PAPER NO. 445

IRRIGATION SYSTEM IN PAKISTAN MEASURES TO IMPROVE IRRIGATION EFFICIENCY AT THE FARM LEVEL

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Paper No.445

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BY

I.A. KHALIQ(*)

1. INTRODUCTION

This paper seeks to introduce the Irrigation practices in Pakistan, the investigations done for determining the irrigation efficiency, the concepts for improving the on-farm water management with optimum utilization of the available infra-structure in the Indus Basin with a view to maximizing the agricultural output.

Islamic Republic of Pakistan is a South-Asian country situated between 24° and 37° N and 60° and 78° E with Iran and Afghanistan on the West and North-West, China on the North-East, India on the East and South-East and with Arabian Sea in the South. Its estimated population is about 75 million with a growth rate of the order of 3 percent. The four provinces of Pakistan are North West Frontier Province, Punjab, Sind and Baluchistan.

Pakistan comprises the Indus Basin with the river Indus and its tributaries flowing through it, the Northern and Western Highlands, the Baluchistan Plateau and the Thar Desert. The Indus Basin supports an integrated network of irrigation system which is the largest contiguous irrigation system in the world. The climate is tropical in the plains and subtropical in the mountainous regions. Temperatures range from mean monthly minima of 40°F during December and January to mean monthly maxima of 100°F during June and July.The incidence of rainfall in Pakistan is highly variable, with less than 4 inches in some parts of Sind province to more than 20 inches near the foothills in the NWFP. Rate of evaporation ranges between 60 to 80 inches annually. Without assured irrigation supplies, a large area of Pakistan can not support any agriculture, as the rainfall over this tract is either meagre or unreliable. The Indus Plain has been formed by the alluvium deposits of over 600 feet depth.

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2. LIMITATION OF WATER COMPARED TO LAND

The gross area of Pakistan is nearly 200 million acres. All the available water resources, surface as well as groundwater, are hardly sufficient to support good irrigated agriculture in about 20 percent area of Pakistan viz. 40 million acres. Considering the vast areas available in Pakistan, water resources will, in the long run, be the major constraints in agricultural extension into new areas. It is, therefore, very essential to utilize the available water with the utmost care for maximizing agricultural production and put an end to the avoidable wastage in the irrigation system, as well as, in the out-dated cultural practices.

3. CHARACTERISTICS OF THE RIVERS

The Indus and its tributaries originate at very high altitudes and initially flow along snow covered glacial regions. The rivers are formed with water from snow-melt, springs and rains at the lower altitudes. They are usually in spate during July and August due to monsoon rains.The peak flows in the rivers are 50 to 200 times the normal winter flows, which are low and steady. River flows and their rate of rise during March to June fluctuate from year to year, similar fluctuations are experienced in the falling stage during September and October.

The annual surface water potential of the Indus, Jhelum and Chenab under various conditions of flow is quoted below to give an idea of the variations which have to be kept in view for planning of the water projects required for supporting agriculture:

Flow Grade	Indus at Kalabagh	Jhelum at Mangla	Chenab at Marala	Combined flow in one year
		(Figures in M.A.F.)		
Mean	91	22	26	139(Statistical Year)
Maximum	120	33	35	186(1959-60)
Minimum	61	13	18	96(1974-75)
Median	91	23	26	140(1966-67)
80% availability.	79	17	21	117(Statistical)

Besides the main rivers in which reliable flows are received, there are many other streams and torrents in the downstream reaches which provide very erratic and irregular flows which may total up to 12 M.A.F. in a median year. Hence it may be assumed that 152 M.A.F. flow will be available in a median year. The distribution of this flow in the various months and crop seasons is given below:

MONTH	FLOW IN M.A.F.	PERCENTAGE
April	8.651	5.6
May	12.662	8.3
June	30.446	20.0
July	29.673	19.5
August	30.849	20.3
September	16.182	10.6
Kharif Total:	128.463	84.0
October	6.037	4.0
November	3.559	2.3
December	2.819	1.9
January	2.481	1.6
February	2.802	1.9
March	5.946	4.0
Rabi Total:	23.694	16.0
Total for the Year:	152.157	100.00

During the Rabi season only 16 percent of the annual flow is available and during the three flood months of June, July and August 60 percent of the annual flow occurs.

