Mr. A. R. Kazi for the readers of the Engineering News, the main technical features of the Barrage are put forth.

The Guddu Barrage

In the year 1940, the Government of India decided to proceed with the construction of a high Dam at Bhakra. This combined with the heavier withdrawals of waters in upper riparian areas threatened seriously the working of the inundation canals in the upper and lower Sind. Two Barrages were therefore, proposed, one at Kotri and the other at the northern end of Sind Province. Work, however, could not be commenced until independence in 1947. Later in 1953 while work was still in progress on the Ghulam Mohammad Barrage, the Government of Sind in consultation with the Government of Pakistan decided to start the upper Sind Barrage, generally known as the Guddu Barrage after the name of a dead channel of the Indus. This was the third Barrage for the ex-Sind Province. The earliest one was the one at Sukkur completed in the year 1932. It provided guaranteed supplies to 7.5 million acres of land in the middle Sind. The second, Ghulam Mohammad Barrage near Hyderabad was completed in 1955 for the lower Sind area of 2.7 million acres of culturable commanded area.

Important Features

The design of the latest structure has many unique features. The most apparent, above the water level is the absence of steel frameworks or of counter balances for the gates. The gates are power driven intro-

duced for the first time in this country to save foreign exchange. These were designed by Dr. Max. Laufer of Dinglerwerke, Germany and promise a new approach in the use of such equipment.

The Barrage is 4,445 ft. long. It is the second largest barrage in Pakistan next only to Sukkur in overall length, but is the deepest one in Indo-Pakistan continent. The Barrage has seven spans of 60 ft. each on the right pocket, three on the left pocket and 54 spans constitute the main weir. There is one lock channel 50 ft. wide and 270 ft. long. A typical cross section of the weir and the pockets is shown in Fig. 1. The Barrage has two fish ladders. It is designed to allow a maximum flood discharge of 1,200,000 cusecs and a super flood discharge of 1,400,000 cusecs. The recorded maximum flood discharge at this site is 1,100,000 cusecs. Minimum winter discharge is only 20,000 cusecs. The height of the Barrage gates is 20.5 ft. on the weir and 22.9 ft. on the pockets. The pond level is fixed at R. L. 255.5.

The Location of the Barrage

The location of the Guddu Barrage along the Indus to serve the 2.7 million acres of lands in the upper Sind caused a greater controversy than has been the case on any similar Project. Various schools of thought showed advantages of locating it elsewhere than where it is now built. One section strongly advocated its location some 60 miles upstream, near Mithankot, showing advantages of command and hydel power. After many deliberations and studies of the economics involved, which can form a subject in itself, it was decided to position the new structure at the extreme northern tip of ex-Sind Province. The next problem was the actual siting in the wide meander belt

GUDDU BARRAGE
WEIR SECTION

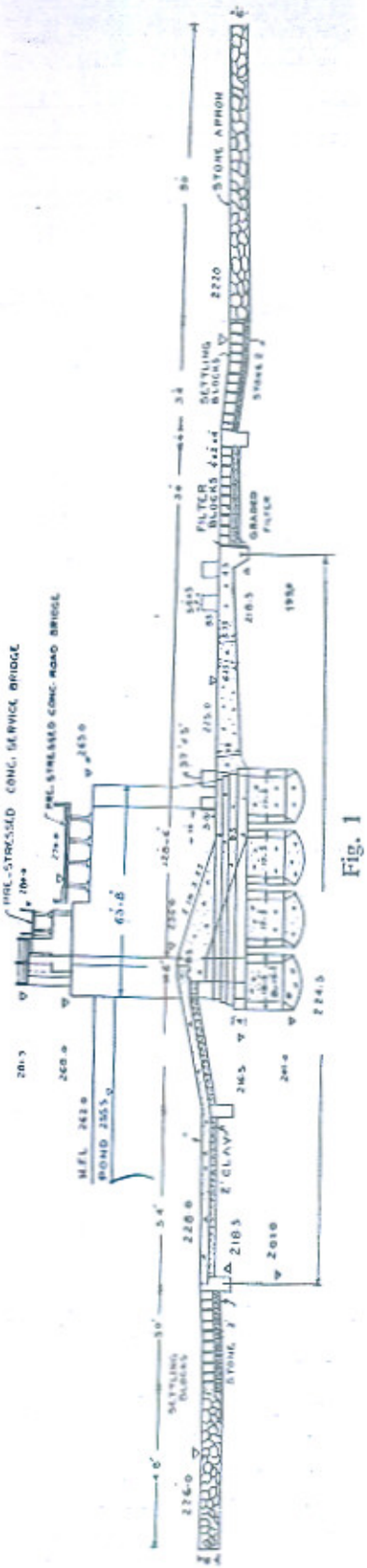
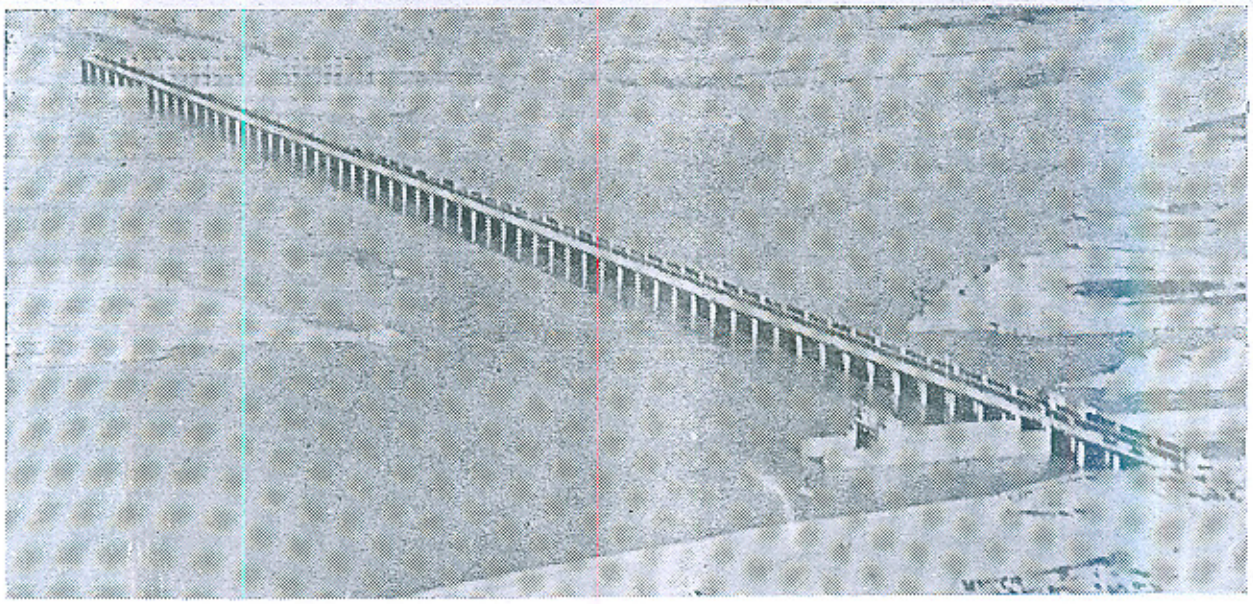


Fig. 1



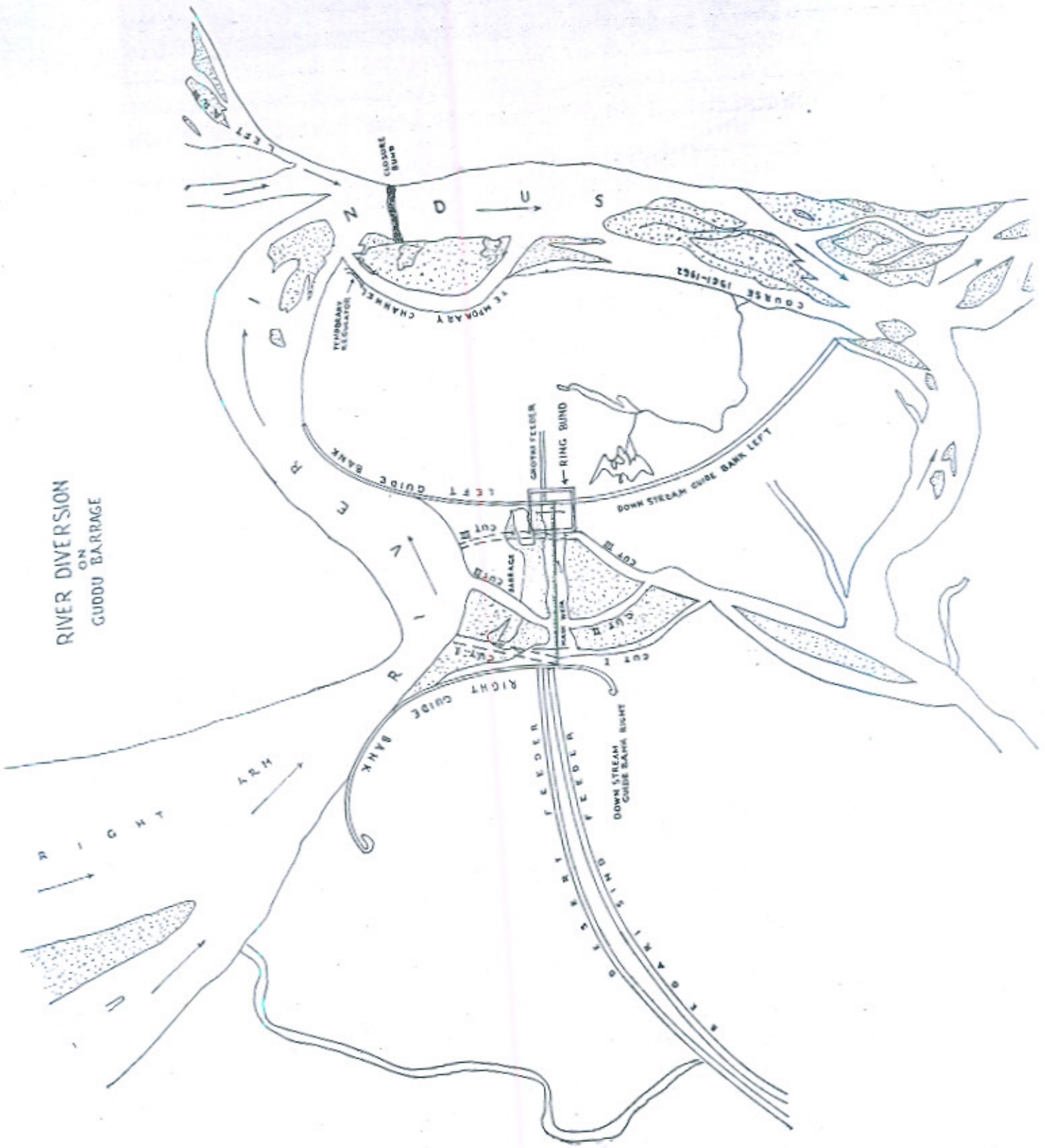
Guddu Barrage, also showing the Navigation Locks and Right Side Canal Regulators.

of the river. Constructional problems and future operations of canals had to be weighed. For the first time in the history of construction of such barrages, the structure was decided to be located on the main axis of the river course which it had followed during the last 40 years. Such a siting involved heavy river training works, both difficult and time consuming and a great risk throughout the construction period.

Up till now over 14 barrages or weirs have been built on the Indus system. The ex-Punjab practice has been to locate the structure on some creek of the river and to divert the river through the structure on completion. Where river flows in a valley or the main offtakes so justify, the location of a structure in relation to the river's course can be a flexible proposition.

Where river enters the deltaic region or flows on a ridge of its own formation of fine sand and silt, in a wide meandering belt, with offtaking channels on both banks, a very careful thought has to be given to the future operations of canals. The Guddu Barrage had many such problems and a bold decision had to be taken to locate the structure on the mean axis of the river in order to cause least silt trouble in the future on the canals system.

The decision to locate the structure on the mean axis of river called for unprecedent constructional problems of pushing out the river from the normal course and of keeping it away during the construction period and guarding all the time against dangers of erosion. In fact during the third year of construction, the river almost took away the entire two seasons work. An important group of engineers wanted the location of the Barrage changed at that stage to follow the traditional practice of building it on the dry. Foreign consultants and contractors


RIVER DIVERSION
ON
GUDDU BARRAGE
INDUS
RIVER
CLOSURE BUND
LEFT
RIGHT
ARM
TEMPORARY REGULATOR
COURSE 1961-1962
RING BUND
GHOTKI FEEDER
LEFT GUIDE BANK
DOWN STREAM GUIDE BANK LEFT
CUT III
CUT II
CUT I
MAIN WEIR
BARRAGE
RIGHT GUIDE BANK
DOWN STREAM GUIDE BANK RIGHT
KASHMORE FEEDER
GHOTKI FEEDER

insisted on the services of more than 125 experts besides other facilities to carry on the work on a cost-plus basis. All this was resisted and the work was continued by the determined Pakistani project officers as planned, to the surprise of many. The river was kept under control to the end. The problems of its diversion back through the new structure posed some equally difficult problems.

Extensive model tests helped plan many protection measures and to take positive decisions that proved workable even though difficult.

Dewatering of Foundations

This barrage is the deepest so far constructed in this country, the capping of the wells or caissons under the piers being 45 feet below the flood level outside the coffer dam. A deviation had to be made from the normal practice of dewatering the foundations through open sumps. Instead, open tube-wells and wellpoints were resorted to, enabling concrete being laid under almost ideal conditions. This method, though costly, improved the quality of foundation work, provided a check on the soil bearing pressures, avoided artificial fills, uncertain compaction and gave considerable ease of working on a dry bed. It was also possible to save on the depth of steel sheet piles, thus saving on foreign exchange.

Canal System

Three canals take off from the Barrage—two of them on the right bank. The Desert Canal is designed to carry 13,275 cusecs while the capacity of Begari Sind Feeder on this very bank of river is 14,784 cusecs. The left bank canal called the Ghotki Feeder has a discharge of 8,390 cusecs. The Head Regulators of all the three canals have capacities greater than the designed drawoff at 36,429 cusecs.

Total length of the main canal is 482.1 miles, the Desert Feeder including the Pat Feeder canal being 208.0 miles, Begari Feeder and Begari and Sind Canals 190.5 miles and the Ghotki Feeder 83.6 miles. The length of the main branches is 321.1, 191.7 and 181.1 miles respectively and sub-branches equal to 308.2, 463.2 and 446.6 miles for the three canals in the same order.

The construction work on canals, branches and distributaries, included road bridges, regulators, falls, syphons, aqueducts and railway bridges as is shown in the following table. The work on these proceeded simultaneously with the Barrage:—

Particulars	Desert Feeder including Pat Canal	Begari Feeder	Ghotki Feeder	Total
Road Bridges over branches and sub-branches ...	139	126	92	357
Road Bridges over minors and distributaries ...	118	148	180	446
Head regulators and cross regulators ...	158	292	139	589
Falls on Feeder Canals ...	14	1	13	28
Syphons ...	1	...	...	1
Aqueducts ...	...	...	1	1
Railway Bridges ...	1	19	16	36

Unique Technical Achievements

Apart from the constructional and technical difficulties faced and resolved successfully during the four and a half year of enthusiastic work on the job round the clock, the final year's achievements have been unique in many respects.

The diversion operation is normally attempted, for a chance of success, during the low flood periods of winter months. At Guddu, with the maximum of efforts, the Barrage could be brought to completion up to

the last but six spans on the left (that included the huge lock span), up to the end of December, 1961. There was little hope of completing the entire Barrage before April or May, 1962.

The river course in that season was favourable for a diversion in respect of its right arm branch only carrying 75% of the river flows. A left arm of river starting 16 miles upstream joined the main river some 2½ miles downstream of the position where the right arm crossed the mean axis of the Barrage.

Three major decisions had to be taken:—

(*i*) To go in for a river diversion that very season through a partially completed structure and risk an earthen cofferdam against failures because it was to rest in part on the concrete floor without adequate bond. Such a diversion had never been attempted before.

(*ii*) To locate the closure-site some two and a half mile downstream of the place where leading cuts would be given. The closure sites would have to stand an extraordinary afflux to enable the river to flow in reverse direction for over two miles.

(*iii*) To depend on a temporary regulator of a far smaller capacity than normally provided because there was no time to build a bigger one. Further to locate the temporary regulator at a site different from the one indicated by model tests. This decision was also necessitated by the time factor only about 2 months being available within which to complete it as well as to excavate a long tail channel of 10,000 cusecs.

All these decisions were successfully implemented because of almost ideal planning and a clear conception of all that was involved. The river was successfully diverted through the partially completed Barrage by the middle of March, 1962 with 25,000 cusecs in the river. The rest of the work inside temporary cofferdam enclosing last 12 bays was completed before May, 1962 to provide controlled supplies to the entire canal system one year ahead of schedule.

In these respects a history was made.

Stone Transport a Problem

Arrangements for the transport of about 40 million cubic feet of stone for the Barrage, the guide banks and diversion of river presented a major problem. Initial supplies were slow because of the new railway track of 75 miles in between Jacobabad and the site. The maximum amount of stone was thus needed during the last three months. The Pakistan Western Railways did a commendable job to haul the entire needs over 150 miles through three train loads a day from right bank *via* Jacobabad and supplemented it by a train-load a day from the left bank. The last position involved an additional road transport of over 32 miles by trucks.

