Report No. 1122a-PAK

Pakistan: A Review of the Indus Basin Project, 1960–1975

April 21, 1976

South Asia Projects Department
Irrigation and Area Development Division

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CURRENCY EQUIVALENTS

Currency Unit	=	Pakistan Rupee (PRs)
PRs 9.90	=	US$1.00
PR 1.00	=	US$0.10
PRs 1 million	=	US$101,010

WEIGHTS AND MEASURES

Maund	=	82.286 lbs.
Bale (raw cotton)	=	392 lbs.

FISCAL YEAR

July 1 to June 30

GLOSSARY OF ABBREVIATIONS AND TERMS

CCA	-	Culturable Commanded Area
CCG	-	Canal Command Groups
GCA	-	Gross Commanded Area
GWH	-	Gigawatt hours
HYV	-	High Yielding Varieties (of crops)
IBP	-	Indus Basin Project
ISS	-	Indus Special Study
M	-	Million
MAF	-	Million Acre Feet
NWFP	-	North West Frontier Province
PTW	-	Private Tubewell
WAPDA	-	Water and Power Development Authority
Doab	-	Term used in the northern part of the Indus plains for the interfluve between two rivers.
Kharif	-	The summer growing season, April to September
Peak Load	-	The maximum demand on the electrical system
Period Under Review	-	The report deals with the period from 1960 to 1975
Pulse(s)	-	Crop-plant of the family Leguminosae grown for consumption both by human beings and domestic animals. Also referred to as grain legume.
Rabi	-	The winter growing season, October to March

PAKISTAN

A REVIEW OF THE INDUS BASIN PROJECT, 1960-1975

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A REVIEW OF THE INDUS BASIN PROJECT, 1960-1975

I. INTRODUCTION

1.01 In May, 1971, the World Bank as Administrator of the Indus Basin Development Fund and the Tarbela Development Fund reported on the completion of the works under the Indus Basin Project (IBP) and on the status of the Tarbela dam. Now that Mangla dam and the link canals have been functioning for five years--and before the Tarbela dam has made its contribution to the overall system--it is timely to review the effectiveness of the works in meeting the original objectives of the Indus Basin Development Fund Agreement of 1960. 1/

1.02 This report complements the semi-annual progress reports on the works and the financial status of the IBP and Tarbela funds issued by the Bank as the Administrator. The most recent progress report for the period up to December 31, 1975 indicates that all outstanding works and financial matters concerning the IBP have been terminated with minor exceptions. Financial statements show an estimated balance of foreign exchange of US$347 million subject to finalization of the remaining costs chargeable to the Indus Basin Development Fund. Most of this balance will be transferred to the Tarbela Development Fund.

1.03 The purpose of this review is to assess the benefits attributable to IBP, not only as replacement works but also as a result of more timely releases of irrigation water due to storage and of the substantial amounts of hydro-electricity supplied by Mangla to the power system.

1.04 A Bank mission visited Pakistan in October/November, 1975 to obtain information to serve as the basis of the analysis of the performance of the IBP. This report is based on the findings of that mission. It also draws on the work of the Bank's irrigation and drainage review mission of 1974/75, 2/ and other sources. In late 1968 and again in 1969/70, World Bank missions visited Pakistan to review the Action Program that had been set out in the Indus Special Study of 1964/66 which had been included in the 1964 Indus Basin (Supplementary) Agreement.

1.05 These reviews by the Bank and other studies and research in Pakistan led to the conclusion that a Revised Action Program was necessary. The United Nations Development Program is supporting a major planning project in Pakistan which has as its overall objective the "Preparation of a Revised Action Program and National Investment Schedule for Irrigated Farming Development and Land Reclamation in the Indus Basin and adjoining areas in Pakistan." The Bank has been designated as the Executing Agency for this UNDP project.

1/ See Annex 1.

2/ Special Agriculture Sector Review, Volume II: Irrigation and Drainage, Report No. 922a-PAK, January 1976.

II. THE INDUS WATERS TREATY

Background

2.01 Evidence from archaeological sites in Pakistan shows that as early as 1000 B.C. land near the main rivers of the Indus plains was being cultivated under flood irrigation. The first canals were constructed some five or six centuries ago and extended under the great Moghul emperors. These early canals were inundation channels some of which were of considerable size. They delivered water to the fields when rivers were high in summer, but tended to be unpredictable in operation and subject both to frequent breaches and serious siltation problems.