4. EVOLUTION OF IRRIGATED AGRICULTURE:

From times immemorial crops had been cultivated in some areas with the help of rains and utilizing the moisture left in the soil by the floods of the rivers and torrents. A few hundred years ago inundation canals were constructed by making cuts in the river banks at suitable locations where the river approach remained stable. These canals helped in spreading the flood water for cultivating lands adjacent to the rivers. To stabilize the offtaking conditions of inundation canals and for new canals weirs and barrages were built across the rivers to divert water into the canals. All such diversion structures enabled the canals to take verying quantity of water, on run-of-river pattern, whenever the water was available in the rivers. In these circumstances, appropriate cropping patterns and cultural practices were evolved based on run-of-river supplies and the agricultural production was, therefore, subjected to the vagaries of hydrological conditions. A map showing the canal systems of Pakistan is attached as Figure-1.

5. WATER MANAGEMENT OF THE INDUS BASIN

As the winter flow in the rivers is limited, only 21 million acres of land has been provided with perennial irrigation facilities through the canals having an aggregate diversion capacity of 98,000 cusecs i.e. 6 million acre feet per month. These canals can draw off almost the whole winter season supplies of the rivers in a normal year.

Besides the perennial canals, there are non-perennial canals, including the canals for rice growing in an area of 14 million acres, having an aggregate diversion capacity of 148,000 cusecs i.e. 9 million acre feet per month. These canals generally operate from April 16th to October 15th.

Inter-river Links were planned for efficient utilization of the river flows through transfer of the surplus water of the Western rivers to meet the irrigation needs on the other Eastern rivers.

The canals in Pakistan were operated on run-of-river pattern until 1967, when the first big reservoir with a live storage capacity of 5.34 m.a.f. at Mangla on the Jhelum river was completed under the Indus Waters Treaty(1960) as a replacement work to enable India to with-hold the entire flow of the Ravi, Beas and Sutlej which had been used in Pakistan canals.

Although Tarbela Dam on the Indus with a live storage capacity of 9.3 m.a.f is not yet fully operational, the total water availability for producing the main winter crop of wheat in the irrigated areas has increased by about 35 percent in a median year and nearly 50 percent in the year of minimum flow. With the commissioning of Tarbela Dam, the era of run-of-river diversion into the canals and the consequent uncertainty about water supplies during critical periods is over. Now water can be released to meet the period-wise requirements of major crops grown on various canal commands. This will bring about improvement in cropping pattern (with more cash crops) as well as in the yield per acre of the irrigated crops. Now the farmers can concentrate on production planning and procurement of non-water inputs like improved seeds, fertilizers, pesticides, tractors and modern farm implements and technical know-how from Extension Workers.

Since 1960, the major development of groundwater through installation of tubewell pumping in areas underlain with useable quality of groundwater was taken up in the public sector. This has served as a valuable demonstration of the technical and economic viability of tubewells. Since then, the private sector has taken a big initiative in the installation of tubewells to augment canal water and for arranging timely and assured water supply to their farms.

At present over 100 m.a.f. surface water is diverted into the 43 canal commands in a year. Out of this about 75 m.a.f. of water reaches the outlets. It is supplemented with about 33 m.a.f. groundwater pumped annually by about 12,000 public tubewells and about 150,000 private tubewells. 108 m.a.f. water is available for use in 89,000 main water courses in the system. Out of 108 m.a.f. it is estimated that about 40 percent water is utilized by the crops and 60 percent is lost in the water course and in the farms. This is based on the results of the 61 watercourses survey carried out by WAPDA Master Planning Division. The conveyance loss in the water courses include the seepage, evaporation, spillage, leakage, non-beneficial evapo-transpiration and deep percolation.