Benefits

The estimated cost of the Project is Rs. 474.8 million of which the Barrage accounts for nearly 200.0 million rupees. The system will irrigate a gross commanded area of 3.25 million acres of which culturable commanded area is 2.73 million acres. This command includes about a million acres of virgin soil with Kharif irrigation intensity of 75%. An area of 0.225 million acres is reserved for forests. The entire command is non-perennial. The main crops will be rice, millets, maize, cotton and sugar-cane.

The late floods of each season are proposed to be utilized for giving a heavy flooding to the soil in October that will produce what is called 'Bosi' Rabi cultivation. If water is available in excess of the prescribed quota of lower barrages, or when storages higher up so permit, further waterings could also be given to the Rabi crops.

The possibilities of increasing the command as and when more water is available from storages or tubewells are very promising on this project.

In pre-barrage period when this area depended on the inundation canals, the cultivation raised was as follows. Rice 2,69,763 acres, Dry Kharif Crops 2,62,849 acres, Bosi Rabi 1,80,643 acres and Dubari 2,31,507 acres. It is expected that on full development, the cultivation will increase to rice, 8,54,107 acres, Dry Kharif 7,94,731 acres. Bosi Rabi 2,01,557 acres and Dubari 1,00,054 acres. In terms of food grains, in million maunds, it will amount to—Paddy 7.88, Dry Kharif, 3.39, Bosi Rabi 0.52 and Dubari 0.63.

It is estimated that in its fourth year of operation, the Project will provide a return 4.4 per cent; in its 10th year, a return of 6.9 per cent and on full development a return of 12.6 per cent. The provision of Barrage has saved the inundation system from complete failures of the crops because of the heavier withdrawals in upper riparian, and storages created such as Bhakra. Many other developments will be guaranteed in the area as a result of increased agricultural activities, thus raising the standard of living for the inhabitants.

No Foreign Consultants and no Foreign Aids

The Project has been financed out of the resources of the Province without any foreign aids. The Pakistani engineers on the job developed a design that reduced foreign exchange component to the minimum.

The work was executed through departmental forces without any big contractors, the exceptions being the one for supply of gates and gearings and another smaller one for the pre-stressed concrete deckings for road and regulators bridges. The United Nations Technical Assistance Programme provided three to five foreign engineers and work-superintendents primarily to supervise the concrete work.

This Project is another example of the capabilities of Pakistani Engineers. Given confidence and opportunities the Pakistani engineers can achieve a lot. In the design and construction of irrigation works by traditional methods our engineers carry a pride of performance. There is a know-how, the ability and above all the zeal to work even under the most trying conditions of unclaimant weather, temperature rising to nearly 125° F and all the adverse conditions of wilderness.

The Project was initiated and undertaken by the Irrigation Department of ex-Sind Government and continued to be handled by the Irrigation Engineers of West Pakistan until its completion.

Low Cost Housing

by **ASHFAQ HASAN***
M.Sc. Engg. (London).

Introduction

The 'Low-Cost-Housing' is a popular demand throughout the world. This slogan has been taken so far in Pakistan that the meanings implied are being taken as 'No-Cost-Housing' instead. Every country and every nation in the world is endeavouring to produce cheaper and better accommodation to meet the housing shortage. The task of housing millions of our people is a colossal one, both for the Urban and the Rural population. A large influx of refugees at the partition aggravated the housing shortage. According to the first plan, the refugee population alone needed 5,00,000 dwellings in Pakistan which would need enormous resources and many years of house building activity. In fact the problem is more grave and indeterminate than merely of making up the above shortage because of the explosive rate of our population growth, which alone would require about 4,00,000 dwellings annually.

The relation of house to the happiness of an individual and the well-being of the country is vital. Every family in the country is deeply concerned. It is the house which largely makes the degree of health, comfort, happiness and efficiency of an individual and on the performance of an individual depends the performance of the whole nation. Yet, for several decades both in respect of quantity and quality of housing, no progress has been made in the country as a whole. Truly speaking, the conditions have worsened considerably especially in the Urban Areas and for Low Income Groups due to steep rise in land values, shortage of building materials and ascending cost of construction.

How to Reduce the Cost ?

The cost of construction can be reduced in three ways. Firstly, by avoiding any wasteful expenditure; secondly by economising in the materials and labour in construction and thirdly by better planning. The new suburban buildings and even some of the private urban buildings are often characterized by lack of design and construction, excessive use of expensive building materials and inadequate planning for use of land. A majority of our dwellings are being constructed on the advice and guidance of mistries who tend to err towards safety owing to lack of technical knowledge and confidence. Such products can easily be noticed because of their monstrosity in architecture. This trend is not happy by any means. It always pays in the long run to requisition the services of an Engineer for structural design and an Architect for planning. Any money spent on the advice

*Director Building Research, 2-Lake Road, Lahore.

of experts is returned to the client manifold.

The economy in materials can only be achieved after studying the performance, properties and the function to be performed by each unit. Since the materials consume as much as 75% of the outlay on building, this aspect deserves more careful consideration. It has hitherto been understood that the only way to reduce the cost of construction is to lower the specifications and sometimes it is done at the cost of performance or life of the structures. Such economy is in fact wasteful and can only render momentary satisfaction. The real economy lies in saving expenditure without lowering structural efficiency or its life. It would need years of research to find a complete and correct solution. However, on the basis of knowledge so far available the following suggestions are put forth for consideration:

(*a*) *Doors and Windows.*—The openings in the doors and windows cost six to seven times that of a dead wall and should therefore be reduced to a bare minimum. The present trend of providing excessive window areas for ventilation and light is based on the Western climate and ideology. The conditions in our country are different. The day-light factor is so high that more frequently the glazed windows have to be covered with thick curtains especially in summer. Besides, the glass panes allow a direct passage to the incident solar radiation to the interior. It has been estimated that 88% of the heat is conveyed to the interior by the clear glass panes as against less than 25% in the case of 9" solid wall. The proportion of solar radiation absorbed by glass panes is only 3% while the losses are almost negligible. A reduction in window areas would therefore not only improve thermal comforts but will also reduce the construction cost. Here, it is relevant to say that the present building byelaws which provide a minimum of 25% openings need revision and reduction. These byelaws are based on Western concepts and climate and should be amended to suit our climate.

(*b*) *Timber.*—The timber shortage is posing a serious problem to the building trade. The quality of timber available is much below standard and its cost in West Pakistan has registered an increase of 6 times the price level that prevailed before the war. The irony is that the forest reserves are so limited and there is no hope of the situation easing in any foreseeable future but a ray of hope appears in utilizing the surplus timber of East Pakistan. Coming to the brass tags, the present-day cost of Deodar is Rs. 13/- to 15/- per cubic foot, in logs while East Pakistan timber of reasonably good quality like 'Garjan' and 'Treated Civit' can be made available here between Rs. 8/- to Rs. 9/- per cubic foot. The cost of joinery can thus be reduced by about 33% merely by exploiting the East Pakistani timber. Some private enterprise should come forward in this trade which promises quite a future.

(*c*) *Masonry.*—The masonry shell in a building consumes about 25% of the outlay. The reduction in the cost of this item is possible by adopting thinner wall sections and reducing the height of rooms. The research abroad has shown that the indoor temperatures depend on the type of roof construction rather than the height of ceiling. The low ceiling may only provoke a psychological dislike for some time but it is bound to vanish with the passage of time. In ordinary dwellings a height of 9-10 feet should be sufficient.

It has been seen in the course of analysis that the bricks in the masonry are much understressed and the factor of safety is, as high as, 40. There is sufficient scope for economy in bricks. The best answer lies in adopting perforated bricks which will not only reduce the construction cost but will also improve thermal comforts. But their production is solely dependent on the mechanical plant requiring a huge outlay in foreign exchange. It may not therefore be advisable to switch over to complete mechanization at the present juncture. The new bricks developed by the West Pakistan Building Research would reduce the cost of the brick masonry by about 15%. The normal size of new bricks is $8'' \times 4'' \times 4''$ as against $9'' \times 4\frac{1}{2}'' \times 3''$ in the present bricks. These bricks will also reduce the consumption of mortar besides increasing productivity and decreasing the thickness of walls.

(*d*) *Roof.*—The roof is another expensive item in the building and lot of economy is possible by proper designing. The old conception of adopting mud roofs is slowly being replaced by the modern Reinforced Cement Concrete roofs owing to paucity of timber and durability of reinforced concrete. It has been seen that the present tendency of using flat reinforced concrete slabs for roofs is an expensive resort as their cost ranges from Rs. 3.50 to Rs. 4/- per sq. ft. On the other hand, a beam and slab combination will cost Rs. 2.75 to Rs. 3.25 per sq. ft. which raises a controversial issue of 'aesthetics'. This can be solved by adopting a series of beams at 3′ to 4′ centres and fixing a ceiling underneath, of which a great variety is available in the market. The cost of such a roof structure is not likely to exceed Rs. 2.50 per sq. ft. and in effect this will give a flat ceiling underneath.

The adoption of 'Zed Tiles' for roofs will also reduce the construction cost considerably. Such tiles have recently been developed by the West Pakistan Building Research. The use of these tiles will reduce the consumption of steel by 60% and that of concrete by 40% over conventional beam and slab construction giving a resultant saving of about Re. 0.50 per sq. ft. of plinth area.

(*e*) *Indigenous Materials.*—We are fortunate to have huge reserves of mineral wealth in West Pakistan which offers a great potential for use in building trade. Vast tracts of natural clay for brick making, a huge rocky mountainous region for stones and natural aggregates, the deposits of limestone for producing quicklime, the riverain tract charged with sand for building purposes form only a few instances of mineral deposits which can be put to use in natural form. Gypsum is also available in abundance in Pakistan but unfortuntely it is not yet being exploited for the building industry. Gypsum panels which are light in weight and have a pleasant finish can be used as a walling material in between load bearing columns. In more advanced countries, Gypsum panels finished with vinyl are being produced for general building use. This will be a new avenue for our industry and it is hoped that private enterprise will come forward to fill the gap.

The effort should be made to exploit to the maximum the locally available materials for use in buildings. For instance, if natural gravel is not readily available in any area for concrete work, we might resort to Reinforced Brick Work or develop expanded clay lightweight aggregates instead of carrying gravel from hundreds of miles. The Sangla Hill, Shahkot and Chiniot stone can also be used in concrete work around central area

of ex-Punjab to reduce the construction cost. Similarly, if sand is not available we might resort to 'no fines' concrete. The use of lime for building mortars and plasters should be popularized because it improves the qualities of mortar not only from workability point of view but also from structural point of view.

(*f*) *Factory Production and Standardization.*—It is universally acknowledged that the cost of construction can be reduced by a mass scale production of building components. The building as a whole can be divided into a number of units to be produced in factories for quick erection at site on the principle of prefabrication. These methods will not only produce better quality goods owing to controlled and uniform factory conditions but will reduce the erection time considerably. The new avenues to be explored are the wall panels, doors and windows, lintels and roof units etc. etc. These components can be manufactured from precast or prestressed concrete products or gypsum boards. The progress in this direction would primarily depend on standardization of various components as it will be uneconomical to establish a factory to produce a huge variety of dimensional units to suit each requirement and taste. As a first step towards standardization, it is necessary to adopt a reasonable module in building construction and a 4" (or 10 cm.) module may be adopted which will fit in accurately in linear units of feet, meters or yards.

(*g*) *Planning and Designing.*—The cost of construction can be reduced by better planning in the sense to avail maximum use of the common walls. A square planning in a house is cheaper than any other variation or open planning. Similarly, the placement of services like the bath rooms, kitchen and pantry which require water supply and sewerage lines has a considerable bearing on the cost of construction. If these rooms are placed close to one another and on the same side, the construction cost can be reduced. Similarly, the planning of a colony as a whole should be given a careful thought because a properly planned colony can reduce considerable development expense in the services. There are always a number of solutions to a particular problem but only one which may be the cheapest. Our resources are so limited that we can't afford the luxuries of West. The criterion of land use in relation to the covered area in a plot and the percentage area under residential plots in relation to that under roads and open parks must always be examined carefully. The present trend is dangerously shifting towards waste of expensive land and needs to be curbed. The need of the hour is for vertical planning rather than horizontal.

Necessity of Research

The real solution to the problem can only be found through sustained research. Even in the present stage of scientific advancement there are about 100 research organizations in various countries of the world continuing their research on buildings and its materials to suit their climate and customs. Some of these organizations are working since the last 40 years. The experience and research work done by others can guide and simulate better and cheaper housing but it can rarely, if ever, provide a ready made solution for all nations, for all climates and for all social customs of the world. Only by painstaking efforts can, methods best suited to the time, place and society be developed. This briefly explains

the reason for our slow progress towards cheaper and better housing. In fact, it would have been ideal to embark on research work on this applied science right from the day of Independence as was done in India. But the importance of research in this field has not been recognized till recently and a nucleus was created by the West Pakistan Government only in May 1961. This nucleus is not yet fully equipped by way of staff, accommodation or instrumentation to answer all the problems for the benefit of common man. The research in this field requires co-operation and participation of an Engineer who is responsible for construction and structural soundness, an Architect who conceives the layout and design, a Physicist to analyse the thermal performance and other physical properties of units and a Chemist to give chemical constituents of materials and advise on durability and suitability of a new material. Before closing, it appears quite appropriate to reproduce the following quotation from the report of United Nation Housing Mission to South and South East Asia in 1951, which also reflects the general belief in this country.

> "Often it is believed that a single agency or expert had developed a house of such a high standard and such a low cost that no further research is needed; no such magic formula exists."

Closure

The building is a complex structure involving a vast number of units. It is necessary to give a deep thought to each particular unit to bring down the construction cost as the cumulative effect of all the small savings can be substantial. The specifications for each item of work of a building to be constructed should be carefully drawn by the Engineer and Architect. The present practice of the departments to leave all the estimating work on the Draftsman is costly and wasteful; its evils have already come to be recognized. Some bold steps may be required to change the conventions and bring the Engineers out of their shrunken shells.

References

1. Low Cost Housing—*Economy in Wood Work*—publication of the Building Research, Lahore.
2. Developments of New Bricks and their Influence on Economy. Paper presented by the same author at the Science Conference in March 1963.
3. The Chosen Material of Thermal Selectivity: Glass by Raymond Ayoub —Extracts published in '*Ekistics*' of September, 1961.
4. Ceiling Heights in Tropics—Abstracts of Researches in various countries—Annual of *Architecture and Town Planning*, India, 1960.
5. Low Cost Housing in Asia by G. A. Atkinson of Building Research Station, England—'*Nirman*' Exhibition Number of March 1954.

Symposium

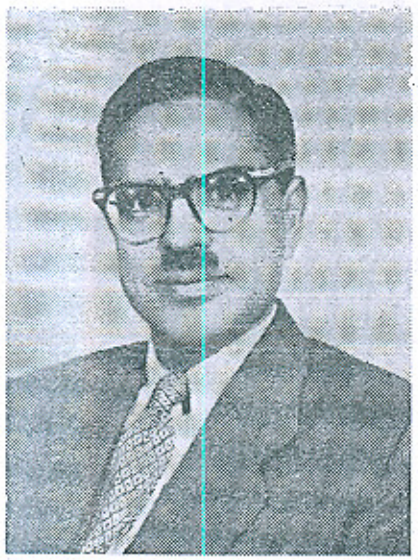
Modernization—Development of Water & Power Resources in Pakistan, March 4th—6th, 1963.

Thirty years ago, on March 4th, 1933, Franklin Delano Roosevelt, President United States of America inaugurated a peaceful social and economic revolution, unprecedent in history. One of his order was the authorisation of the development of Tannessy River Valley which brought prosperity to innumerable peasants of the region and great wealth to the nation as a whole. In memory of this great programme of Modernization in America, the United States Information Service organized a three days Symposium on the Water & Power Resources of West Pakistan from 4th to 6th March. The Symposium was inaugurated by Mr. A. R. Kazi, Secretary, Irrigation and Power followed by Dr. Charles M. Elkinton, Chief of Food and Agricultural Division A. I. D., Karachi who spoke on Economic Development in Prospective.

The subject of the 4th March Symposium was Water Potential of Pakistan and its Development. The speakers of the evening were Mr. Sarfraz K. Malik and Dr. Nazir Ahmad.

Irrigation Practice in Pakistan was the subject discussed by Mr. H. J. Asar and Sardar Allah Baksh and on the last day Chaudhry Abdul Hamid, General Manager, Power Wing, Wapda spoke on Development and Generation of Electric Power in Pakistan.

In this Magazine we have reproduced brief excerpts from the speeches of each participant.



Modernizing of Water and Power Resources

by **Mr. A. R. KAZI**
Secretary, Irrigation and Power, Government of West Pakistan, Lahore.