2.02 The canal system which exists today was started in the nineteenth century under the British administration. The early canal systems were designed on a perennial basis with water delivered all the year round. Later, with increased demands on limited rabi river supplies, some canals were designed to operate non-perennially, that is, in kharif only. The newest canal systems which are served from the barrages at Taunsa, Gudu and Kotri, are largely non-perennial. Non-perennial canals are generally operated from mid April to mid October. In a year of low kharif supplies the period during which the canals are open may be curtailed but, conversely, in a year of good rabi river flows, non-perennial canals may be given supplies outside their normal season. Areas of fairly shallow, fresh groundwater were generally designated as non-perennial, as it was considered that Persian wheels could be used both for drinking water and for rabi irrigation, as had been the practice in the inundation canal areas. On the other hand perennial supplies were generally provided where groundwater was deep, saline or brackish and considered unsuitable for irrigation. Established water rights are the main reason for the distinction between perennial and non-perennial areas in individual canal commands. 57% of the culturable commanded area (CCA) in Sind has been designed for perennial supplies whereas 45% of the Thal Doab and Indus Right Bank area in the Punjab is designated as perennial. In the remainder of Punjab, that is, the Jhelum/Chenab zone 1/ the proportion of perennial areas averages 64%.

2.03 The modern irrigation system of the Indus plains commands a gross area of about 38 million acres and comprises some 38 thousand miles of canals in 42 canal commands. The total CCA is officially stated to be about 33.5 million acres. However, in practice, no more than about 25 million acres regularly receive surface water supplies; the remaining land, which is culturable waste, 2/ is largely in the Lower Indus area of Sind. About 20 million

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1/ Jhelum/Chenab zone, refers to the area of the Punjab now served by water from the Jhelum and Chenab Rivers directly and via the link canals.

2/ Within the command area of main canals, but not yet developed for irrigation.

acres of the total CCA are designated for perennial supplies and 13 million acres for non-perennial supplies. In addition several small areas of land are still irrigated by inundation canals and these amount to about 100 thousand acres.

Partition and Its Effect

2.04 Partition in 1947 cut right across the Indus river system. Pakistan became the downstream riparian state on all the tributaries, and the division of the waters was transformed from a national to an international problem. The good offices of the Bank were offered to India and Pakistan in 1951; the offer was accepted in 1952. In 1954, the Bank put forward a proposal for settlement comprising three essential features:

(a) The waters of the three western rivers - Indus, Jhelum and Chenab - were to be allocated to Pakistan, and the waters of the three eastern rivers - Ravi, Beas and Sutlej - to India. Requirements of the areas within Pakistan, hitherto fed by the eastern rivers, would in future be met by waters to be transferred from the western rivers by means of a system of replacement works. It was estimated that some 14 MAF would be required, ultimately, to replace the water designated for use in India.

(b) India would make a contribution to the cost of the replacement works.

(c) During the construction phase, India would limit her withdrawals from the eastern rivers in proportions to match Pakistan's capacity to replace.

In September 1960 after several years of difficult negotiations India and Pakistan signed the Indus Waters Treaty incorporating these provisions.

2.05 To compensate Pakistan for the loss of the waters of the Eastern Rivers, six governments and the Bank along with Pakistan and India agreed to provide funds to enable a system of replacement works and some development works to be constructed which would enable Pakistan to transfer water from the Western Rivers to the areas dependent on supplies from the Eastern Rivers. The proposed system of works consisted of Mangla Dam on the Jhelum River, Tarbela Dam on the Indus River, 400 miles of new link canals, three major barrages, the remodelling of three existing link canals and two barrages, and a program of tubewells and drainage. The total cost of the system was originally estimated at US$838 million equivalent.