Considering mainly the available surface water supplies in a median year, the following order of magnitude estimate of the remaining water potential for development of agriculture in the irrigated areas has been worked out:

Sr. No.	Mode of Development	At Source	At Canal Head	At Mogha	At Farm Inlet		
					Total	Kharif	Rabi
			(in m.a.f.)				
1.	Through conservation of loss in water courses	-	-	-	12.3	7.4	4.9
2.	Ground Water pumping	-	-	12	9.4	2.8	6.6
3.	Canal Remodelling	-	6	4.5	3.4	3.4	-
4.	Surface Storage	18	13.5	10.1	7.6	1.5	6.1
5.	Riverain Area Ground Water storage	10	9.5	7.1	5.4	1.1	4.3
	Future Potential Total:				38.1	16.2	21.9
	Present Availability:				73.1	43.5	29.6
	Total Future Potential:				111.2	59.7	51.5

As the median year's surface supplies will be available only for fifty percent of the time, some carry-over reservoirs like Skardu Dam will be needed ultimately to store water in good years and use the storage in poor years to ensure water supplies upto the level of median year's supplies. In the long run, it may also be possible to over-pump from the ground water reservoir in very dry years and ensure equitable management of the surface

and groundwater over the whole canal system or Doab or even whole Indus Basin.

6. ON-FARM WATER MANAGEMENT

The final links in the system for delivery of irrigation water to the crop are the watercourses extending from the canal outlet to the farm, and the field itself. Recent surveys have determined that water management efficiencies in these links of the delivery system are substantially lower than had been generally assumed. The surveys and associated studies also identified the large potential benefits that can be obtained by On-farm water management improvements.

Systematic investigations of watercourse delivery losses and field application efficiencies were not made until recently. Some limited observations were made in the mid 1960's under the Lower Indus Project. However, systematic and extensive observations were started under the Mona Reclamation Experimental Project by Colorado State University(CSU) and WAPDA in 1973. In 1975-76, CSU/WAPDA carried out a survey of 40 watercourse commands distributed over the Indus Plains, spending about one week on each watercourse 1/. WAPDA Master Planning further expanded the survey data base through a programme of observations in 61 watercourse commands over a full year cycle extending over two crop periods.

7. THE WATERCOURSE SYSTEM: In each canal command, the land is divided into watercourse command areas or "chaks" varying in size from 200 acres to 700 acres. There are some 89,000 watercourses chaks in the Indus Basin Irrigation system, each containing generally 20 to 50 farms. Each chak comprises a complex miniature irrigation system with an average of about 10 miles of channels.

8.1 CHARACTERISTICS AND OPERATION

Flow in the watercourse is governed by a canal outlet, or "mogha", designed to pass a constant discharge that selfadjusts in proportion to limited variations in flow in the parent channel. The original design concept was that watercourse discharge should be about the application rate that could be efficiently handled by a single farmer, estimated to be one to three cusecs, although in rice areas of the Southern Region, some watercourses are such larger. The size of the watercourse command was established as a function of the flow rate, taking into account design cropping intensity, the assumed irrigation requirements and the topographical features. Since design intensities at the start of the project were very low in comparison to current situation, the watercourse systems, at present, suffer from in-built capacity and flexibility constraints.

1/ *Farm Irrigation Constraints and Farmer's Responses Vol.III, Consequences of the Present Farm Water Management System. CSU Water Management Research Paper 1978.*

The distribution of water to farms within a watercourse command is generally by a weekly time rotation called the "warabandi" with each farmer allotted a specific time period starting on a particular week day in proportion to his holding assuming the flow in the watercourse to be constant, in which he receives the entire flow of the watercourse. Water is directed into various branches of the watercourse network by constructing earth diversion dams at Junctions, and to farm fields by cutting the watercourse bank, and later restoring it, at designated points called "nakkas". Water may be distributed on individual farms through the farmer's own channels or by flowing from field to field. In SCARPs (Salinity Control and Reclamation Projects providing additional tubewell water), the public tubewells are located at the head of the watercourse and tubewell water mixed with canal water, is distributed in the same manner. Private tubewell water is often transferred between farms using portions of the watercourse channel network.

The boundaries of the chak and the alignment of the main watercourse channel system, or "sarkari khal", are sanctioned by the Provincial Irrigation Departments. The main watercourse system is located in a public right of way and average about two to four miles in length. The Irrigation Departments, when requested by any share holder under the Canal Act, establish the official rotation schedule, called the "pakka warabandi", but have no other operational function within the watercourse command. The farmers often make informal adjustments in the warabandi to suit their mutual needs and convenience. The farmers are required by law to maintain the main watercourse under enforcement of the Irrigation Departments, but this enforcement is rarely exercised. Farmers have their own arrangements for mobilising the labour for the collective responsibility of cleaning the watercourses before the start of the winter crops. A typical watercourse layout is shown in Figure-2.