Mr. A. R. Kazi stated, it is a great privilege for me to be called upon to inaugurate a series of talks of the kind that start today. I am grateful to our friends from the United States Information Service for having shown me this honour. The reason for their choice may be my 30 years' association with Irrigation and Power Resource Development and my position as Secretary of Irrigation and Power Department ; otherwise there are many others who may have inaugurated the Symposium better. Under any circumstances it is my desire to contribute something that may be useful in its services.

National Resources Committee of Roosevelt

It is apt that we meet to discuss this subject on the thirtieth anniversary of that great personality Franklin Roosevelt, who is not only known to the world for the New Deal but who established in 1935 the National Resources Committee in the United States of America, that was a forerunner to the now famous T.V.A. Another Roosevelt had made his nation take a wider look at the water resources of that country in 1905 but the social and economic revolutions initiated by Franklin Roosevelt in 1933 stand before us as an excellent guide or the solution of Pakistan's difficult problems.

Largest Irrigated Lands of West Pakistan yet Imports Food

In West Pakistan we have taken pride in the largest contiguous system of irrigation in the world. It is also one of the oldest, having developed over many centuries. As needs of the people grew, project after project was added, thousands miles of canals were dug, diversion weirs and barrages were built to lead water to new areas, till we reached almost the end of our flow supplies. In spite of these ever increasing irrigation boundaries, the food grains produced in the country, could not keep pace with the demands of growing population. For the last decade we have been importing food grains; but the people are still underfed.

Integrated Use of Water and Power

The economy of this country is built around agriculture. Irrigation water provides the means and vocation to 80% of the rural

population who scarcely balance their family budget today.

On the power side, almost nothing was done to develop this resource until independence. It is often said the standard of a nation is judged by the per capita consumption of electric power. On this yardstick we stand in a very low category among the developed or developing nations of the world. We did not even utilize the falls along the canals for energy. The concept of multipurpose development of water and power resources has only recently been appreciated against the background of heavy shortfalls in our growing need for food and power.

Modernization of Water Resources

Modernization has wide implications when applied to water and power resource development. The subject of the Symposium has a special significance, in that we have to obtain the maximum returns from our limited potential.

We have realized that our approach to the utilization of the available resources has to be different from the stereotype projects undertaken previously. In this regard we have to emphasize on:—

(*i*) correct and complete assessment of all our resources of water and power ;

(*ii*) a correct assessment of our needs present and projected ;

(*iii*) systematic development according to a well conceived programme.

(*iv*) the scientific and optimum use of the gifts of the nature, direct or developed.

We have only recently appreciated that under-ground water is as much a reservoir of our water assets as storages behind high dams. Some of us have even started thinking in terms of creating artificial storages under-ground.

Modernization of Power Resources

On the power side a good start has been made. The completion of a single grid from the northern end of West Pakistan to Karachi in the south is well in sight. The Hydel Stations are all located or are to be located in the north. For these long distances the transmission voltages have to go much higher than 132 KV or even 220 KV. The discovery of natural gas has luckily made it easy to provide base or peaking stations at suitable locations in the net-work. However more research is needed. We are now obtaining the first 'net-work analyser' solely for research purposes. We have to catch up with the developments elsewhere in the world.

The use of nuclear power in this country is still in the planning stage. Within our limited financial resources there is not much hope for introducing costly nuclear power. The production methods are undergoing changes to evolve economic development. We need not, however, defer introducing nuclear power in a small way pending the last word in an efficient plant. Perhaps a small unit can be accommodated in the Southern Region, even it goes out of date very soon.

Modernization by Research

Modernization is an ever-developing process and the role of research to meet the challenge before us cannot be over emphasised.

Given proper studies, proper planning backed by research ; there is no reason why we cannot attain a high standard of technical know-how for our own problems which

where put into effect will not only make us self-sufficient but sustain us so in future as well. Perhaps we can export both food and power. It is a challenge that has to be met.

I am sure this symposium will provide the necessary initiative and incentive towards the development of correct ideas and ideals.

I once again thank the United States Information Service for providing me the opportunity of expressing a few of my ideas today.

I wish the Symposium a great success.

Economic Development in Prospective

by **DR. CHARLES M. ELKINTON**

U. S. Aid Programme

It was the post-war period that there came to independent statehood more than 40 new nations, one of which is Pakistan. All of the new states have high aspirations for improving the livelihood and the way of living of their citizens. However, many of the new countries were actually short, and still are very, very short, of technical skills and capital, both of which are so necessary for a major increase in production and an increase in the income of the citizens. It was in this general setting of the war-ravaged countries of Europe and the Far East, along with the new countries and the countries which are not new but which are greatly underdeveloped, that the United States moved on from the lend-lease programme which had been established by President Roosevelt in World War II, to the Marshall Plan and the Point Four Programme that has been carried on during the last decade and a half.

In 1948 you will also recall that the United States offered Soviet Russia the same kind of assistance that was offered to France, to Germany, to Austria and other countries of Western Europe. However, the Soviet Union and their satellites chose not to accept this assistance. Western Europe and Japan, of course, had the best reservoir of technical knowledge and the basic resources. Thus they quickly recovered to a state of economic viability and social stability. What has happened in Western Europe including Germany, and in the case of Asia Japan, is one of the wonders of the twentieth century, how rapidly these countries regained their level of production and income. This was, of course, as I have said, due to the fact that they had a great body of technically highly competent people as well as great resources,

U. S. Technical Knowledge and Food Surplus to be Shared

There is also a firm belief on the part of the American people that the technical knowledge and skills developed in the United States over many generations, can be and should be shared with the less developed countries that aspire to develop a better life for their people. For this reason, America has freely shared its technical skill and its rich abundance of food with countries that are in need.

This food is no longer viewed as surplus commodities but is viewed rather as a great asset and a true blessing to needy people who are short of food. Further, of course, the food assistance has in many countries served as the cornerstone for their programmes of economic and resource development.

The food, technical aid and capital elements of the assistance programme are always keyed into the development programmes and the essential self-help of the receiving countries, and this aid is given in support of the national objectives and aspirations of these countries. With the whole-hearted support of the American people, aid has been extended in this postwar period to about 100 countries without respect to race or religious faith. Many of the new and developing countries have used such assistance as the United States have been able to give very effectively and have achieved or soon will achieve economic viability, a good rate of economic growth and a steadily improving level of living.

Aid Only Till the Country Needs

Basically, we believe that no country would accept assistance from outside unless absolutely necessary in their particular stage of development. Western Europe, Japan, more recently Greece and Israel, have reached a stage of development which many say has an automatic growth factor built in. In other words the economy is very much on its own and does not need to rely on outside aid. Without listing countries I believe there are a number of other countries that are rapidly approaching this position, and I am sure that we will see in the years just ahead a very striking rate of growth in the Pakistan economy.

Developing Countries in Turn Become Aid Countries

At present Germany, Japan, Italy and France are a few countries, as well as the Food and Agricultural Organization, UNESCO, WHO are increasingly carrying a larger role in the assistance programme to the developing of African countries, which need large scale assistance. We of course are very pleased in the United States that these countries which we helped some years ago now have reached the stage where they are willing to extend a helping hand of economic aid to the less developed areas.

Our Belief

We believe that by a modest investment you encourage millions of common hard-working people to have a new hope and to strive harder to achieve their own objectives. We see on the horizon in this improvement, in this economic and social improvement on a very broad base among many many countries, a fortune in the future, the human dream of brotherhood of man.

Water Potential of Pakistan–Its Development

by **SARFRAZ KHAN MALIK**

In this article Mr. Malik has conducted a survey of the water resources of the country and the present trend at their utilization. This informative article was the first one to be read in the Symposium on Modernization.

If we open the almanac of the world we will find that Pakistan is known as world's largest jute producing country and has one of the largest and the finest irrigation system. In fact Pakistan has 33 million of contiguous acres under irrigation as compared to China which has 47 million acres, India 35 million acres and the United States of America about 22 million acres. Taking into account the percentage of irrigation to the gross area Pakistan is the most vastly irrigated country in all the continents.

Geography and Topography

Pakistan has an area of about 370,000 square miles, of which West Pakistan comprises of 310,000 square miles. Geographically and hydrologically the country provides striking contrasts to an observer. Its East Wing is the most thickly populated area having a population of over 800 persons per square mile while in the West Wing in the regions of Baluchistan the population does not exceed 8-9 persons per square mile. It has some of the world's most humid zones in East Pakistan yet in the Baluchistan the annual rainfall is sometimes nil in a dry year. Its northern areas join one of the world's highest mountain ranges of the Himalayas yet it is not devoid of deserts where equatorial temperatures are sometimes exceeded during the hot months.

Whatever be the geography and topography of Pakistan, one thing is evident that Pakistan is primarily an agricultural country where 77% of the people reside in villages and plough their land.

Economic Exploitation of Water Resources

In a country like Pakistan which is mostly arid and where the water resources are also meagre as compared to its land resources, this development is all the more important and Pakistani Engineers have not failed to realise this fact. The irrigation works already constructed in the past decade now utilise almost the entire perennial flow of our rivers so that any future development or improvement in the existing irrigation facilities can only be based either on conservation of flood flows which are wasted into the sea or on the development of water resources which have remained unexplored so far. It is, therefore, self-evident that a complete inventory of our water resources must be made before it is possible to plan its optimum utilisation. Water potential of Pakistan consists of the

surface water resources and the ground water resources. Both these resources depend for their recharge on the natural precipitation of the area which may consist of both rainfall and snow fall. For this purpose it is desirable that the various components of the hydrological cycle namely:—

:: precipitation both rainfall and snow fall, its amount distribution,
:: snow surveying above the (snow line),
:: river supplies,
:: ground water supplies,
:: quality of natural waters,
:: evaporation from free water surface,
:: infiltration and sub-soil flow, be adequately assessed before hand.

Importance of a Good Hydrologist

The role of a hydrologist is of utmost importance in national development, studying and measuring water resources of the country so as to present to the Government a complete picture of any catchment area showing:—

(1) where the water is, (2) how much there is, (3) what uses are made of it, (4) what uses can be made of it, (5) what the sources of water are, (6) where water can be stored for utilisation and (7) what relations exist between the known surface water resources to the natural precipitation of the area.

This background is essential for a clear factual picture before any development project can be taken in hand.

Problems of East Pakistan

In East Pakistan, as in West Pakistan, water is the most vital resource. The Province has abundance of rainfall during the monsoons and the flows of the East Pakistan rivers and ground water provide plenty of water potential. The land is rich and fertile and with provision of adequate irrigation and drainage could produce food supply in abundance. But high floods during rainy season cause loss of life, property and crops and of the total water supply during this season only a relatively small quantity can be utilised. The rivers and creeks of East Pakistan provide an effective network of channels for inland waterways transportation but these are adversely affected by the high waters of the flood season and extremely low flows in the winter season. The water problems facing East Pakistan are:—

:: Supplying irrigation water during the dry season which would increase cultivation.
:: Reclaiming the low lying areas and areas flooded by tides and the improvement of salinity conditions by flushing with sweet river water.
:: Improving channels for water transportation.
:: Development of hydro-electric power to supply it at reasonable cost for industrial, agricultural and domestic consumption.
:: Providing municipal water supply both for domestic and industrial uses.

Power Potential of East Pakistan

Installed power capacity in East Pakistan in 1947 was only 7300 KW. By 1955 it was expanded to 67,000 KW. By 30th June 1962 the installed power capacity reached 256,000 KW. With the coming up of the new projects it is expected that by 1970 the total installed generating capacity in the Province will be well over $\frac{1}{2}$ million KW. East Pakistan in most parts is a flat terrain. The Hydro-potential is therefore limited and for increasing power development other natural resources will also have to be explored.

The Three Regions of West Pakistan

West Pakistan can be divided into three basins from the view-point of surface water

resources.

The Indus River Basin into which drains the mighty Indus River with all its tributaries, namely, Ravi, Chenab, Jhelum, Beas and Sutlej. The inland Basin of North Baluchistan which is very arid with salt pans and huge area of boulder strewn sections and the Coastal Area, the streams of which have much better water than those of the inland basin with small rivers lie Dasht, Hingol, Hab and Porali.

The Coastal Region

The streams of the coastal area and the inland basin are flashy in character. Their perennial flows seldom exceed 50 cusecs but during flood discharge up to fifty to sixty thousand cusecs individually and then again reverting to normal the day after, leaving no signs of their behaviour of the previous day. Their mean annual flow has been estimated as 4 to 5 M.A.F. The sediment load carried by these streams is very high due to the tremendous soil erosion from the denuded and disintegrated rocks of their catchment.

The sediment load estimated in these streams is of the order of 4 to 5 million tons per day during high floods. Therefore before thinking of any storage dams for the development of the area the high sediment content of these rivers has to be taken into account.

The Indus Basin

By far the most important of these basins is the flat and fertile Indus Plain of West Pakistan. The average annual inflow of the Indus and its tributaries is twice the flow of the Nile and more than ten times that of the Colorado river; in Europe only the Danube compares in size with it and in U.S.A. only the Mississippi and the Columbia are larger. Half the water carried on to the plain by the river is diverted into a highly developed system of canal irrigation and is used to irrigate some 23 million acres which by far is the largest single irrigated region on the earth. The precipitation in the head reaches of most of the streams draining the Indus Basin is in the form of snow. Lower down in the sub-mountainous tracts the rainfall averages from 30" to 40" gradually decreasing to less than 5" in the West. In the plains the average rainfall varies from 15" in the former Punjab to less than 5" in the South.

The rivers of the basin are subject to extreme variation of flow. The normal summer discharge being about 20 times the winter minimum. The mean annual flow of the whole system is 168 M.A.F. of which the Indus Main brings about 90 M.A.F. The Indus Basin covers an area of 348 square miles of which about 200,000 sq. miles lie in Pakistan. In terms of acres the gross area of Indus in West Pakistan is about 130 million acres. Of this 75 million acres are culturable, but the net area sown is about 30 million acres of which about 23 millions are irrigated.

Division of Water between Pakistan and India

With Independence came up the problem of sharing of water supplies of the Indus between India and Pakistan. The dispute was finally solved with the signing of the Indus Water Treaty in 1960 between the two countries. Under the Treaty the water carried by the western rivers carrying an average of 135 M.A.F. of flow annually, is reserved for the exclusive use of Pakistan and that carried by the three eastern rivers bringing down 33 M.A.F. of water annually is reserved for the exclusive use of India. The plan provides for the construction of works for transfers of water from the

Western to the Eastern rivers. This includes the construction of two large storage dams one on the Jhelum at Mangla and the other on the Indus at Tarbela and seven large link canals. The plan also provides for the Remodelling of the existing links and barrages namely, Marala Ravi Link, Marala Headworks, Bombanwala Ravi Bedian-Depalpur Link, Balloki Suleimanki Link, Balloki Headworks and the Depalpur, Fordwah, Bahawal, Qaim, Mailsi and Pakpattan canals system. A provision for drainage and tubewell also exists.

The Break-up of Water Resources

The gross annual discharge of the three Western rivers has been estimated to be 135 M.A.F. Out of this quantity the utilisable discharge is estimated to be of the order of 105 M.A.F. Total culturable land in West Pakistan is about 75 million acres of which that with irrigation facilities is only 35 million acres. About 24 million acres are currently being irrigated in West Pakistan. The water presently being used for the existing irrigation requirements is of the order of 75-78 M.A.F. Water required for the new projects which cater for raising the existing area under irrigation to 35 million acres is estimated to be 95 M.A.F. This leaves only 10 M.A.F. out of the total utilisable discharge of 105 M.A.F. to be made use of.

Problem of Salinity and Water-logging

The first and foremost problem facing Pakistan today is the problem of salinity and water-logging. The additional water requirements for prevention and reclamation of salt affected areas are considered to be of the order of 19-20 M.A.F. at the same time we need expansion of irrigation for the rapidly increasing population of our country. Some optimistic estimates have lately indicated high potentials of ground water in the upper Indus Basin plain giving an estimated figure of 1900 M.A.F. of usable supplies. This reservoir is reported to be fit for making available, through tubewells, about 15 M.A.F. of water every year perennially for irrigation. These estimates, however, are yet subject to verification.

Hazard in the Aim of the Goal

The attainment of this goal has thrown a great challenge to the Engineers of Pakistan. If you realize how complex the operation of our irrigation systems would become when we inaugurate the huge link canals system now being constructed under the Indus Basin Water Treaty, if you visualize the calculated operation of replenishment depletion of our flood control-*cum*-storage-*cum*-hydro power reservoirs. If on top of this you superimpose the problems connected with the operation of numerous tubewells and hydro and thermal power stations which will supply power for these tubewells, if you also take into account the drainage requirements of the saline ground water strata and its mixing and dilution with fresh water in correct proportions, if you also think of the operation of the ground water resources for prevention of instruction of saline zone into the sweet water zones and if you also give your kind thought to the continuous pumping operation in the presently water-logged areas in order to lower the watertable which in turn would effect the water and power supply of our country as a whole, then you will have some idea of the hazards that face the Engineers who will regulate the future multi-purpose systems of our country. A start in this direction has already been made and I wish them good sense and Godspeed.

Water Potential of West Pakistan–Its Present Development

by **Dr. NAZIR AHMAD,**
Irrigation Research, Lahore.