The Indus Basin Development Fund Agreement

2.06 Under the Indus Basin Development Fund Agreement 1960 ("the 1960 Agreement") signed at the same time as the Indus Waters Treaty, the six governments (Australia, Canada, Germany, New Zealand, United Kingdom and United

States) and the Bank agreed to contribute to a Fund (the Indus Fund) administered by the Bank, an aggregate amount of US$691 million, partly in loans, and partly in grants, including the equivalent of US$235 million to be provided by the United States in rupees. India's payments in sterling under the Indus Waters Treaty amounting to US$173.8 million equivalent (including US$28 million to be kept in a Special Reserve to meet a contingent liability to India in case of extension of the Transition Period, or otherwise to be paid to Pakistan) were also to be paid into the Fund. Pakistan agreed to contribute in rupees the equivalent of £ 9,850,000 (US$28 million) and in sterling £ 440,000 (US$1.2 million). The total available resources of the Fund thus amounted to US$867 million equivalent (in addition to US$28 million to be held in the Special Reserve) compared with a preliminary estimate of the cost of the system of works of US$838 million.

2.07 Under the 1960 Agreement, the resources of the Fund were to be disbursed to meet all the costs of the system, in rupees and in foreign exchange; rupee expenditures would be met partly with the rupee contributions of the United States and Pakistan and partly with purchases by the Indus Fund of rupees with foreign exchange. Following the establishment of the Indus Fund, the Bank undertook a thorough review of the estimates of the cost of the entire system of works which was to be financed out of the Fund, and reported in 1962 that its revised estimates, although still preliminary, showed that it would not be possible to finance the whole system with the resources of the Indus Fund.

2.08 After intensive discussions and negotiations among the Bank, the contributing governments and Pakistan, a new financial plan for a reduced system of works was adopted in which the Mangla Dam on the Jhelum River, the barrages and the link canals would be given first priority and the tubewells and drainage would be omitted; any funds remaining in the Indus Fund would be made available to Pakistan to finance the Tarbela Dam on the Indus or another water development project, to be agreed by the Bank and Pakistan after a study of the water and power sector in West Pakistan. The new financial plan contemplated increased contributions by the Contributors aggregating US$315 million equivalent on the understanding that Pakistan would accept them as a final release of any obligations, moral or legal, of the Contributors to finance the entire system of works provided for in the 1960 Agreement. For its part, Pakistan would assume the obligation to provide all future rupee requirements of the Indus Fund not covered by the United States original rupee contribution. No further purchases of rupees with foreign exchange would be made by the Fund, and Pakistan gave up its right to receive the Special Reserve which therefore remained in the Fund. 1/ The Indus Basin Development Fund (Supplemental) Agreement, 1964 reflected the formal agreement of the Parties on the reduced project to be financed by the Indus Fund, and, the increased contribution of the Parties.

1/ See Section 4.02 of the Indus Basin Development Fund Agreement 1960, and Section 4.03 of the Indus Basin Development Fund (Supplemental) Agreement 1964.

III. INDUS BASIN PROJECT

3.01 The engineering plan of the Indus Basin Project, redefined by the 1964 (Supplemental) Agreement, is probably the largest program of civil engineering works ever to be undertaken, involving a gigantic system of works consisting of the following:

(a) an earthfill dam on the Jhelum River (Mangla dam) with a live storage capacity of 5.34 million acre-feet, including hydro-electric power equipment with an installed capacity of 300,000 kw. 1/ The dam is so designed as to enable its height to be raised in the future when the demand for irrigation water supplies warrants it;

(b) a series of new major inter-river link canals joining the Indus to the Jhelum, the Jhelum to the Chenab, the Chenab to the Ravi, and the Ravi to the Sutlej. The net volume of water to be transferred from the three western rivers (excluding conveyance losses) amounts to some 14 million acre-feet annually and irrigates about 5 million acres;

(c) five new barrages and an inverted siphon at points where a link crosses a river;

(d) remodelling of the two existing barrages, three existing inter-river link canals and of existing canals affected by the construction of new links; and

(e) the organization and administration by the Bank of a study of the water and power resources of West Pakistan (the Indus Special Study) intended to provide the Government of Pakistan with a basis for development planning in the water and power sectors of the economy within the context of their successive five-year plans. The first objective of the study was the completion of a report covering the technical feasibility, the construction cost and the economic return of a dam on the Indus at Tarbela.

3.02 A feature of the construction of the IBP works has been the high quality of planning and organization which led to completion by contractors, both Pakistani and expatriate, on or before the completion dates set down in the overall plan. The major construction risks inherent in work of this nature on rivers subject to rapid seasonal flow variations were successfully avoided or overome. As a result, it was unnecessary to make any payments to

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1/ Financed under IBP. Total installed capacity will finally be 800,000 KW.