9. WATERCOURSE DELIVERY EFFICIENCY

Delivery efficiency is defined as the ratio of flow at the point of delivery to the flow at the watercourse head. The average watercourse delivery efficiency is the average of delivery efficiencies to each farm in the watercourse command, generally represented by the average of delivery efficiencies to a head, middle and tail farm. For planning purposes in the 1960's, watercourse average delivery efficiencies were assumed to be from 85 to 90 percent, that is a 10 to 15 percent loss. However, the CSU/WAPDA Master Planning surveys established that delivery efficiencies are much lower, averaging about 55 percent overall, with losses around three times as much as formerly assumed. Based on the evaluation so far done of the survey results of the 61 watercourses in which irrigation applications were measured on farms at head, middle and tail locations and allowing for operational losses, representative delivery efficiencies for different situations are given in Table-1.

TABLE-1

WATERCOURSE DELIVERY EFFICIENCIES
(Percent)

Category	Efficiency	
	Rabi	Kharif
All 61 watercourses	55	56
Province		
NWFP and Punjab	58	61
Sind and Baluchistan	45	44
Canal Type		
Perennial	55	56
Non perennial	54	56
Groundwater Development		
Non-Scarp	56	58
SCARP	44	44
Private Tubewells	62	64
Location in Canal Command		
Head	52	53
Middle	54	53
Tail	60	60

Source: WAPDA Master Planning Watercourse Survey

Losses from watercourses occur by seepage, leakage, spillage, non-beneficial evapo-transpiration and evaporation. Ponding tests made by the LIP Consultants in the mid-1960's indicated seepage rates of 10 to 15 percent, almost the same as assumption of 85 to 90 percent watercourse delivery efficiency made in the Projects. However, these were non-flowing tests in which leaks and spills were carefully eliminated, thus isolating only one component of the total loss. As shown in the Table, there is little difference in the delivery efficiencies between perennial and non-perennial canal commands but in the SCARP areas the efficiencies are 12 to 14 percent lower. The delivery efficiency on the watercourses with private tubewells is, however, much higher. The observations also indicate that the watercourses which are located in the head reaches of the canals and distributaries have a

lower delivery efficiency reflecting the wastage associated with greater water supplies. The farmers on the older canals realise the value of water and have evolved some collective measures to maintain the watercourses but on the newer canals the water delivery efficiencies are comparatively lower.

Examination of the delivery efficiencies for reaches of the watercourses having coarse, medium and fine textural soils did not bring out that higher losses were necessarily associated with the coarse textured soils. This is explainable because of the large component of losses by waste and spillage compared to the seepage and due to the sealing effect of the sediment carried in the canal waters during flood months.

Leakage through watercourse banks causes surface ponding alongside the watercourse expanding the surface area for seepage and evaporation and often damaging crops adjacent to the watercourse. Leakage occurs at authrised and un-authorized nakka cuts of which there may be hundreds in a watercourse system; through holes made by burrowing animals; and at other weak points due to cattle trespass and crossings by the wheeled traffic of the farm.

Watercourse banks often have little or no freeboard and spillage by over-topping is common, especially in SCARPs, as indicated in Table-1 where tubewell discharge is added to the canal water flow. In most cases watercourses capacity expansions were not included in the SCARPs "under the expectation that the necessary improvements would be made by the farmers".

High losses in watercourses result in inequitable distribution of water to farms in the watercourse command. Effects of inequitable distribution are indicated by variations in cropping intensities of head, middle and tail farms, as shown in Table-2.

TABLE-2

CROPPING INTENSITIES OF FARMS ON WATERCOURSES

Province	Number of Watercourse	Cropping Intensities, Percent		
		Head Farm	Middle Farm	Tail Farm
NWFP	5	143	144	139
Punjab	36	138	128	108
Sind and Baluchistan	20	105	111	88

Source: WAPDA Master Planning Watercourse Survey

10. APPLICATION EFFICIENCY

Application efficiency is defined as the ratio of water stored in the crop root zone to water applied on the field, expressed in percent, but not exceeding 100 percent. That is, if the water applied on the field is less than the storage capacity of the root zone, indicating under-irrigation, the application efficiency is 100 percent. Application efficiencies significantly less than 100 percent indicate over-irrigation and, depending on the desirable leaching fraction, waste of water.