West Pakistan has very limited sources of water to irrigate its vast culturable Indus plains. In this article the author has discussed all resources of available water and explained how a substantial amount of water can be made available by rendering soil evaporation from the high water table.

Existing Source of Surface Water in West Pakistan

After the water treaty with India, West Pakistan is left with only three rivers, the supplies of which are very limited and insufficient to irrigate the vast culturable land of the Indus Plains.

The average total annual flow of the three Western rivers, Indus, Jhelum and Chenab constitute 138 maf. (189,000 cusecs/day). The main flow is of the Indus which constitute about 70% of the total surface run off. About 81% (155000 cusecs/day) of the total run off occurs during the six summer months particularly during the two and a half month of the monsoons. The flow during the winter six months constitute only 19% (35900 cusecs/day) of the total. The individual flow of each river is as under:—

The culturable area in the Indus Plains constitutes 71 million acres of which at present only 33 million acres are receiving irrigation, 20 million acres in the ex-Punjab and Bahawalpur and 13 million acres in the ex-Sind.

Surface Water Utilized and Wasted to Sea

After the completion of Mangla Dam it will be possible to utilize 45 maf. of water in ex-Punjab and Bahawalpur and 38 maf. in the former Sind. Estimate shows that about 11.5 maf. of the total water is lost through rivers system and additional 6.6 maf. will be lost when the replacement works are completed. It is presumed that about 2 maf. will be utilized in Kashmir, so that the net flow going as waste to sea will constitute 34.9 maf. The details are as under:—

138−2−11.5−6.6−45−38=34.9 maf.

TABLE 1

River		Total maf.	Summer six months, flow and % of total maf.		Winter six months, flow and % of total maf.	
Indus	...	90.3	76.4	83.4	13.9	17.6
Jhelum	...	22.7	18.1	79.4	4.6	20.6
Chenab	...	25.0	20.2	81.0	4.8	19.0
G. Total	...	138.0	114.7	81.0	23.3	19.0
And Mean	...	(189,000 cus./day)	(155,000 cus./day)	...	(35,900 cus./day)	...

These diversions of 83 maf. of water from the rivers have taken place during the last seventy to eighty years. At present the canals have a capacity to divert 150000 cusecs (110 maf) through 17 barrages existing in the Punjab and Bahawalpur area. Similarly in Sind through the three barrages 83,000 cusecs (60 maf) of water can be withdrawn.

An idea of the discharging capacity of the canals can be had from Table 2. Unfortunately the river supplies are not available throughout the year to feed the canals at full capacity. Some of the canals are either seasonal working only during summer or carry low order of discharges as are available in the rivers particularly in the winter months.

Loss of Water in Transit

All the water diverted at the canal heads does not reach the fields. A considerable amount of water is loste ither by evaporation, transpiration or by seepage.

Conveyance loss has been estimated by many workers, the accepted figures are of Kennedy, Benton, Blench and Khunger. These are as under:—

	% of total flow			
	Kennedy	Benton	Blench	Khunger
Loss from:				
Main canals ..	5	16.4	5	15.5
Branches ..	15		15	
Distributaries ..	6	6.1	7	5.4
Watercourses ..	21	20.2	20	6.5
Total ..	47	42.7	47	37.4
Field ..	25	19.1	..	..

Thus about 47% water delivered at the head is lost during conveyance from canals to the fields.

Scientists working with Dr. Revelle have estimated the loss of water in conveyance in the ex-Punjab, Bahawalpur and Sind as under:—

Punjab

(*i*) Seepage through canals. =13.9 maf.

(*ii*) Evaporation and transpiration. = 6.8 ,,

(*iii*) Water delivered to fields 45—13.9—6.8 =24.3 ,,

Sind

River water entering the ex-Sind province is 78.7 maf. (138—2—45—11.5/2—6.6—78.7). The water diverted into the canals is to be 38 maf.

Water reaching the field is 20.9 maf., as 11.4 maf. being 30% of the total is lost by seepage and 5.7 maf. being 15% of the total is lost by evapo-transpiration.

Depth of Irrigation Water at Fields

In the ex-Punjab and Bahawalpur, 20 maf. are under irrigation. In Sind the area under irrigation is 13 maf. The depth of water on the fields is hardly 24.3/20=1.22 ft. and 20.9/13=1.6 ft. in the two zones. The contribution from rainfall if taken equal to 5.2" in ex-Punjab and Bahawalpur, gives 8.7 maf, and 2.1" in Sind gives 2.3 maf. This amount when added to flow at field raises the water potential to 33.0 maf. in the upper and 23.2 maf. in the lower region. This amount of water delivered to fields is very small and has been in fact the cause of all ills of the land, the low yields and the salinity.

To raise the production of the land and to deal with the problem of salinity, we need

TABLE 2

Capacity of canals, culturable and irrigated areas, in West Pakistan

In thousand Acres

Site	Capacity in Cusecs	Gross Area	Culturable Area	Irrigated Area	
				Kharif	Rabi
Punjab:					
Thal Canal ..	6000	2046	1616	232	378
Taunsa Canals:					
(*a*) Muzaffargarh ..	8301	659	596	139	220
(*b*) Dera Ghazi Khan ..	8757	*	*	*	*
Rangpur ..	2000	360	347	108	144
Total ..	25058	*			
Chaj Doab:					
Upper Jhelum Canal ..	9031	580	540	310	247
Lower Jhelum Canal ..	5200	1623	1499	654	774
Total ..	14231	2203	2039	964	1021
Rechna Doab:					
M. R. Link ..	25000	179	161	42	42
Upper Chenab Canal ..	16500	1511	1425	542	395
Lower Chenab Canal ..	11000	3703	2982	1366	1762
Haveli Canal ..	5242	1123	1011	505	614
Total ..	57742	6516	5579	2455	2813
Bari Doab:					
C. B. Doab ..	2629*	704	642	327	318
L. B. D. C.	7000	1822	1460	783	901
Depalpur Canal ..	6950	1045	983	290	338
Pakpattan Canal ..	6594	1396	1258	470	622
Mailsi Canal ..	5400	791	647	227	310
Total ..	28573	5758	4990	2097	2489

*Total Cap. of U.B.D. Canal is 6900 cusecs and delivery in Pakistan is 2629 cusecs

[*Contd.*

TABLE 2—(*Contd.*)

In thousand Acres

Site	Capacity in Cusecs	Gross Area	Culturable Area	*Irrigated Area*	
				Kharif	Rabi
Bahawalpur:					
Eastern Sadiqia ..	4917	1135	937	304	424
Fordwah ..	3366	465	425	138	172
Bahawal ..	5400	791	647	227	310
Qaimpur ..	520	45	42	44	24
Abbasia ..	1064	131	110	45	44
Panjnad ..	9567	1575	1339	601	553
Total ..	24834	4142	3500	1359	1527
Sind Area:					
Guddu Barrage Canals ..	..	..	..	..	..
Desert Canal ..	13275	..	..	..	..
Begari Sind Feeder ..	14764	..	..	..	..
Ghotki Feeder ..	8390	..	..	..	..
Total ..	36529	3250	2730	1648.8	301.6
Sukkur Barrage:					
Right Bank Canals ..	13103	2002	7500	7500	2339
Left Bank Canals ..	..	..	..	..	..
Khairpur Feeder East ..	2094	368	*	*	*
Khairpur Feeder West ..	1936	303	*	*	*
Rohri Canal ..	10883	2552	*	*	*
Eastern Nara Canal ..	13649	2060	*	*	*
Total ..	41665	*	*	*	*
G. M. Barrage:					
K. B. Feeder ..	9075	604	604	55	18
Pinyari Feeder ..	13636	786	786	178	10
Fuleli Feeder ..	14859	929	929	329	51
Lined Canal ..	3602	487	487	56	12
Total ..	41272	2806	2806	618	91

more water. Countries with climate similar to that of ours, use 3 to 4 times more water on land as is being used in this country. There are three ways open to us to deal with the problem:—

(*i*) Reduce the land under irrigation or cultivation.

(*ii*) Store the maximum possible water during summer and use it during low supply periods.

(*iii*) Exploit other sources such as ground water, reduce losses of water both as a result of seepage and evaporation etc.

We deal with these aspects one by one.

(*i*) Reduction of Land Under Irrigation

At present about 80% of the population depends on agriculture. They having small holdings, reduction of land under irrigation is not practicable. At present about 7 million acres of land along the flood plains of the rivers in the Punjab and Bahawalpur is given irrigation only during summer.

Irrigation intensity in the rest of the area is hardly more than 100% during both the summer and winter seasons. During each season as shown in Table 2 hardly 50% of the land is put under crops. Had there been more water available intensity of cultivation could be raised? Under the existing circumstances reduction in cultivation is not possible.

(*ii*) Construction of Storages for Flood Water

In West Pakistan there are not many sites where big storages can be built. Many considerations such as engineering, economical cost, utilization of water etc., have to be given while selecting a site. Any attempt made to construct a storage will take several years and will need vast monetary resources also.

At present four sites are under consideration which will store 26.4 maf. of water. Some of these still need investigations. Investigation of only Mangla is complete and it is being constructed. Tarbela is still undecided and the fate of the rest two is still unknown. However, if all these four dams are ultimately constructed their total storage will be as under:—

Mangla, ultimate storage	..	7.0 maf.
Rohtas to be investigated	..	3.0 ,,
Tarbela, investigated, ultimate storage	..	6.4 ,,
Dok Pathan to be investigated	..	10.0 ,,
Total	..	26.4 maf.

Construction of a dam normally takes a decade. The serious question is that the major flow takes place during short duration of very high floods. This offers a serious problem of storage and utilization particularly during the long period of short supplies.

(*iii*) Exploitation of Alternative Resources

Dr. Revelle has estimated that in the 28 million gross acres of the ex-Punjab and Bahawalpur, annual water seeping into the formation is 20 maf.

Its components are:—

(*a*) Canal seepage	..	13.9 maf.
(*b*) Seepage from river	..	2.0 ,,
(*c*) Infiltration from rainfall.	..	1.0 ,,
(*d*) Seepage from new links		3.0 ,,
Total	..	20 maf.

The total area of 28 million acres is such that 19 million acres of these have non-saline underground water and the rest 9 million acres have saline groundwater.

The proportional amount of water seeping into the two regions amounts to:—

(*i*) Non-saline ground water area, $19/28 \times 20 = 13.6$ maf.

(*ii*) Saline ground water area, $9/28 \times 20 = 6.4$ maf.

The surface water being utilized in the two areas from the canal supplies is:—

(*i*) on non-saline ground water area, $13.3/20 \times 24.3 = 16.5$ maf.

(*ii*) on saline ground water area, $6.7/20 \times 24.3 = 7.8$ maf.

It is estimated that mining of the underground water at the rate of 3.33 ft. per year will yield 15.8 maf/year. After consideration of reseepage of this mixed water, loss by evapotranspiration, the amount available from this source will be:—

(*i*) Non saline ground water area = 14.1 maf. Thus the total supply from ground water source will be equal to $14.1 + 13.6 = 27.7$ maf. and if the total surface water will be added, the total available on non saline ground water, land will amount to $16.5 + 27.7 = 44.2$ maf/year against the presently 16.5 maf. only.

Similarly the water which can be made available from area having saline ground water will amount to 17.8 maf. which includes 7.8 maf. from canals surface supply, 6.4 maf. out of the seeped water from canals, and 3.6 maf. from the mining of ground water. In addition 1.0 maf. of water with salinity order equal to 10,000 m.moh/cm will be pumped out for disposal out of this area.

Water Budget According to Revelle's Report

Thus according to Dr. Revelle's report instead of 24.3 maf. of canal supplies for 20 million acres of ex-Punjab and Bahawalpur, 37.7 maf. of water will be recovered from ground water now going waste. It will make the supplies equal to 62 maf. About 8.0 maf. is supposed to come from rainfall making up the total equal to 70 maf.

For Sind the available water at field after elimination of evaporation and seepage loss etc. is 21 maf. and to it 2 maf. can be added from rainfall. It will make up the supply equal to 23 maf.

The overall depth of water on the irrigated land will thus increase to $\frac{70+23}{20+13} = 2.8$ ft. per acre per year which is nearly double the existing order.

Alternative Proposals

How far this estimate is realised in actual is still questionable. A proposal is now put forth by which mining may not be necessary.

In this note the water resources of only Rechna and Chej Doabs are discussed. These two Doabs are irrigated from Lower Chenab and Lower Jhelum canals. Feeder canals like Upper Jhelum, Upper Chenab and Haveli lined channel also pass through these. There will recently be three link canals, Rasul-Quadarabad-Balloki, Trimmu-Sidhnai passing through the region.

Water Being Lost by Evaporation from Rechna and Chej Doabs

In these Doabs ground water exists close to surface. Their total area is about 10.145 million acres. Here in a land of 0.77 million acres watertable exists within 5 ft. Another 4.42 million acres have water within 10 ft. About 2.7 million acres have water within 15 ft. and in the rest below 15 ft. If we assume that the loss by evaporation and transpiration from these regions is equal to that from a bare soil as estimated recently, it is worked out that

about 5.6 million acre feet of water is being lost in these Doabs.

Along the main canals there exists at least 10 ft. wide strip of free water which has excessive weeds growth. In the rest about 100 to 1000 ft. of land strip watertable lies within 2.0 ft. It is estimated that from this area about 0.46 million acre feet of water is being lost in a year. This makes the total estimate of evaporation equal to 6.05 million acre feet.

Conveyance Loss Equals Evaporation

The main canals of the two doabs not considering the Haveli lined canal, B.R.B.D. Link and the future links are 700 miles in length and assuming 6.0 cusecs as loss per mile length of the canal (assuming average width equal to 150 ft. only), the seepage loss comes equal to 6.0 million acre ft. which just equals to that being lost by evaporation.

If we consider that 20% of the water let into the main canal at diversion seeps into the formation then 11900 cusecs seep in summer and 4600 cusecs during winter giving an average of 8250 cusecs corresponding to 6.0 million acre ft. of water. This is the second confirmation of the estimated evaporation loss.

Water Budget for Rechna and Chej Doabs

These studies pointed out that in Rechna and Chej Doabs about 6.0 million acre ft. of water is going into the formation. This is under the present case of high watertable when the average seepage head is 5 ft. only. If it is increased to 15 ft. then there is a possibility of increasing the present seepage to three times. Thus it is estimated, the existing seepage loss of 6.0 million acre ft. will increase to 10 or 12 million acre ft.

If we assume that 750 miles length of river bounding the two Doabs will add only 1.0 million acre ft. and rainfall contributing on the average equal to 1.02" per year on 10 million acres add another 1.0 million acre ft., the links will add 1.5 million acre ft. so that we have additional source of seepage equal to 3.5 million acre ft.

If we assume 35% loss of water from the average discharge of 19750 cusecs/day (14 maf.) let into at canal heads in two doabs then water available at the fields will be 9.1 million acre ft. With watertable lowered to 15-20 ft. additional supply from seepage of canals, rivers, rainfall etc., will give additional 14.5 million acre ft. making the total supply equal to 23.6 million acre ft. of water for a land of 10 million acres provided evaporation loss is saved. At present only 6.5 million acres are under irrigation, so that the depth of water in land will be 23.6/6.5=3.6 ft. which compare very well with the estimate as given by Dr. Revelle's Scientists.

Pumping During Winter, Recharge in Summer

During summer we have more water and the pumping can be stopped so that ground water will be charged and may come up. During winter extensive pumping will take down the watertable to 15-20 ft. below surface again. In this way serious losses of surface water will be eliminated and there will be innumerable advantages.

Thus, by this method, it is possible to increase the supply of Rechna and Chej Doabs constituting about 1/3 the cultivable land of ex-Punjab and Bahawalpur from the present 8.5 million acre ft. to 23.6 million acre ft.

Irrigation Practices of Pakistan

by **H. J. ASAR,**
Chief Engineer, Remodelling, Lahore.

On the second day of the Symposium on Modernisation Mr. H. J. Asar dwelt upon the Irrigation Practices of Pakistan. Mr. Asar gave a brief history of the development of Irrigation in the country and the present practices peculiar to this country.

Touching the brief history of development of irrigation works he mentioned some of the advances made during the last few decades in this country and their present status.

The excerpt from his address runs as under:

Irrigation in East Pakistan

Pakistan is primarily an agricultural country and largely depends on Irrigation. East Pakistan has problems of its own. It is almost entirely an agricultural area and her density of population per square mile is the highest. It is situated in deltaic region of the mighty rivers and gets flooded almost every year. Flood control is thus the gravest problem of East Pakistan. In the deltaic area, drainage is so effective that immediately after the subsidence of flood sub-soil water falls rapidly and there is no moisture left to grow more than one crop. It has, therefore, been felt essential to resort to Irrigation schemes, including flow, lift and tubewells to enable raising of two to three crops a year instead of one by inundation alone. Amongst the many schemes Ganges Kobadak and Teesta Barrage are the biggest of all. Reclamation of saline lands by construction of bunds is another process adopted to raise food crops on otherwise waste lands.