India for an extension of the transition period allowed in the Indus Basin Treaty of 1960. This released the full amount of US$28 million held in the special reserve.

3.03 Two other circumstances led to savings in the IBP fund. First, Pakistan has borne a somewhat larger proportion of the total costs than had been estimated. Because of the practice of requiring contractors when tendering to specify what proportion of the contract price they would require in rupees to meet rupee costs incurred by them, and what proportion they would require in foreign exchange to meet other contract costs, the foreign exchange component of contracts awarded since 1964 has been somewhat lower than in contracts awarded before that time, resulting in Pakistan meeting from its own resources a larger proportion of the total costs. Second, contract costs were lower than the estimates based on experience gained up to 1964, partly because unit prices were lower than expected, and partly because the works have been completed without major mishaps during critical construction phases when they were vulnerable to adverse river or meteorological conditions. The allowances for flood risks and engineering difficulties which were prudent and necessary to allow for in the early stages of such a vast and complex scheme of works have not therefore been fully used. The savings due to lower prices, the reduced use of the contingency provisions and other adjustments including foreign exchange and earnings from investment of the funds have amounted to about US$136 million in the IBP fund. 1/

3.04 Estimates made in 1962 for the cost of IBP, after adjusting for the changes in the project components agreed in 1964, amounted to US$1,149.5 million. Up to December 1975, a total of US$1,246.5 had been spent. Some small further expenditures remain, but it is likely that total cost overruns will be less than 10%. Tables 2 and 3, Annex 6 show annual expenditures by project component up to mid-1975. As noted above, the Indus Basin Fund, which covers only foreign exchange, remains in surplus despite these cost overruns because of a higher than expected proportion of rupee costs in the total project, which have been borne by Pakistan and not by the Indus Basin Fund.

1/ Subject to some uncertainty pending the settlement of claims, particularly Chasma Barrage, but not likely to differ from the $136 M by more than 3%.

3.05 In addition to the expenditures on the IBP itself, Pakistan has made significant investments, totalling 1,092.45 million rupees, in related water development projects during the period 1960 to 1974. Over 80% of these expenditures were on four of the approximately 100 projects undertaken, namely Gudu Barrage Project - 442.29 M. Rs.; Taunsa Barrage Project - 198.77 M. Rs.; Ghulam Mohammed Project - 197.09 M. Rs.; and Thal Project - 50.87 M. Rs. The next most significant expenditure, and the only one of any size in NWFP, was for the Warsak High Level Canals - 27.84 M. Rs. Over 84% of the expenditures on these five projects took place in the period 1960/61 to 1966/67. The expenditures for the years 1960/61 to 1973/74 were as follows (in millions of rupees). 1/

1960/61	1961/62	1962/63	1963/64	1964/65	1965/66	1966/67
128.03	158.54	122.82	155.78	161.93	37.24	46.09
1967/68	**1968/69**	**1969/70**	**1970/71**	**1971/72**	**1972/73**	**1973/74**
46.34	36.09	39.64	20.52	12.58	38.06	88.79

3.06 The principal dimensions and quantities of the Indus Basin Project works are given below:

	Live Storage (MAF)	Dimensions Main Dam (Feet)	Main Spillway Capacity (Cusecs)	Excavation (Million cu. yds.)	Fill (Million cu. yds.)
Mangla Dam (River Jhelum)	5.34	8,400 (Length) 454 (Maximum Height)	1,100,000	135	143

Link Canals	Capacity (Cusecs)	Length (Miles)*	Excavation (Million cu. yds.)
Trimmu-Sidhnai (T-S)	11,000	44	23.0
Sidhnai-Mailsi (S-M)	10,100	62	35.0
Mailsi-Bahawal (M-B)	3,900	10	2.4
Rasul-Qadirabad (R-Q)	19,000	30	38.3
Qadirabad-Balloki (Q-B)	18,600	80	90.0
Balloki-Suleimanke II (B-SII)	6,500	39	20.5
Chasma-Jhelum (C-J)	21,700	61	119.0
Taunsa-Panjnad (T-P)	12,000	38	22.5
		364	350.7

* Canal Mile = 5,000 feet.

1/ The figures do not include the expenditures by Pakistan for "Raised" Chasma Barrage as no item for this project was included in the Annual Development Plan documents from which the above data were assembled.