Application efficiencies were measured on head, middle and tail farms in the 61 watercourse survey. Overall results of the survey are summarized in Table-3. The average application efficiency was determined to be close to 70 percent with little variation between seasons. The application efficiencies for non-perennial areas were recorded to be about 10 percent lower than those in the perennial commands. Soil type appears to make a significant difference in application efficiencies with coarse soils having greater losses. Some wasteful cultural practices are also responsible for low application efficiency. As might be expected, application efficiencies are lower on head farms as compared to tail farms because of the relatively more plentiful water supply near the watercourse head. Uneven surface has low application efficiency.

TABLE-3

FIELD APPLICATION EFFICIENCIES
(Percent)

Category	Efficiency	
	Rabi	Kharif
All 61 watercourses	70	68
Province		
NWFP and Punjab	73	69
Sind and Baluchistan	64	65
Canal Type		
Perennial	72	71
Non Perennial	63	60
Groundwater Development		
Non SCARP	69	67
SCARP	70	69
Private Tubewells	78	74
No Tubewells	64	64

TABLE-3(Contd)

Category	Efficiency	
	Rabi	Kharif
Soils		
Coarse	48	48
Medium	77	76
Fine	66	64

Source: WAPDA Master Planning Watercourse Survey

Watercourse command efficiency is the combination of watercourse delivery efficiency and field application efficiency and indicates the percentage of watercourse head diversion actually stored in the root zone for uptake by the crops. Watercourse command efficiencies observed in the 61 watercourse survey, with this definition average about 39 percent.

11. WATERCOURSE IMPROVEMENT PROGRAMMES

The desirability of modifying earthen watercourse channels to reduce losses and improve operational characteristics has along been recognized but recent determination of higher than assumed loss rates has given a new impetus to the research and pilot projects. A pilot project for polythene & polythene in brick masonry lining of watercourses was undertaken by the Punjab Irrigation Department in 1973 under IRDP(Integrated Rural Development Programme) but was discontinued after lining 16 watercourses in various Divisions. Monitoring of these watercourses is being done by Irrigation Research Institute. Applied research has been underway since 1973 by CSU/ WAPDA at Mona on a variety of concepts for reduction of watercourse losses. Approaches range from simple cleaning and trimming, compacted earth embankments, to masonry and concrete linings.

A pilot programme for watercourse improvement and precision land levelling of 1500 watercourse commands has been undertaken with the cooperation of USAID. Watercourse improvement is provided by the compacted earth method except that the head reaches and sections in villages are masonry lined. Technical supervision, pacca nakkas and brick and cement are provided by the Government but the farmers provide all of the labour. Precision Land levelling is provided on a cost sharing basis. On the average, about 20,000 feet of channel are improved and 30 pacca nakkas, 4 culverts and 2 buffalow baths are provided for each watercourse command for an average cost, without farmers' labour, at Rs. 4.0 per foot. The results of the wa-

tercourse improvement on a few watercourses in the Punjab area, as evaluated by the project officers of Agriculture Department, show that there is 21 percent increase in water supply, 20 percent increase in cropping intensity and 21 percent increase in yield per acre of major crops.

Although farmer acceptance is good during construction, there is some doubt among project administrators that farmers will provide the frequently needed maintenance after construction.

12. SUGGESTED ACTION

As a result of watercourse improvement programme the savings affected in the conveyance losses are a fraction of the water made available at the outlet and therefore the extra availability of water in different periods corresponds to the pattern of flow at the outlet. This means that the saving of conveyance losses is maximum when the outlet are getting their authorized share while the canal system is running full, usually during the flood period(July and August) when the value of water is the least. Whereas the non-perennial channels do not operate during most of the Rabi (winter) season, hence there is no question of saving of water during this period or short water supplies in the system when water is most valuable. With this pattern of availability of extra water, the lands in the tail end of water course will no doubt get more water according to the existing pattern of flow. Due to the capacity and flexibility constraints of the present earthen canals distribution system, the outlets cannot supply fluctuating quantities of water to meet the demand of crops in different stages of growth. As the ultimate objective of all such programme is to improve the agricultural output, it is, therefore, essential that the water course improvement has to be considered as part of the package deal for the development of irrigated agriculture, which should provide for, inter alia, adequate and timely irrigation supplies according to crop demand, drainage needs, non-water inputs, farmer's education through extension service, adoption of site-specific cultural and reclamation practices and improved maintenance of the canal and drainage system. For the formulation and implementation for this plan, a multi-disciplinary organization is needed under a dynamic leadership to bring about institutional coordination among the various Government Department/Agencies and un-official organizations and to enlist active support and participation of the farming community. The major components of possible programme should include the following:-