West Pakistan

West Pakistan has an area of 310,000 sq. miles and a population of 42.9 million giving intensity of 137 persons per square mile. The landscape varies from the snow-covered peaks of Himalayas in the north to vast alluvial plains in the centre and deserts in the South. The annual rainfall varies from 4″ in the arid zone to over 40″ in the mountains. Most of the rains occur during the monsoon period from June to September while winter has infrequent showers of medium intensity during December and January.

Perennial Rivers Ideally Located with Fertile Vast Arid to Semi-arid Land

The Province is traversed by the main Indus river and its tributaries namely Sutlej, Beas, Ravi, Chenab, Jhelum, Kabul and other streams big as well as small. These rivers are well spaced and ideally suited for development of water resources and construction of Irrigation Projects. As the

climate of West Pakistan is arid and semi-arid agriculture without artificial irrigation is limited in extent, crop pattern and crop yield.

Irrigation Practice from Prehistoric Times

Irrigation in the Indus Valley was known even in the prehistoric times and the ancient civilization depended on inundation irrigation along the river courses. Among the Muslim rulers, Sultan Feroze Shah Tughlaq constructed a number of canals from Sutlej and Jamna rivers in the 14th century. By the 18th century many inundation canals existed along the narrow belts of the Indus and its tributaries and this went on developing in the nineteenth century.

Weir Controlled Canals Take Shape

The first weir controlled canal was the Upper Bari Doab Canal which almost followed the alignment of Hasli Canal constructed by Moghul emperors to bring water for Shalimar Gardens at Lahore. This canal was taken out from river Ravi at Madhopur now in India and was completed in 1859.

In the second half of the 19th century, the British administration continued to develop the existing old irrigation systems and constructed many new canals. The instances, are the Upper Bari Doab, the Lower Chenab, the Lower Jhelum, the Sidhani, the Swat Canal, Kabul River Canal, Beghari Canal, Desert Canal, the Sukkur Canal, the Kasli Canal and improvement of the Fuleli Canal. The Muzaffargarh and D. G. Khan inundation canals were taken over by the Irrigation Department in 1880.

At the turn of the century, a bold Project called the Triple Canal Project was undertaken. It consisted of the Upper Jhelum Canal, the Upper Chenab Canal and the Lower Bari Doab Canal. The Upper Jhelum and Upper Chenab Canals irrigate large parts of the Chaj and Rachna Doabs and in addition work as feeder channels to supply water at Khanki and Balloki respectively. After the 1st World War, the Irrigation system was extended substantially. In Sindh, the Sukkur Barrage was completed, with a system of 7 off-taking canals. An area of 7.5 million acres was brought under irrigation. In the ex-Punjab and Bahawalpur areas, the Sutlej Valley Project was completed with 4 weir controlled Headworks at Ferozpur, Suleimanki, Islam and Panjnad. Eleven canals were taken off from these Headworks and an area of 6.4 million acres was commanded. Just before independence, the Thal Project was completed for the irrigation of an area of 1.5 million acres in the Thal Doab.

Recent Links

After independence in 1947, the Water Dispute Problem with India took a serious shape and for replacement of supplies on the Sutlej Valley Canals, 3 Link canals were constructed. They were, the Marala Ravi Link, the Bombanwala Ravi Bedian Dipalpur Link and the Balloki Sulcimanki Link. In addition work on 5 new projects was also undertaken; namely the Taunsa Project, the Ghulam Mohammad Barrage Project ; the Kurram Garhi Project, Warsak Dam Project and the Gudu Barrage. Work on all these Projects has now been almost completed. West Pakistan has the largest contiguous system of irrigation in the world. There are 16 headworks across its rivers. The main canals and their distributing systems have a length of about 30,000 miles, with a total culturable commanded area of 33 million acres out of which over 24 million acres are being cropped annually. There are about 4600 miles of drains for disposal of

storm water and subsoil water of water-logged areas.

Special Technique of Construction of Structures on Sand Foundation

Alongside the growth of irrigation, the technique of constructing Headworks and canal design developed progressively. Practically all the canals in this sub-continent take off from the rivers after they have debouched from the hills. Rocky foundations are not available for the weirs constructed across them to pond up supplies for diversion into the canals. The weirs are usually of small height 10 to 15 feet as distinguished from dams and are constructed on the permeable river bed material namely sand. The Irrigation engineering in this part of the country occupies a conspicuous and unique position in the design and construction of Weirs on Sand foundation. This practice having proved successful through ages is universally accepted and occupies an important place in the Engineering science.

Construction of Regime Channels

Similarly the design of Irrigation channels has been developing side by side. Prior to the close of the 19th Century there was no organised system governing the design of channels. As a matter of fact, a Channel should be designed in such a way that it should neither silt nor scour. Pioneer research in this direction was done by Mr. R. G. Kennedy who established a formula by which a non-silting and non-scouring velocity could be worked out from the depth of the Channel. Later research, however, showed that the non-silting and non-scouring velocity is not only related to depth 'D', but is also uniquely linked with the Bedwidth, 'B'—Mr. G. Lacey finally determined that the non-silting and non-scouring velocity is dependent upon the Hydraulic Mean Radius 'R' which incorporates both 'B' and 'D'. Accordingly Mr. Lacey established that for a Channel in an incoherent alluvium (like pure sand), the width, depth and slope of a channel carrying a given discharge and a given silt charge are uniquely fixed if the channel is required to neither silt nor scour. It is on this basis that all the irrigation channels are designed now-a-days. The Irrigation Research Institute has all along kept itself busy in improving upon the assumptions made in the design of channels.

The Canal System

The function of a Headworks is to facilitate withdrawal of water into the off-taking canals which in turn carry the much needed water to the fields. The system is very much like a tree in which the roots suck water from the soil and pass it on to the trunk. The trunk distributes it into the various branches, sub-branches and ultimately to the green leaves. In a like manner, the Headworks divert water into the main canal. Just as there are no leaves on the trunk, the main canal does not serve any fields. The main canal distributes water into various branches, distributaries, minors and ultimately into the green fields which are like the leaves of the tree. It is only the distributaries and the minors which take water to the land to be irrigated and then pass it on to the individual fields by means of outlets and water courses. This network of irrigation channels is known as the Canal System.

Full Supply Factor and the Capacity of a Channel

How the capacity of a channel is fixed, depends upon two things. Firstly, the minimum levels are determined by survey

from the individual fields to be irrigated. Then the elevation is worked out from point to point. This elevation is required to command the fields and to create the flow in the canal. The process starts from the agricultural fields and is worked back up to the River the source of supply. Secondly the quantity of water or discharge to be run in the canal is determined by the Full Supply Factor and the Intensity of Irrigation in the particular area. Full Supply Factor is the area on a canal which one cusec of discharge at the head of the canal is proposed to irrigate and the Intensity of Irrigation is the percentage of culturable irrigable area which is irrigated each year.

Dams for Conserving Flood Water

In Pakistan the canals utilize even the last drop of river flows in winter so much so that the canals and the distributing irrigation channels have to run by rotation. The conditions in September when supplies are required for maturing of crops often become precarious and so is the case in April and May which is a sowing season. In order, therefore, to remove the inherent shortage of supplies in the winter months, the excessive flows in the rivers in summer should be conserved by constructing dams and creating large reservoirs. A step in this direction has already been taken in the form of Mangla Dam and Tarbela Dam which are integral parts of Indus Basin Settlement Plan. More reservoirs should follow to meet the needs of the existing canals in winter and to afford enough water for improved agricultural practices.

Reducing Canal Seepage

The seepage losses in the canals and distributary systems is very great as was brought out by Dr. Nazir Ahmad last evening. Every effort to save the seepage losses is a step forward to make available that supply for irrigation; lining of the canals and distributaries has been under active consideration of the Irrigation Department. Many large canals have been lined. The unfortunate position is that this tract of the country has extreme changes in temperature in summer and winter which cause expansion and contraction and we have yet been unable to devise absolutely water-tight lining. The efforts are however continuing.

Exploit the Ground Water Reservoir

Apart from conservation of surplus flows of the rivers as already mentioned, there exists a huge ground water reservoir which can be exploited to make available water for irrigation. This has been surveyed and estimates prove that irrigation practice by Tube-wells is possible on large scale. Apart from the advantage of Irrigation, the Tubewells help lowering of the Water table where it has risen high and has caused water-logging and salinity. This is a big problem in itself and large multipurpose projects covering power production, sinking of Tube-wells, and operating them can meet with the needs of irrigation, removal of menace of water-logging and salinity and adoption of improved agricultural practices.

Recent Indus Basin Works

The Indus Water Treaty has brought in its wake construction of five Barrages, seven Links and two Dams and Remodelling of existing Links and Canals to effect transfer of irrigation supplies from Western rivers to the canals being fed from Eastern rivers namely Ravi, Sutlej and Beas now gone over to India.

The existing Links are to be remodelled to make them fit to carry the discharge they

are now assigned to carry and also be safe against the flood hazards they encounter. The Marala Ravi Link and Bombanwala Bedian Dipalpur Link traverse against the country slope and being close to the sub-mountainous tract have to face the sheet flow they have obstructed. They must be safe after providing adequate cross drainage facilities otherwise any damage thereto would simply cause chaos in the agricultural world dependent upon them.

Irrigation practices have gone a long way to improve agricultural production. The goal of further improvement is there and as was mentioned by Mr. Kazi last evening, concerted efforts in the realm of Research and a will to achieve the said goal are bound to bear fruit.

~~~o~~~

Irrigation Practices

by **SARDAR ALLAH BAKSH**

On the second day of the Symposium on Modernization dealing with Irrigation Practices, Sardar Allah Baksh dwelt upon the function of outlets, water courses and the canal revenue system. He also gave suggestions to increase the water potential of Pakistan.

A brief excerpt of his address is given below.

The Outlet

An outlet is the last, Government owned structure on any canal system.

It is designed with the following points in view:—

:: It should be strong and have no moving parts.
:: It should draw its proper share of silt from the parent channel.
:: It should work efficiently with small working head.
:: It should be cheap and lastly.
:: Should be least affected by interference of the consumers.

Type of Outlets

With the above objective of design in view, three main types of outlets have been developed in this country. These are:

(*i*) Pipe out.
(*ii*) Open flume area.
(*iii*) Adjustable proportional Module (A.P.M.)

Pipe outlet is non modular. It is generally used for seasonal supplies on inundation canal. Some outlets are such that their discharging capacity remains unaffected by fluctuation of water level in the parent channel. These are called Module. These are generally used on main canals and branches. The common type of Module are the Gibbs, Khanna rigid O.S.M., and Ghafoor's rigid flume.

The semi-module are in extensive use. Their discharging capacity is effected by water level in the parent channel and is independent of water level in the water course. Open flume type is used for tail clusters and within 1000 feet length upstream
~~~

of the control point of the canal. The adjustable proportional module is also used on some canals.

The discharging capacity of outlet is kept between one to three cusecs, so that it carries proportion distribution of fertile silt and one man is able to control the flow.

The Water-Course

When the water comes out of the outlet it drops into the water course which leads it to the fields. The maintenance of the water-course is the responsibility of the consumers. A properly designed and well maintained water-course will reduce losses of water *en route*, and thus convey more water for the use of crops. If water is applied through one 'NAKKA' it causes a lot of wastage through SOAKAGE.

The Canal Revenue System

A complete canal system such as the Upper Chenab Canal or the Lower Bari Doab Canal, is called a Circle, under the charge of a Superintending Engineer. A circle has three or four Canal Divisions, each under the charge of an Executive Engineer, who is the chief revenue officer. He is assisted by a Deputy Collector and a team of Zilladars and Patwaris. A Patwari is normally responsible for 3000 acres of cropped area whereas a Zilladar is responsible for about 30,000 acres of cropped area.

The *abiana* is charged only for the crops that actually mature. Remission of revenue is given for the crops which fail to mature. Detailed procedure has been laid down by the Irrigation Department for the assessment of revenue for the mature crops.

Irrigated Area and Population

Out of total area of 196 million acres in West Pakistan, the present irrigated area is 30.03 million acres being 16.2% of total and after completion of projects in hand 11.0 million acres will be brought under plough raising the irrigated area to 21%. Similarly after 6.2 more million acres are brought under cultivation in East Pakistan the percentage of irrigated area will rise to 77.4%.

The population, on the other hand, has increased during the last ten years by 24.0%. The only way to feed the increasing population appears to be by construction of more storages, use of ground water and economy in flow of water by minimising wastage.

15th All-Pakistan Science Conference Lahore 1963

Pakistan Association for the Advancement of Science held its fifteenth session from March 19-23 at Lahore. The Conference was inaugurated at 9-30 A.M. by President Mohammad Ayub in the Panjab University Hall. Mr. Justice Mohammad Sharif, Vice-Chancellor, Panjab University welcomed the President who inaugurated the Conference with a brief address. Dr. I. H. Usmani, the President-elect read out his 90 minutes address. In this volume we have reproduced excerpts from the address of Mr. Justice Sharif, remarks of the President and some portion of the address of Dr. Usmani.

In the afternoon the Conference split up into eight sections where presentation of papers and sectional presidential addresses were delivered. Mr. A. R. Kazi, President-elect for the section of Engineering, Irrigation, Hydel Power, Hydraulics, Communication, Electricity and Public Health read his address on New Horizons for Engineers in Pakistan on 20th March. Another feature of this year's conference was the presentation of twenty-two papers on Engineering subjects. The section remained busy with the reading and discussing of papers throughout the session of the Conference ; thanks to the untiring efforts of Syed Monawar Ali, Project Director, General Investigation Division of Wapda, whose efforts made this session a singular success.

In this volume we have put forth a few papers read in the Conference together with the Presidential Address of Ch. Mohammad Hussain, Director Land Reclamation, to the section of Agriculture, Animal Husbandry and Forestry.

Presidents of the sections and their addresses

Section 'A'

Agriculture, Animal Husbandry and Forestry, Ch. Mohammad Hussain spoke on "West Pakistan Agricultural Potential, the Problems and their solutions".

Section 'B'

Biology, Botany, Zoology and Entomology, Dr. Ghulam Ullah, Entomologist, Pakistan Forest Research Institute, Peshawar, spoke on "Some Insect Problems of Fruits and Forests."

Section 'C'

Chemistry and Applied Chemistry, President, Prof. M. A. Kazi, Sind University, Hyderabad and Research in Pakistan.

Section 'D'

Education and Social Sciences, President, Mr. A. G. Butt, Principal, Central Training College, Lahore, spoke on "Teacher—His Role and Importance in Social Evolution".

Section 'E'

Engineering, Irrigation, Hydel, Power, Hydraulics, Communication, Electricity and Public Health, Mr. A. R. Kazi, Secretary, Irrigation and Power, West Pakistan, spoke on "New Horizons for Engineers in Pakistan".

Section 'F'

Geology, Geography and Anthropology, President, Mr. Abdul Hai Khan, Survey of Pakistan, Lytton Road, Quetta, spoke on "Mineral Industry in Pakistan".

Section 'G'

Medicine and Veterinary Sciences, President, M. Maqsood, Deputy Director, Cento Institute of Nuclear Science, Tehran, spoke on "Some Aspects of Biological Effects of Radiations".

Section 'H'

Physics, Mathematics, Statistics Astronomy and Meteorology, President, Dr. A. M. Chaudhry, Professor of Physics, Dacca University, spoke on "Study of Structure of Matter by the Method of X-ray Crystallography". This year eleven countries sent 22 delegates to take part in the deliberations of the Conference. India and China sent four delegates each, whereas two each came from U.S.S.R., and U.S.A., and France, Iran, Germany, Canada, Netherlands and Great Britain sent one delegate each. About 650 Pakistani delegates were registered at the Conference who came from all parts of Pakistan.

The important Symposium included Pharmacology, its teaching and place in Industry and 'the Role of Scientists in the Atomic Age'.

~~~ o ~~~

Welcome Address

by Justice MOHAMMAD SHARIF

Justice Mohammad Sharif as Chairman Reception Committee and Vice-Chancellor, University of the Panjab welcomed the Field Marshal Mohammad Ayub Khan, President of Pakistan and the distinguished delegates from abroad.

Technical knowledge a measure of country's advancement

Mr. Justice Sharif stated that it cannot be disputed that in this age, the importance and the status of a country is measured by the advance it has made in Scientific and Technical knowledge. In the 20th century to be without this branch of knowledge is to be like a person who had been stripped of his helmet and sword in the Middle Ages. The time has passed when it was possible to sustain life by the production and the export of raw material to feed factories of the West. The very existence of an independent State depends upon its capacity to utilise all its material resources for the manufacture of
~~~

its own consumer goods and, if prosperity is the aim, to export it to other countries at competitive rates. This cannot be achieved without the requisite scientific knowledge and the know-how. The necessity is more pressing in countries like ours where the growth of population has a continuous tendency to outstrip the means of production.

The Present Day World too Small

With the undreamt of progress in Scientific knowledge and Technology and the unprecedented development of communications, the world has ceased to be as big as it was once considered to be, when one country could live in isolation, regardless of what was happening in other places and to other peoples. The only sure way to live a life of ease and comfort is to do something to make others stand on their own legs and utilise the resources God has given them. This means sharing of knowledge by those who know with those who do not, in a spirit of fellow-feeling and comradeship.