1) With the commissioning of Mangla and Tarbela reservoirs and effective management, the existing network of canals can be given assured water supply corresponding to the seasonal water requirements of the major crops. Adequate funds may have to be provided to maintain this system, which is a great national asset, under proper operational efficiency.

2. Arrangements are also to be made to provide to the farmers all non-water inputs including improved seeds, fertilizers, pesticides, tractors with farm implements, bank loans and technical know-how about modern cultural practices.

3. There is an urgent need to educate the farmers and create an intense awareness among them about the inherent agricultural potential of their farms which may be of the order of three to five times the present day agricultural output.

4. Institutional vacuum beyond the outlet has to be filled up with multi-disciplinary organization to bring about coordinated management of the land, water and other resources for realizing the latent potential in the most efficient and quickest way. Farmers may have to be organised into Cooperative/associations or some arrangement compatible with the local traditional socio-political conditions to carry out collective responsibilities of maintenance and improvement of watercourses and management of surface and groundwater for maximizing agricultural production.

5. For proper water management including improved irrigation efficiency at the farm level, farmers may take the following measures:

   a) On all canals in areas underlain with useable quality ground water, 'pacca nakkas'(gated masonry structure) be constructed on watercourse and their regular cleaning be carried out. Small tubewells may be installed in the farms to exploit the ground water reservoir & to provide control to the farmers on this source of water for responding to the crop needs.

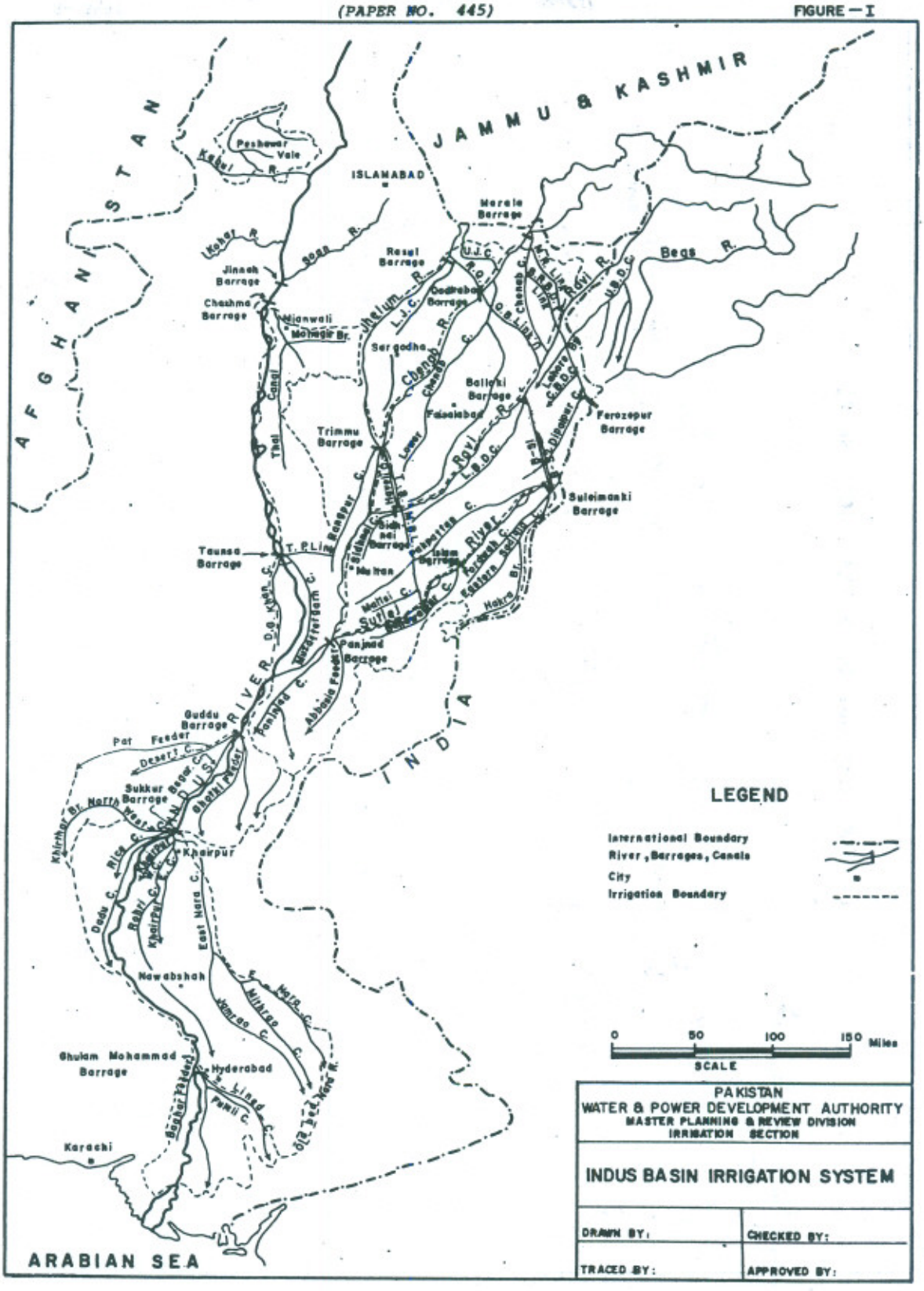
   b) On all canals in areas underlain with unuseable quality of groundwater(with the exception of rice growing areas in the southern region and other areas with high groundwater table), lining of the effective length of watercourses, which remain under operation for most of the time in a warabundi cycle, may be carried out to conserve the good qualtity surface water and to reduce the drainage bill in pumping out and disposal of the saline effluent.