It is gratifying to see that human brotherhood is being slowly realized and the proof of this fact is afforded by the presence of a number of eminent Scientists who are here to advise us and guide us in dealing with our peculiar problems.

Pakistani Scientists should Develop Patriotism

The West can help through supply of equipment and trained scientists. Without that help it would not be easy to make real progress. Another hindrance, and I am now speaking of the Panjab University, is that some bright students trained at foreign Universities in Natural Sciences for our own needs, were not allowed to stay and were bred by very attractive offers for other jobs within the country. In some other cases, after successfully completing their study abroad, the boys did not return and settled in foreign lands. While reasonable remuneration can be assured, a little sense of patriotism has to be cultivated.

It should not be forgotten that respect and esteem do not follow riches, but are earned by selfless service to those among whom one is born and bred.

Pakistan is yet to find a Rockefeller

As things stand, in Pakistan most of the scientific education and research is being financed by the Government, unlike other countries where private benefactions play a significant role in the advancement of scientific knowledge.

It is encouraging to see that currently the Dawood Foundation and the Saigol Foundation have provided funds for scholarships for advanced studies but the country has yet to produce men like Rockefeller, Carnegie and Nuffield.

Our aim, more to produce, to feed more

Our aim is very simple and modest. We are not at all interested in the fantastic ambition of landing on the moon or in the invention of instruments of destruction which can wipe out humanity in one blast. We want to produce more to feed more; we would like to protect our soil from getting out of cultivation through salinity and water-logging; we want fertilizers; we require in industries to transform our materials into finished goods and to raise the general standard of living and, above all, we aspire to live an honourable life in consonance with our traditions and the dictates of our own religion.

In the study of Science we have a purpose far beyond mere ministration to human needs.

With this brief address Justice Sharif humbly requested the President Field Marshal Mohammad Ayub Khan to inaugurate the Conference.

Field Marshal

Mohammad Ayub Khan Inaugurates the Science Conference

FIELD MARSHAL MOHAMMAD AYUB KHAN inaugurated the four days All-Pakistan Science Conference in the Panjab University Hall, Lahore. The hall was jam packed and the audience included Malik Amir Mohammad Khan, the West Pakistan Governor, Begum Mahmooda Salim, provincial Education Minister, Vice-Chancellor and eminent scientists and educationists. Scientists from China, Canada, USSR, USA, Great Britain, Germany, Holland, India and representatives of Cento or FAO besides about 300 scientist delegates from all over Pakistan were present in the Hall. After the Welcome Address of Justice Mohammad Sharif, the President declared the Science Conference open after a brief speech which is reproduced below. The President made another short, unscheduled speech after Dr. Usmani, the General President of the Conference had read his abnormally long 90 minutes address. The excerpt from the address of Dr. Usmani is also reproduced in this volume.

President Speaks

It gives me great pleasure to inaugurate this conference and to extend a cordial welcome to all those who have assembled here today and more particularly to our distinguished guests from abroad who have travelled long distances to participate in this conference.

Age of Science and Technology

It is a commonplace to call this an age of science and technology. There is no doubt that a rapid advance in science and technology is the most powerful factor in determining the lives and destinies, the health, wealth and prosperity of millions of people today. It has brought unimaginable affluence and prosperity to the highly developed countries of the world. The standards of material wealth and comfort which in the past were available only to a small "privileged" classes, are now within the reach of the common man, in those countries. This has, however, further widened the gulf between the rich and the poor countries.

Importance of Scientific Education

We are a new and a developing country. The task before us is formidable. We have not only to bridge this gulf but also to catch up with the highly developed countries. This is why during the last three or four years, I have repeatedly emphasised education as a factor in economic growth and the importance of scientific education to economic development.

We are engaged in the task of developing our economic resources. We have to build bridges and dams to develop and multiply sources of power to build industries and to exploit natural resources of the country. We are largely an agricultural country and we need to modernise agriculture so as to improve the quality of our crops and increase their yield. The expansion of our irrigation system in the past has created problems of waterlogging and salinity. We have to reclaim the land and conserve the soil.

World-Wide Competition

We shall need a large number of scientists and technologists for our economic development. We want them not only in adequate numbers but they must also be of the highest quality. We must remember that this is an age of ruthless world-wide competition and that our scientists should be able to participate effectively with the scientists of the other countries in making important discoveries and inventions.

They should be able to probe along with them, the mysteries of nature, in the air, under the ground and in the sea. Without equal partnership in the advancement of knowledge, we cannot occupy our rightful place in the society of nations or develop our country properly.

Above all, our scientists must be dedicated men and women, who have not only technical competence but also high ideals and character. We are concerned not only with solving technical and scientific problems but also with the preservation of our country's spiritual and cultural heritage and with bringing her into harmony with the requirements of the contemporary world. That is why the Government, in its educational policy, has laid so much stress upon religious education and the safeguarding of national ideology.

Technical Needs

We also need technologists and research workers in industrial development, in agriculture and in management, we need trained administrators in the Public Services; we need trained artisans and operators in every field perhaps most of all we need trained technicians to act as foremen, supervisors and training personnels in all branches of development.

The responsibility for producing this manpower rests with the educational system. I am happy to say that during the last two years the system has been reoriented towards the University for producing in due course young men who have not only the necessary intellectual competence but also high ideals, determination and character. We can also look towards the various Research Councils in the fields of industry, agriculture, atomic energy, medicine and engineering to produce the manpower required for exploitation of our natural resources.

I know that many of our needs have yet to be met, we need more polytechnic and engineering colleges, more and better equipped laboratories and libraries, more facilities for fundamental and applied research and better conditions of work. As our resources expand, these needs will also be met. It will be the endeavour of my Government to continue to give strong support to education within our resources.

The path is long and arduous but we are moving in the right direction. Our tasks, indeed, are gigantic and our targets are high. I sincerely hope that these tasks and targets will be pursued with vision and vigour. If the progress is slow, I hope it would be because every long-term development plan is like a

snow ball which only gathers size and momentum as it goes along.

Science and Religion

In the West, there has often been a tendency to regard science and religion as antagonistic to each other. This antagonism is alien to Islam. Indeed, the reverence for truth, the inductive spirit and the humane rationality manifest in Islamic thought contributed in no small measure to the Renaissance movement in Europe. This continues to inform our attitude to scientific development.

Before I conclude, I would like to refer to the dilemma posed by scientific advancement. Whereas science has brought the promise of limitless wealth, it has also brought the threat of total destruction. The nuclear arms race carries with it the very real possibility of a war that would overnight destroy millions of human beings, would wipe out the laboriously built up cultural and material heritage of all the ages and reduce the survivors to conditions of primitive barbarism or lingering death through disease. I sincerely hope that mankind will be spared of this madness and that the scientists of the world would unite to use their knowledge for the betterment of mankind and not for its destruction.

I wish you every success in your deliberations.

President's Admonish to Scientists

President Mohammad Ayub during his unscheduled remarks after the address of Dr. Usmani spoke in a serious tone.

He said that since its formation the Science Council had met once and he had already expressed his concern to Dr. Saleem-uz-Zaman Siddiqui about the progress made by it.

Scientists lack team work

He exhorted the scientists to work with team spirit and to devote themselves to applied science rather than to inventions. He complained that the scientists and technicians were individualistic in outlook and did not make a good team. He, therefore, appealed to them to get together and formulate concrete proposals for implementation. He promised that the Government would give them support and would do all that was possible.

He agreed with Dr. Usmani that the question of establishing experimental farms and polytechnics had not been given enough attention and this aspect had remained neglected. He was of the view that in fact that was the way the future lay.

He pointed out that efforts should be made to pool all the resources for scientific research in the interest of the development of the country adding that "we should have experimental farms in our villages to teach the people different types of arts, crafts and technology so as to divert the attention of the people to concentrate in the towns and as such to produce superior manpower in our villages.

People's problems

He said that the scientists would do a great service to the nation and the country if they identified themselves with problems of the people and submitted concrete proposals. Some of the scientists including the builders, he said, transplanted foreign ideas without regard to the conditions prevailing in our country. 'This', he said, 'was not proper'. The scientists had to find out and teach the correct methods by using the cheapest material available in the country, he concluded.

Science for Survival*

by **Dr. I. H. USMANI**
Chairman Atomic Energy Commission

Dr. Usmani presented his address in the following words :

I speak to you not as a scientist but as an advocate and servant of science. This advocacy and service are difficult in a country where science is regarded as something sinister and repugnant to religion and where even the scientists consider Humanities to take precedence over science in our educational system. Let me, therefore, open the case for science by answering three basic questions (*i*) what is science? (*ii*) what is the use of science? and (*iii*) why should any importance be given to it in our affairs?

Science and Religion

In its pristine form, science is that motive force in the soul of man that impels him to seek the ultimate truth through inquiry into the causes of effects and the secrets of nature. It helps man to know himself, his environment and the Creator and Designer of the Universe of which he is an insignificant part. Science is an adventure of the human spirit which has taken him to the peaks of the highest mountains, the depths of the deepest oceans, the innermost recesses of the nucleus of the atom and out into the realms of space and the cosmos—all in search of truth for its own sake. Religion arrives at the same point through faith and resignation to the will of God. How then can these two dynamic forces which constitute an integral part of the human mind and soul be antagonistic to each other? "Science without religion is lame, religion without science is blind."

Science and Humanities

The artificial conflict between Science and Humanities has been perpetrated by a class of people whom I take the liberty of calling the "Educated illiterates." In these days to live in the second half of the 20th century and not to know why the pressing of a switch turns darkness into light or how the pressing of a button brings the softest music broadcast from a station thousands of miles away to

*General Presidential Address delivered at the Fifteenth All-Pakistan Science Conference, Lahore on 19th March, 1963.

our doorstep or why the aeroplane tears through the skies against the laws of gravity or what causes the seed to grow into a plant and human life itself to be sustained, is inexcusable. Let me at once say here, however, that science is not gadgets and machines only. It is something more noble and aesthetic which reveals the beauty, the symmetry, and the mystery of matter and life.

Science and Technology

Let me now turn to the second question: "What is the use of Science?" The great wall of China, the town of Mohenjodaro, the Colosieum of Rome and the pyramids of Egypt stand testimony to the superb craftsmanship and technology of the older civilizations; but these civilizations perished because their technology was based on the empirical and not the scientific method. During the 8th and the 11th centuries the Muslims passionately devoted themselves to the study of nature. The progress could continue to grow and multiply but religious bigotry, intolerance and orthodoxy put an end to the great contributions of the Muslim scientists to the development of the scientific method and evolution of technology based on scientific principles.

In Europe as in the days of the Muslim empires science was nursed under the royal patronage of kings. More than 300 years ago the King of England recognized the importance of science and established the Royal Society under a charter which gave complete freedom and autonomy to the scientists to pursue the researches in their respective fields of interest.

As science was put to use, poverty, disease and hunger began to disappear; countries with large territories, large human and natural resources and small countries with limited resources, all alike began to achieve higher standards of living; classless societies began to emerge; the tyranny of the few over many began to vanish and freedom of ideas, thoughts and speech began to lead to the establishment of the governments of the people, for the people, by the people.

Science and Development

Today, the knowledge and the tools placed at our disposal by science are so powerful that we can increase the productivity of the soil to meet the requirements of food of the growing population of the world. We can divert the courses of rivers and convert deserts into fertile lands. We can wipe out the pests and diseases by powerful drugs, chemicals and antibiotics. We can harness the energy of the atom to turn the wheels of industry and rocket into space to probe the world of stars and the planets. We can communicate with each other in a flash of a second over hundreds and thousands of miles and finally we can produce a staggering variety of goods for our consumption and comfort ranging from a fountain pen to a motor car, from a stove to a refrigerator, from a plastic bowl to nylon fabrics. At present, according to the figures compiled by the United Nations, the world is spending $120 billion per year on armaments which is equal to two-thirds of the entire national income of all the under-developed countries and slightly less than the net annual capital formation in the whole world. During the last ten years more money has been spent on weapons than on education in the past 300 years. If during the next ten years, this huge expenditure could be diverted to the under-developed countries, their annual per capita income could be tripled and poverty which we see on global scale

could be left only for the historians to describe.

Discovery of Pakistan

We are a nation of 94 million people living in two groups of 52 million in East and 42 million in West Pakistan separated by more than a thousand miles of Indian territory. The climate, the language, the diet and the habits of the two groups are different, yet the spiritualities forged by religion, a common attitude of mind and sets of values of life cherished by a people with a common heritage, can transcend all geographical boundaries and physical barriers and knit a people into a nation. We have an area bigger than the areas of England, France, Belgium, Holland, Austria and Switzerland combined. We have the largest artificial irrigation system in the world and are the leading producers of the three of the most important natural fibres, namely jute, cotton and wool. Our mineral wealth has yet to be discovered but of the minerals we have found, the most abundant are natural gas, limestone, rock salt, gypsum and silica sands. We have deposits of chrome, iron, copper, uranium, lead and other metalliferous ores which have a twisted chemical composition but nevertheless in sufficiently large quantities to meet our requirements for a long time if only scientific researches and new technological processes could be developed to separate them. Our forests abound with bamboos, woods, weeds and grasses which can be turned into paper and rayon on a large scale. Besides 56 million acres under forest, we have nearly 86 million acres of cultivable land of which we plough only 62 million acres. Pakistan, therefore, is not devoid of natural resources. In fact we are better placed than many other nations of the world. We have agricultural resources, and forest and mineral wealth that can sustain a growing population. But despite these assets, what is the position? The yield per acre of our crops is one of the lowest in the world. Nearly 150,000 acres of our fertile lands go out of cultivation every year due to water-logging and salinity. Our per capita income is one of the lowest in the world and our annual consumption of power stands at 34 units per person compared to 7000 in Norway 5000 in the United States, 2000 in the United Kingdom and about 900 in Japan. There is no major disease which is unknown to us. Large sections of our population suffer from Tuberculosis, Leprosy, Cancer, Blindness and a host of tropical killers, and hundreds of thousands are rendered homeless by floods or drought every year. Yet our population continues to grow at a higher rate than 2% per year. Not more than 16% of our people can read or write.

The enormity of these problems has not deterred us from forging ahead. During the last 15 years of our independence we have faced the problems with courage, fortitude and determination and despite many difficulties, handicaps and obstacles our record of progress under your dynamic leadership, Mr. President, has been amazing. The number of primary schools has been multiplied from 37,445 in 1947 to about 47,500 in 1960 and the enrolment of children in these schools has correspondingly increased from 3.1 million to 5.5 million in these years. Compared to three universities at the time of independence, we now have ten including four technical universities of which two are exclusively for agriculture and two for engineering. Our industrial production has jumped several fold and could grow at a higher rate but for shortage of foreign exchange available. The variety of goods

produced within the country ranges from textiles to machine tools and the level of production of certain items is so high that nearly 25% of our total foreign exchange is earned from the export of manufactured goods. We have built hydrodams, barrages and canals for irrigation of millions of acres of cultivable land and generation of power. We have constructed hundreds of miles of new roads and have also established means of communication by sea, rail, and radio. We are using atomic energy in the fields of agriculture and medicine and will soon have nuclear power plants to augment our electric generation capacity. We have even fired sounding rockets and entered the space age. But in all this endeavour we have rushed to build the top without a scientific base purely through the implementation of our development plans by our civil servants in the public sector and individual enterprises in the private sector. Neither class possesses the scientific background with the result that to execute a plan or a project both take the line of least resistance. The administrator to show "achievement" and the industrialist to make quick profit, employs foreign "Consultants", "Experts" or "Advisers" to prepare the design and specifications, calls tenders for machinery and instals the imported equipment under the supervision of these "Experts". Quite often the project on completion is also run by foreigners. This, Sir, not only raises the cost of the projects but at times leads to national wastage of resources and distorted development. Such wastage could be avoided if we had an institute for research into the binding properties of different soils and the strength of materials locally available. Is it not paradoxical that having one of the most intricate and extensive canal irrigation systems in the world, we do not have an institute of research for the investigation of problems of hydrology, by hydrodynamics, seepage, canal lining sub-soil classification and the designing of the water reservoirs, the barrage and the dams, which would be second to none in the world in equipment and staff. The pre-Partition institute at Lahore is an apology for such an institution where the total built-in area is perhaps less than the sprawling secretariat of Water and Power Development Authority (WAPDA) and where the young scientists get a salary less than the stenographers working in the WAPDA offices? Perhaps you are aware, Sir, how in a particular hydropower project the whole masonry was washed away only a few minutes after the inauguration of the project. Why should we have paid such a heavy price for depending upon foreign "Experts" who ignored the advice of our own engineers and the value of scientific research in designing and study of structures which should have preceded the construction of the project? In this subcontinent we used to have a very thriving industry based on vegetable dyes like "indigo" but the discovery of synthetic derivatives from coal-tar swept the indigo plantations out of production causing untold misery, financial loss and unemployment to millions. Before our very eyes, paper, plastics, nylons, rayon and other artificial fibres have pushed jute, cotton and wool out of the world markets. The writing on the wall is there, if only we could wake up in time and intensify our research efforts to treat our fibres differently, to diversify their uses and coexist with synthetic competitors. We have some of the finest quality iron ore (magnetite) with more than 50% iron content lying on the surface of the hills of Chitral

but the extent of this deposit is not more than 8 million tons. To the foreign experts this is a "pocket" deposit not worth bothering about. I wonder what blast furnaces produced the artillery of Babur when he conquered India or which electric smelting furnace forged the steel that took the sword of Islam from the shores of the Atlantic in the West to the Pacific Islands in the East. Why shouldn't we develop the technology of our own which could produce iron and steel in smaller furnaces at a price for our own markets? Why should we not be given a fraction of the Rs. 1000 million proposed to be invested in the iron and steel mills of Karachi and Chittagong for research? The Chitral ore alone could meet our requirements for the next 10 to 15 years and the Kalabagh ore if successfully treated could revolutionize our economy. How much have we spent on research in these ores? Let us consider yet another example that of building techniques and materials. In the good old days did the Moghuls, who have left behind monuments which are architectural wonders of the world, use cement and steel for reinforcement? Didn't they build road bridges and water dams with mortar, bricks and earth? Is there any harm if we evolve designs of arches and roofs based on the Mughal concept, use indigenous materials developed in our research laboratories and adopt them for providing decent shelter to our villagers in place of mud huts and hovels, without using an ounce of cement or steel? Isn't it a fact that the people of Mohenjodaro, Taxila and Harappa had better sanitary drains, roads and houses thousands of years ago, than the filth ridden, poorly ventilated agglomeration of mud huts for human habitation, we call a village? Modern science can bring light and power to the very doorstep if only we had the means to investigate the problems of rural electrification on a scientific basis. Leave it to the foreign "consultants" and their verdict will be that rural electrification is "uneconomic" and that the load factor will not justify the "return" on the investment in the generation, transmission and distribution of power. To them and our Treasury officials, unless there is a visible return of 6% on investment in a project, it is considered uneconomic and unfeasible. To them an invisible return in the form of increased industrial output of our cottage industries and agricultural production, better living conditions and prosperity of the people is of no consequence. Intensive researches are required to be done on A.C. and D.C. transmission systems, merits of single and three-phase supplies, cheaper wiring, cabling and conversion of heat direct into electricity etc. We in our Second Five-Year Plan have provided millions for investment in the power sector but not a penny for research on the problems of harnessing solar, wind or tidal energy wherever possible, of reducing losses in transmission and improving the efficiency of insulators, turbines, transformers and switchgears.

In short, there is not a single sphere of developmental activity in the fields of Agriculture, Health, Industry, Mining, Power Irrigation or Communications, where the scientific method of (*a*) survey (*b*) extension and (*c*) research cannot and should not be applied in the interest of better and more rational growth of economic development. Unfortunately the importance of investment in science and the scientific effort is not realized by our Planners and Administrators. As I have said before, they are science-

conscious but not science-minded. But just as the British deliberately created a class who ruled in their name, we expect you, Sir, to be a pioneer in creating a class of talented men and women—the scientists, the engineers, the artists, the writers and the scholars—who should be given the highest status in society, the highest salaries and the highest positions of honour and prestige in the country, so that the value of administrators alone is not highlighted as in British days, and the value of trained intelligence is recognized. The scientists in this country should be on "top and not on tap."

For some time to come, we should pay every medical graduate Rs. 50,000 provided he establishes his practice in a selected village. We should grant long-term, interest-free loans to our young engineers to set up small industries or workshops and our agricultural graduates should receive state lands and loans to cultivate model farms. All this investment would more than stop the flight of talent from the country and increase productivity and prosperity. All this would attract our youth to scientific careers at home rather than abroad. The scientist would come to be respected and honoured. The investment in youth will pay handsome returns and build the nation more quickly than investment in any other field.

According to the latest census figures there are as many as 24 million children of school going age and up to 1960, we have been able to provide schools for only 5.5 million in 47,500 schools—116 children per school. Nearly 2 million children are added every year so that to provide thousands of school buildings, millions of books and hundreds of teachers, will be staggering task for the resources of the State to accomplish. In two years time an adult cannot only learn a trade, but become a literate at the same time. If at every Tehsil headquarters we had an experimental farm, an industrial school and a vocational training centre for our adult population not only opportunities for gainful employment will open but in ten years' time literacy rate will automatically go up. The aimless drift of matriculates to the universities for a cheap degrees could be arrested and the character of our universities could change from a factory producing half-baked graduates to real centres of higher education and learning for those who show spark of talent in them. With an investment of less than $15 million our six universities could come up to the highest level of first class institutions of teaching of science and research. This is a fraction of the $100 million worth of commodities that we get in the form of aid from the United States alone. Let that country where the pulse of science beats the fastest, realize that winning the battle of the minds of the intellectuals is more important than dumping their farm surpluses. In our Second Five-Year Plan we have allocated a mere 4% of the total outlay on education. Let that be doubled or tripled in the next plan and invested in the establishment of experimental farms, industrial schools, polytechnics, vocational centres and the universities, rather than in mass literacy programs through State-run primary schools Mass literacy will follow and need not precede economic growth. The Soviet Union is producing four times as many engineers and three times as many doctors as the United States and this gap may mean the victory of one system of education over the other. In the Soviet Union, apart from the symbol of status attached to a scientist many spectacular things are being done to attract attention to science.

We are conscious, Sir, of the importance you personally wish to give to science in our affairs because one of the first actions you took on assuming the reins of Government in 1958 was to appoint a "Scientific Commission" with very broad terms of reference. The commission reviewed the whole position as it existed, defined the tasks for science in Pakistan, and suggested ways and means to improve the scientific effort of the country in different fields. Unfortunately the Report has got bogged down in the Ministry of Education. Although three and a half years have passed, not all the Research Councils have been established and not one of them has received a statutory charter of autonomy. The status and pay of scientists and technicians remain unchanged. The National Science Council has not met even once after its inauguration nearly a year ago. Its Secretary and staff have not been appointed so far. Except the Council at Scientific and Industrial Research and the Atomic Energy Council, no other Council has been provided with funds to establish institutes and laboratories.

Many countries, which have recognized the role of Government in promoting scientific research such as Japan, India, Indonesia, Germany and the United Kingdom, have constituted separate Ministries for science so that in the affairs of the State the point of view of the scientists is reflected at the highest level in the Cabinets of these countries. In the Soviet Union the National Academy of Science occupies such a unique position that its President enjoys a higher status than any Cabinet Minister and the voice of the Academy becomes the voice of the nation and the Cabinet. In the United States, the National Science Foundation, the Science Academy and the Special Assistant to the President for Science and Technology manage the Scientific Affairs of the Federal Government. In Pakistan, where science stands for the very progress, nay survival, of the country, a separate Ministry of Science and Technology entrusted with the responsibility of implementing the recommendations of the Scientific Commission with speed and vigour is very essential.

In the end, Sir, I wish to thank you and all the delegates to the Conference for giving me such patient hearing and hope that in your graciousness you will forgive me for saying something which I may have said in my enthusiasm for a cause, without meaning any ill-will to any. In the end I wish to conclude by a prayer:—

"O God ! grant us the serenity to accept the things we cannot change, the courage to change the things we can, and the wisdom to know the difference." AMEN !

o

West Pakistan Agricultural Potential:

THE PROBLEMS AND THEIR SOLUTIONS

by **Ch. MOHAMMAD HUSSAIN,**
Director, Land Reclamation, West Pakistan.

Chaudhry Mohammad Hussain as President of the section of Agriculture, Animal Husbandry and Forestry for the 15th Annual Pakistan Science Conference delivered his Presidential address on the 20th of March 1963. In this note we have reproduced salient features of his discourse.

Existing Data of the Country

Total area of West Pakistan is approximately 198.23 million acres. Land use data are available for 115.9 million acres. Out of this total area, 61 million acres are cultivable, 39 million acres (less than 20% of total area) are cropped annually. Thirty three million acres are commanded by irrigation system of which more than 25 million acres are annually cropped under irrigated agriculture. The irrigated lands form about 65% of the total cropped area, six to eight million acres are sown under dry farming, and the remaining 20 million acres are rather under-exploited.

According to census of 1961, the population of the whole of Pakistan is 93.8 million, out of which about 43 million reside in West Pakistan. It is estimated that by 1971 the total population in the province will be approximately 54 million. More than 75% of the people of West Pakistan live in farm villages while most of the rest are indirectly dependant on agriculture. In 1960-61, 55 per cent of the country's national income arose directly from Agriculture.

In 1960, 73 per cent of the value of exports came from agriculture against 27 per cent from other manufacturing. About 33 per cent of the area planted each year is under wheat. The food grains, next in importance, are rice and millets followed by maize, sorghum and barley. Other food crops including a variety of pulses, oil seeds, cane sugar, fruits, vegetables and potatoes are planted on slightly more than 20 per cent of the cropped area. The principal non-food cash crops *i.e.*, cotton and tobacco occupy only 10 per cent of the planted area. Nearly 50 per cent of the total food and fibre grown in West Pakistan, comes from the nine canal irrigated districts of former Punjab, slightly over 20 per cent from the former Sind, just under 10 per cent from Bahawalpur, about 15 per cent from Northern area of former Punjab and the remaining 10 per cent from the valley of Peshawar and the other irrigated land of north-west

frontier. Present crop production levels in West Pakistan are low. The population growth shows that 43 million inhabitants in West Pakistan are attempting to grow their food crops on 39 million acres. This comes to 0.75 acre per capita.

Land Forms and Soils in Relation to Agriculture

The soils of West Pakistan can be divided into five physiographic divisions each having its characteristic and uses. The western-most of these lie along the base of the Kirthar, Sulaiman and other ranges of the Western mountains. The second major division occupies the basin between the salt range and the Himalayan foothills.

The third division comprises the small piedmont plain deposited by torrents flowing from Himalayan foothills. Fourth division is the Thal tract which occupies most of the interfluve between the Indus river and Jhelum Chenab system. The fifth physiographical division comprises the scalloped interfluve of Punjab, the level plains of recent river laid alluvium in Punjab and Sind and small isolated outliers of similar alluvium near Peshawar and Bannu.

Climate in Relation to Agriculture

West Pakistan as a whole is either arid or semi-arid. According to precipitation data 66.7 per cent of the whole area receives rainfall from zero to ten inches, 24.2 per cent between 10 inches to 20 inches, 5.4 per cent between 20 inches to 30 inches, and only 3.7 per cent more than 30 inches annually. If rainfall had been the only source of water then 96 per cent of the total area of this province would be barren or sparsely vegetated.

Surface Supply Resources

In the order of the total area irrigated in the world, according to figures for 1955, China stands first with 77.2 million acres, India second with 59.0 million acres, U.S.A. third with 26.2 million acres, West Pakistan fourth with 21.3 million acres and USSR fifth with 16 million acres.

Although in respect of the total area irrigated, the position of West Pakistan is at the 4th place, but in respect of the percentage of area irrigated over the total, it is the highest of all; 11 per cent for West Pakistan against 7 per cent for India, 3.21 per cent for China, 1.36 per cent for U.S.A., and 0.29 per cent for USSR.

Indus river brings into the valley an average of 87 million acre feet of water per year and 80 million acre feet is added by its tributaries, namely the Jhelum, the Chenab, the Ravi, the Beas and the Sutlej. Out of 135 million acre feet, 57 million acre feet are in use and 24 million acre feet will be used to feed the canals, the water of which is being withdrawn by India. After taking into account the losses to the tune of 31 million acre feet, the water that will flow to sea will be 29 million acre feet against 99 million acre feet, going to sea previously.

Ground Water Resources

According to the studies made by WAPDA Pakistan Engineers and U. S. Government experts, there exists 1900 million acre feet of usable water in Upper Indus Plains to a depth of 450 feet. This fresh water aquifer is underlain in total area of 16.4 million acres which is 50 per cent of the present gross irrigated area. This comprises of 4.7 million acre in Rechna Doab, 2.0 million acres in Chej Doab, 4.4 million acres in Bari Doab and 5.3 million acres in Thal Doab.

Agriculture in Relation to Different Zones

The meteorological conditions, which undoubtedly have a marked effect on the

agricultural potential and related problems, divide the province into distinct agricultural zones. They comprise of:—

(i) *The Moist zone*

It covers the area between plain and central Himalayas. The inhabitants mainly depend on terrace cropping. Such areas are eminently suitable for raising of orchards.

(ii) *Semi arid and sub-humid zone*

This region extends over the submontane strip of the Indus plain, the Potwar Plateau and the Western hills. Soil erosion, inadequate arrangements of supplementary irrigation in the case of failure of rains, unscientific cropping and low productivity are the major problems of this tract. As like the humid region this region has also very bright prospects for development of fruit cultivation. The poultry farming, apiary and sericulture have a great scope in this area.

(iii) *Semi-arid zone*

This region lies mainly in the canal irrigated plains of the Indus Basin. The major problem of this zone is the low agri-productivity caused mainly by salinity and water-logging. The area has been contributing the largest portion of food and fibre in the province since the advent of canals. On the basis of surveys and general observations it is estimated that more than 50 per cent of West Pakistan's irrigated or potentially irrigable lands are affected by salinity and water-logging. In view of the increased intensity of cropping it is needed to revise the existing water allowance from about 3.3 cusecs to 6.6 cusecs for 1000 acres.

(iv) *Arid Zone*

This region lies in Southern part of Indus Basin and is canal irrigated. The annual rainfall in this tract is less than ten inches. An area of 1,34,000 square miles of Quetta and Kalat region faces the problem of water shortage. Considerable development of this area is possible if the limited water resources of this area are fully utilized.

Mechanized Cultivation

Mechanized cultivation is suggested for improved Agricultural production. The mechanization may first be undertaken by the big landlords, on co-operative basis by the small land-owners and in Government waste lands of new barrage areas like Ghulam Mohammad, Thal, Taunsa and Guddu Barrage. With the adoption of mechanical cultivation we may get surplus labour. Under present system about 4.18 million heads of draught animals are used in the country and have to be fed. These animals remain busy for 120 days in a year but 35 per cent of the total farm expenditure is due to them. An area of 3.13 million acres on the basis of 3/4th of an acre per draught animal is needed for growing fodder. But with the introduction of mechanized farming this area can be utilized for milch cattle or under other food crops.

Marketing

Production, consumption, marketing of farm products are affected to a great extent by certain economic factors such as small scale and seasonal productions, lack of control over the volume and quality produced and concentration of consumption in certain parts of the country.

(i) *Post-harvest market glut and lack of waiting power*

The lack of 'waiting power' on the part of producers is the main cause of post-harvest market gluts and depressed prices. Opening of 'grain banks' at Union Council Centres will help to a great extent.

(ii) *Perfection in marketing*

Utterly devoid of 'waiting power' and compelled by heavy debts and cash needs, poor cultivators in the under-developed countries are forced to sell immediately or soon after the harvest and thus invite their own doom in the form of 'market gluts' and 'depressed prices'.

Incentive

(i) *Guarantee of attractive prices*

A system of attractive prices guaranteed over a term of years be introduced for providing adequate incentive to the producers.

(ii) *Credit*

Lack of personal savings, lack of organized and institutional credit, contraction of loans on usury terms and not always spending them for productive purposes, are few among those causes which entrench peasants in misery deeper and deeper. The Taccavi grants should be placed at the disposal of the Extension Service of Soil Reclamation, Agriculture Department or A D. C. who have to recommend the cropping patterns and the use of better seeds and fertilizers and other agricultural machinery.

(iii) *Subsidies*

The seed of improved crop varieties and fertilizers may be provided to the cultivators on subsidized rates.

(iv) *Tax Holiday.*

Keeping in view the need of providing relief and incentive to farmers, Government have already granted revenue concession for bringing new lands under cultivation and for sinking of tubewells. Such concessions should be made more liberal and be extended also to the areas put to mechanized farming.

(v) *Crop Insurance*

Compensatory payment to farmers are necessary until fiscal monetary measures are developed to keep economy on keel with resources, labour and land fully employed. Measures for reducing income variability caused by production variability should be adopted. Crop insurance facilities for areas of high calamity risks should be provided.

(vi) *Land Taxation*

At present there are two systems of assessment:—

(*i*) Punjab System, (*ii*) Sind System. The Punjab system is applicable to areas of the former Punjab, North-West Frontier Province, Bahawalpur and some portions of the former Baluchistan. The Sind system is prevalent in the area of the former Sind, Khairpur State, and Nasirabad Sub-Division of the Quetta Division now in the Khairpur Division. The Punjab system consists of three methods, viz. (*i*) fixed, (*ii*) fluctuating (*iii*) sliding scale. The advantage in fixed assessment is that land revenue payee knows his liability and the benefits of any improvement or extension in cultivation that he may carry out during the currency of settlement. It gives better opportunity for better planning and evolving a better paying cropping pattern. The change in the assessment of the revenue from fluctuating to fixed system will also bring an improvement in production. The settlement period can be reduced to 15 years. Advance payment of land revenue with rebate if allowed to the willing cultivators during the term of settlement, will be an additional incentive for improvements.