   c) Improving the layout of the farm with proper levelling, appropriate rate of water application to suit the soils and crops for minimizing the water application loss.

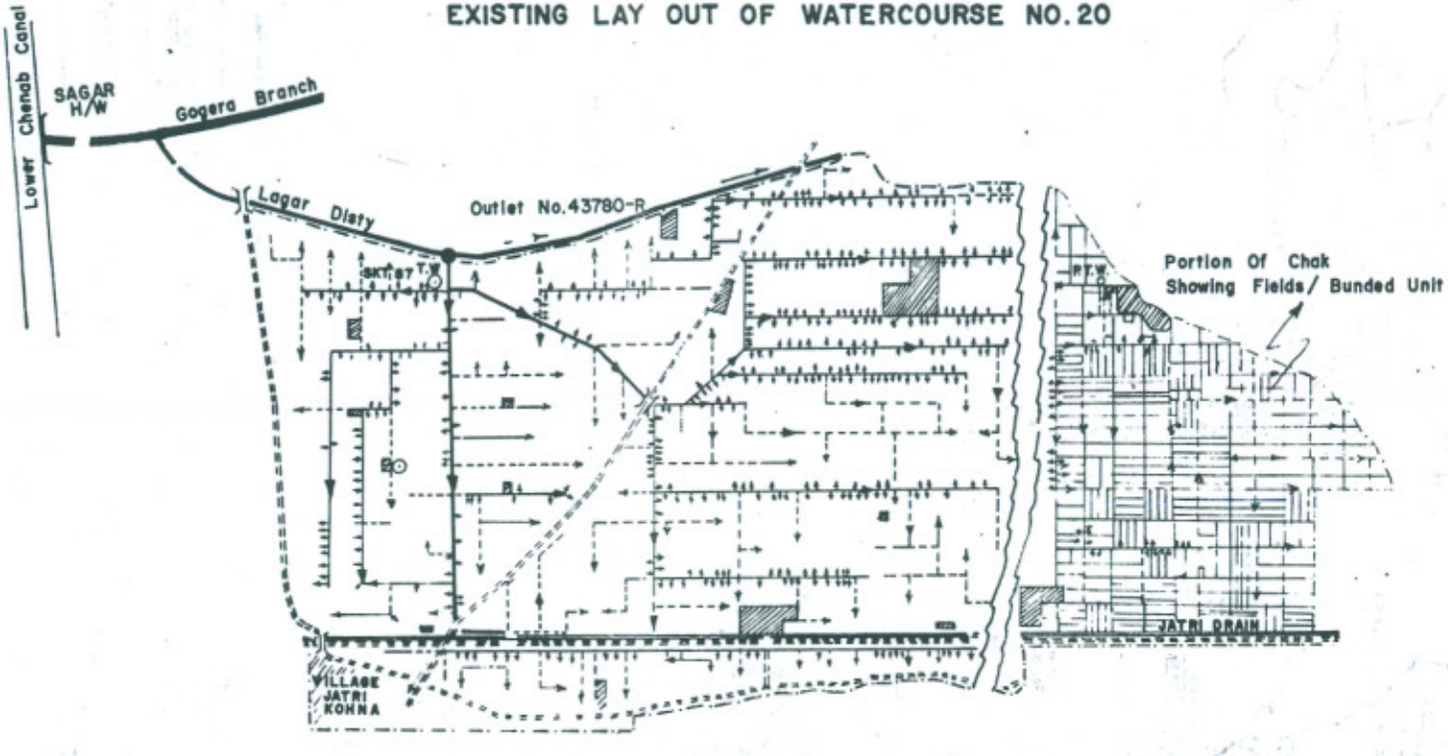
6. The legal instruments, like the Canal and Drainage Act ,the Soil Reclamation Act in vogue, may have to be reviewed to facilitate the total management plan.