News and Notes

SEATO GRADUATE SCHOOL OF ENGINEERING, BANGKOK

Seato Graduate school of Engineering has published its catalogue for the year 1962-63. The new academic year for the school starts from 17th June, 1963. Recently Prof. Bhanheem, Professor of Hydrology was here interviewing applicants for the next academic year. The school prepares students for the degree of Master of Engineering. Curricula presently available are highway engineering, hydraulic engineering (including hydrology) and Structure Engineering. Approximately sixty scholarships will be awarded by the SEATO Graduate School of Engineering for study at Bangkok. These scholarships are available to selected graduate students who are nationals of Borneo, Burma, Cambodia, Ceylon, India, Indonesia, Laos, Malaya, Pakistan, Philippines, Sarawak, Singapore, South Vietnam, or Thailand. Generally, a scholarship comprises a monthly subsistence allowance, tuition, textbook, and research equipment. Students resident outside of Thailand who are awarded scholarships may also receive air travel from their residence to Bangkok. Application forms and catalogues may be obtained by writing directly to the School; alternatively, they are available at embassies of the SEATO nations.

* * *

Visitors from and to SEATO Graduate School

Dr. A. P. Aglibut, Research Professor of Agricultural Engineering, University of the Philippines, Los, Banos, visited East and West Pakistan recently. He was in Karachi on 21st and 22nd March, in Lahore on 25th and 26th March and in Dacca on 28th and 29th March. He delivered two lectures:

(*i*) Potential Evapotranspiration studies in the Philippines.

(*ii*) "Management and uses of Irrigation water in low land rice culture in the Philippines." He distributed literature on "Tentative Guide", Glossary of Irrigation Terms and Level Furrow Irrigation for the Philippines. Both his lectures were well attended and much appreciated.

Dr. Anthony R. Cusens, Professor of Structural Engineering and Assistant Director of Research is visiting Pakistan and will deliver lecture on 1st and 2nd April on Concrete for Construction and Concrete for Buildings.

Dr. Cusens is teaching at Seato Graduate School of Engineering since 1960. The subjects taught in Structural Engineering are advance strength of materials, structural analysis and design, foundations and earth structures, structural laboratory, applied mathematics, reinforced concrete design, experimental stress analysis, prestressed concrete design, and structural model analysis.

Dr. Reynaldo M. Lesaca, Professor and head of Department of Public Health Engineering University of Philippines, visited Lahore in November and lectured at Dacca, Lahore, Rawalpindi and Karachi on the Role of the Sanitary Engineer in Public Health.

Dr. Emilio Seagre of the Department of Physics, University of California, Berkeley lectured at the Graduate School on 24th October on the ultimate constituent of matter.

Mr. G. M. Dorman of Shell International

Petroleum Company, London spoke on bitumen properties and design of flexible pavement on the 28th November at the School.

Dr. Maurice L. Albertson, Director of the Colorado State University, Research Foundation, lectured to the hydraulic research seminar on a "Generalized Approach to Research" during his visit to Bangkok.

Dr. Rachot Kanjanavanit, Senior Lecturer in Civil Engineering at Chulalongkorn University spoke about his structural designs for the new Public Relations Department building for the Government of Thailand.

Dr. Nazir Ahmad, Head of the Physics Laboratories, Irrigation Research Institute, Lahore, was in Bangkok for lectures and a seminar on 12th and 13th December. Dr. Ahmad lectured on "Prerequisites for Installing a Successful Tubewell"; "designing a Low cost and durable tube well", and "Utilization of tube wells to solve water-logging and salinity problems of West Pakistan". He led a hydraulic research seminar on "Instrumentation for Engineering Measurements."

Dr. Srethvit Suvunnetr, Bridge Engineer for the Royal Thai Highway Department, began a 40-lecture Special Programmes course in prestressed concrete structures on 27th December, at Bangkok.

Special Programmes in Pakistan

Prof. A. T. Khan of N.E.D. Government Engineering College, Karachi taught Soil Mechanics to 32 students of which 18 satisfactorily completed the stringent requirements and examination. The course extended to three and a half months and constituted 50 lecture hours.

Prof. A. T. Khan undertook another 50 lecture hours course in Foundation Engineering from 16th January 1963.

Dr. Mohammad Ibrahim, Professor and head of Department of Mechanical Engineer N. E. D. College, Karachi undertook a special course of lectures on Lubrication and Wear from 16th January 1963.

* * *

INTERNATIONAL ASSOCIATION FOR HYDRAULIC RESEARCH

The tenth congress will meet in London in September, 1963. The subjects notified for discussion include:—

(*i*) Recent research in coastal hydraulics.

(*ii*) Correlation of flood prediction and dam design.

(*iii*) Hydro vibrations.

(*iv*) Modern developments in hydraulic machinery and equipment.

In addition to these, three other subjects will be discussed at Seminars. These are as follows:—

(*v*) Stable channels in alluvium.

(*iv*) Sediment transport in pipes.

(*vii*) Laboratory techniques (new instrumentation) in hydraulic laboratories.

The proceedings of ninth convention held at Bubrovnik, Yougoslavia between 4 to 7 September in 1961 have been delivered to members. The proceedings constitute a volume of 1337 pages containing 182 contributions. One hundred and thirty four contributions were made to the four main subjects :

(*i*) Effects of turbulence on Hydraulic structures (27 papers).

(*ii*) Mechanics of Groundwater flow (37 papers).

(*iii*) Hydraulic problems for computers (43 papers).

(*iv*) Modification of natural streams by engineering structures (27 papers). These were general lectures.

(*v*) Hydraulic Problems of the Karst.

(*vi*) Three dimensional boundary layer flow.

(*vii*) Energy Transformation with zones

of separation. The subjects of SEMINAR were,

(*viii*) Hydraulic of small structures in Irrigation and Drainage system (10 concise eommunications).

(*ix*) Fundamental Hydrodynamics of Free surface flow and unsteady flow (38 concise communications).

(*x*) Hydraulic machinery.

The congress was attended by 241 participants and 56 bodies from 33 countries. Participants were from all the five continents, Africa, America, Asia, Australia and Europe. Pakistan sent no delegate. The only contribution from the country was that of Dr. Mushtaq Ahmad and Abid Ali on Effect of Barrages on the Regime of Rivers of Indus Basin. India contributed seven papers including two in the Seminar.

* * *

INTERNATIONAL PROGRAMME ON SCIENTIFIC HYDROLOGY

The General Conference of Unesco has approved the proposals for a long-term international programme in scientific hydrology as formulated in the report of the Committee of Experts which met in Paris on 5, 6 and 9 November, 1962.

Objectives of the Long-Term Programme

Problems concerning the various aspects of water management are now acute in many parts of the world. These problems are not peculiar to the arid zones, for they occur even in humid areas, and they involve far more than mere shortages of water. Destructive floods, waterlogging of land, and poor quality of water are cases in point. To take the single example of water shortage, however, it is evident that the rapid growth of population, and higher standards of living, will not only increase demands for water to serve a larger population but will also increase the per capita demand for water. On the other hand, many serious water problems arise simply from irrational management of water.

The overall objective of the proposed programme is to improve man's ability to use and conserve water resources. The specific objective leading to that end is the advancement of hydrologic science through international co-operation. It was therefore resolved that Member States, with the interested international, regional and national scientific organizations as well as with the assistance of appropriate groups of experts, to promote research and training in the domain of scientific hydrology.

The Member States to take at the earliest time all appropriate measures to ensure their full participation in the proposed long-term programme in scientific hydrology, and in particular to promote, from 1963 onwards, basic hydrologic studies in their respective territories, training of appropriate personnel, and initiation or strengthening of hydrologic services.

* * *

ADVISORY COMMITTEE ON ARID ZONE RESEARCH, EIGHTEENTH SESSION

The eighteenth session of the Advisory Committee on Arid Zone Research was held at the Hydrogeological Institute in Tashkent (Uzbekistan S.S.R.) from 13 to 16 Aug. 1962.

The Committee supported the recommendation of the Symposium on the Methodology of Plant Ecophysiology organized by the Botanical Institute of the University of Montpellier (France) with Unesco sponsorship, to the effect that a long-term programme of research in plant Ecophysiology be encouraged through collaboration between the institutions and the scientists of the interested countries.

Assistance to Research

Assistance was recommended to International Association of Scientific Hydrology for the organization in 1963 of a symposium on evaporation and evapotranspiration; to Professor M. Kassas (United Arab Republic) for the completion of a vegetation map of Egypt; to Mr. A. El-Zur (Israel) for preliminary studies on the application of dendochronology to paleo-climatic research in the Near East.

Symposia

The Committee noted with satisfaction that the Symposium on Demineralization of Water to be organized by Unesco and the Office of Saline Water and to be held in the United States in 1964 would be limited to the scientific aspects of the problem, and recommended that experts in cell physiology be included among the scientists to be invited to the meeting.

Training Courses

A course on geomorphology similar to the one held in the Middle East in 1962 was to be organized in South Asia in 1963.

Date and Place of Next Meeting

The Committee recommended that its next meeting be held in September 1963, in Latin America, immediately following the Scientific Conference on the Arid Regions of Latin America.

* * *

INTERNATIONAL SOURCEBOOK ON IRRIGATION AND DRAINAGE

The members of the FAO/Unesco working group for the preparation of an international sourcebook on irrigation and drainage of arid lands in relation to salinity met at Nimes and Aix-en-Provence from 11 to 14 April 1962, and in Moscow and Tashkent from 31 July to 18 August 1962, following invitations from the Governments of France and the U.S.S.R. respectively.

After reviewing the objectives of the project in the light of the comments received from governments and individuals, the working group wished to stress that the sourcebook is intended primarily for engineers, agronomists, hydrologists soil-scientists, technically trained administrators and other specialists dealing with irrigation and drainage projects and practices in arid lands in relation to salinity and alkalinity. The sourcebook is not intended as a scientific treatise for research workers but is rather intended to show the numerous interrelationships between irrigation, drainage and salinity problems and to encourage an interdisciplinary by those concerned with the planning and management of the project. At the same time, a clear and simple presentation of the scientific concepts and of the available experience will be provided, together with the necessary illustrations and bibliographical references.

* * *

SYMPOSIUM ON GEOMORPHOLOGY AND LAND USE

A symposium took place in Heraklion (Crete) from 19 to 26 September 1962 on this subject.

Specialists from fourteen countries took part in the meeting, at which 17 papers on Geomorthology and 19 on Land Use were read and discussed. At the end of the working sessions a study tour in Crete, to Rhodes and on the Greek mainland was organized for the participants.

* * *

SYMPOSIUM ON CONTINENTAL EROSION

A symposium on continental erosion was organized by the International Association

of Scientific Hydrology. The Italian Commission for Scientific Hydrology offered to act as hosts, and the symposium was held in Bari from 1 to 6 October 1962, including excursions to Apulia and Lucania where there are important hydro-geological derangements. Seven subjects were selected for discussion. The number of papers read on each subject were as under:

(*i*) Erosion and cartography (8 papers)

(*ii*) Basic research and analysis of continental erosion (9 papers)

(*iii*) General research on continental erosion (8 papers)

(*iv*) Special types of erosion (8 papers)

(*v*) Transport of solid material (7 papers)

(*vi*) Transport of solid material and sedimentation in reservoirs (7 papers)

(*vii*) Erosion control (4 papers)

The papers dealing with erosion maps brought out the necessity for further research on this question. On the other hand, those dealing with instruments, measurements and laboratory research on erosion showed that much progress had been made. As regards the transport and sedimentation of solid material, the papers presented were of the highest interest.

* * *

BIOCLIMATIC MAP OF THE MEDITERRANEAN ZONE

(A new Unesco publication)

The bioclimatic maps and brochure, which are on sale as a joint publication of Unesco and FAO and constitute volume XXI in the Unesco Arid Zone Research series, include the following:

Two sheets (East and West) each approximately 100×75 cm., printed in seventeen colours, and covering the Mediterranean region defined above.

An explanatory brochure of about sixty-five pages which describes the method followed for the compilation of the map, giving the characteristics of a certain number of stations and describing concisely the different cartographic zones, and also including an extensive bibliography.

Four small maps in colour on the scale of 1: 10,000,000, included in the pocket of the brochure, and covering the homologous regions of South Africa, North America, South America and Australia.

Price, paper-bound: $10; 50/- (stg.); 35 F.

* * *

SYMPOSIUM ON PHOTO-INTERPRETATION

Between 29 August and 7 September, Commission VII of the International Society for Photogrametry held a symposium on air-photo interpretation at the International Training Centre for Aerial Survey and the Technological University at Delft. The meeting, which was sponsored by the ITC in collaboration with Unesco and FAO, brought together scientists from all over the world who took part in working groups on the following subjects photography, equipment and techniques; geology, geomorphology, hydrology; soils, land classification, soil conservation; vegetation, forestry, plant ecology; regional geography and planning; ice; archaeology; oceanography, coastal research; engineering. The proceedings of the symposium will be published by the ISP during the course of 1963.

* * *

ECAFE/UNESCO SEMINAR ON GROUND WATER RESOURCES WITH SPECIAL REFERENCE TO DELTAIC AREAS

A joint ECAFE/Unesco Seminar on Ground Water Resources of Deltaic Areas was held in Bangkok from 24 April to 8

May 1962, followed by a study tour from 8 to 13 May to the Philippines and Japan to inspect work being carried out on the investigation and development of ground water resources. Two expert consultants, Professor David K. Todd, University of California, Berkeley (U.S.A.), and Dr. G. Santing, senior engineer, National Institute for Water Supply, The Hague (Netherlands) were appointed by Unesco to organize the detailed scientific programme and deliver appropriate lectures. The seminar was directed jointly by Mr. Koichi Aki, Chief Bureau of Flood Control and Water Resources Development, ECAFE, and by Mr. L. Mattsson, director of Unesco's South-East Asia Science, Co-operation Office in Djakarta. Participants from China (Taiwan), France, Federal Republic of Germany, India, Indonesia, Iran, Japan, Federation of Malaya, New Zealand, Pakistan, Philippines, Korea, Viet-Nam, Thailand, U.S.S.R. and U.S.A. attended the seminar, together with observers from WHO, WMO and the International Commission for Irrigation and Drainage. The following specific questions were dealt with in the twenty-four lectures given by the consultants, and the twenty-one papers presented by participants; fundamental laws and practical formulae in ground water hydraulics; well flow problems and analysis, construction and maintenance of wells; ground water fluctuations, ground water levels and land subsidence, effects of tides and other factors; salinity and chemistry of ground water; salt water-fresh water relationships; ground water management; ground water investigations by surface and subsurface methods; artificial recharge of ground water, hydro-geological maps; ground water in deltas.

The papers highlighted the problems and work of a number of countries in the region, in the field of ground water resources investigation and development. The seminar recommended that in view of the importance of the lectures and papers presented at its meeting, the full texts should be published as soon as possible.

* * *

WATER EVAPORATION CONTROL

A symposium on water evaporation control, organized jointly by the Unesco South Asia Science Co-operation Office and the Indian Council of Scientific and Industrial Research, was held at the National Chemical Laboratory, Poona, from 17 to 20 December, 1962. Participants from Afghanistan, Burma, Ceylon, India, Nepal and Pakistan attended. The symposium dealt with the physics and chemistry of monolayers on water surfaces and with field and semi-field experiments; special lectures were also delivered by visting experts.

* * *

ARID ZONE RESEARCH, PAKISTAN

A report has been prepared by the Food and Agriculture Council of Pakistan concerning arid zone research and development in Pakistan. A detailed account of the work so far carried out by different departments and organizations is divided into twelve chapters dealing with arid and semi-arid areas of West Pakistan; mapping; climatology and microclimatology; geology and geophysics; hydrology; vegetation; soil resources; forest wealth; animal wealth; and integrated surveys.

CONFORCE LIMITED

(PRODUCTION GROUP)

6, Egerton Road, LAHORE

Grams : CONFORCE

Phones : { 68758 / 5792

PRECAST AND PRESTRESSED CONCRETE PRODUCTS

Products

- Transmission and distribution line Poles-Spun
- Post-tensioned beams
- Pre-tensioned beams
- Pre-tensioned double tee floor and roof slabs
- Precast channel floor and roof slabs
- Precast columns
- Insulated wall panels
- Architectural wall panels
- Cast Stone, sills, coping Hollow Blocks etc.
- Miscellaneous

In addition to the above, products can be designed to your specification for a particular project. All items can be quoted either at our plants or erected in place.

Economy

Usually precast and/or prestressed concrete will prove to be the most economical in those applications in which a reasonable quantity of identical units is required. By the use however, of the standard designs shown in our brochures, small quantities will in most cases prove to be economical. One of our engineers will be pleased to visit you and supply designs and quotations on any particular project which you may be planning.

CONFORCE LIMITED

CIVIL ENGINEERS AND CONTRACTORS
REINFORCED AND PRESTRESSED CONCRETE SPECIALISTS

(CONSTRUCTION GROUP)

6, Egerton Road, LAHORE

Grams : CONFORCE — Phones : 68758 O 5792

UNITED CHEMICALS FACTORY UNDER CONSTRUCTION AT
KALA SHAH KAKU DESIGN AND CONSTRUCTION BY CONFORCE