7. New policy decisions may have to be taken to rationalise water Rates and other farm cesses, subsidies, bank credits to generate financial resources and to induce efficient management through conjunctive use of surface and groundwater wherever possible, with a view to minimizing the drainage requirements and maximizing the agricultural output in the immediate future.

FIGURE – I


AFGHANISTAN
JAMMU & KASHMIR
INDIA
ARABIAN SEA
ISLAMABAD
Peshawar Vale
Kabul R.
Kabul R.
Swat R.
Jinnah Barrage
Chashma Barrage
Rasul Barrage
Mangla Barrage
Jhelum R.
Mianwali Motorway Br.
Sargodha
Chenab R.
Trimmu Barrage
Thal Canal
Qadirabad Barrage
Ravi R.
Bambanwala Feeder
Ballaki Barrage
Faisalabad
Lower Ravi L.B.D.C.
Ferozepur Barrage
Suleimanki Barrage
Taunsa Barrage
T.P. Link
Bahawalpur
Sidhnai Barrage
Multan
Islam Barrage
Panjnad Barrage
Abbasia Feeder
Guddu Barrage
Pat Feeder
Desert C.
Sukkur Barrage
Khairpur
Nawabshah
Ghulam Mohammad Barrage
Hyderabad
Karachi
Begs R.
U.J.C.
U.B.D.C.
Lahore Br. C.B.D.C.
Dipalpur C.
Eastern Sutlej
Hakra Br.
Fordwah C.
Panjnad C.
Dadu C.
Rohri C.
Khairpur Nara C.
East Nara C.
Mithrao C.
Kotri Barrage
Pinyari C.
Pai Khan Wah R.
LEGEND
International Boundary
River, Barrages, Canals
City
Irrigation Boundary
0 50 100 150 Miles
SCALE
PAKISTAN
WATER & POWER DEVELOPMENT AUTHORITY
MASTER PLANNING & REVIEW DIVISION
IRRIGATION SECTION
INDUS BASIN IRRIGATION SYSTEM
DRAWN BY:
CHECKED BY:
TRACED BY:
APPROVED BY:

EXISTING LAY OUT OF WATERCOURSE NO. 20



SALIENT FEATURES

Design Discharge	1·12 C.F.S.
Actual Discharge	1·5 C.F.S.
Command Area	613 Acres
Public Tubewell	1 No.
Public T/W Discharge	1·61 C.F.S.
Private Tubewell	1 No.
Private T/W Discharge	1·0 C.F.S.

LEGEND

Main Watercourse	⟶
Branch "	⟶
Field Ditches	⟶
Tubewell	⊙
Outlet	●
Nakka	↓
Village / Dera	▨
Kacha Road	=====
Chak Boundary	—·—·—

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FIGURE—II