Barrages	River	Flood of Record (Cusecs)	Design Discharge (Cusecs)	Length of Barrage (Feet)
Sidhnai	Ravi	167,000	150,000	712
Mailsi Structure and Siphon	Sutlej	427,000	429,000 5,000(Siphon)	1,601
Qadirabad	Chenab	880,000	900,000	3,373
Rasul	Jhelum	875,000	850,000	3,209
Chasma /a	Indus	1,176,000	950,000	3,556
Marala	Chenab	1,024,000	1,100,000	4,472

/a The design of the Chasma barrage was subsequently changed to allow for a storage development of about 0.9 MAF. The incremental costs of the higher barrage were borne by the Government of Pakistan through a special fund, the Chasma Raising Fund, administered by the Bank.

IV. ECONOMIC ANALYSIS AND CONCLUSIONS

4.01 The Indus Basin works were built during a period of rapid change in the agricultural, water and power sectors in Pakistan. In addition, the seven years since operation of the works began have included the highest annual river flow on record and two of the lowest. Assessing the role and value of IBP in the developments of the last 15 years, therefore, required a detailed review of the sectors concerned. 1/

Water Supply

4.02 Surface Water--Rabi: The major new source of surface water since 1960 is Mangla and the link canals. Mangla was designed primarily for replacement of flows from the Ravi, Beas and Sutlej rivers as they were diverted for use within India. In years of low flow, Mangla has provided as much as 1.25 MAF extra water (see Annex 2), compared to what would otherwise have been available. In high flow years, it is doubtful whether any incremental supply has resulted from IBP. The exceptional nature of the flows in the last seven years makes it difficult to estimate the relative likelihood of surpluses and deficits compared to replacement, and analysis has therefore been made on the basis of averages. Analysis shows that when the eastern river flows are completely cut off, Mangla will on average provide replacement of the rabi water plus a small increment (amounting to about 1.2% of total rabi surface deliveries) in the month of November. With some water still flowing in the eastern rivers in rabi, there has been a larger

1/ For a more general review of agriculture, see Special Agriculture Sector Review Report, 1976, Report No. 922-PAK.

incremental supply available. This has usually been retained in Mangla to meet peak power demands, with the result that extra deliveries to irrigation in rabi have been close to those expected after full diversion of the eastern rivers--namely 0.3 MAF in November or 1.2% of the total rabi surface supply.

4.03 Surface Water--Kharif: The IBP link canals provide the capability of transferring very large quantities of water from the Indus, Jhelum and Chenab rivers into the Ravi and Sutlej. The links were designed to replace the flows of the Ravi and Sutlej, and the evidence to date (see Annex 2) shows that they have achieved this, and should continue to do so when flows in the Ravi and Sutlej are completely diverted. A precise analysis of the effect of the IBP links on kharif water supply is particularly difficult, since kharif flows are normally very variable (and have been extremely variable since 1967). Furthermore, the flexibility provided by the complex link system makes it difficult to establish exactly how much water has been delivered from one river to another. In 1974/75, the Sutlej was almost completely diverted within India, the inflow being reduced from 12.94 MAF (average 1960-65) to 0.40 MAF. The average reduction in inflow over the period since 1966 is about 7.5 MAF.

4.04 Groundwater: The most significant development in water supply in the 1960-75 period has been the growth in tubewell development, especially private tubewells. In 1960 less than 2 MAF were supplied by tubewells, while by 1974-75, this figure was almost 30 MAF. Some sixty-five percent of this increase came from private tubewells. Of the 120,000 private tubewells currently estimated to be in operation, about 115,000 are in Punjab. The rapid growth of the past years is now leveling off, however. The scope for further development is constrained by three main factors:

- in Punjab the water table is approaching stability, and substantial further development will require either mining of groundwater (which will mean that many existing wells will be rendered inoperative) or increases in the surface supplies to maintain balanced recharge;

- many of the larger farmers who are able to afford a tubewell, and have enough land to justify one, now have them and encouraging small farmers to install wells is more difficult, although there may be a potential for the development of smaller sized tubewells not yet common in Pakistan;

- in Sind the sweet groundwater areas are more limited than in Punjab, and offer less scope for development.

Annex 3 deals in detail with tubewells and groundwater.

Power

4.05 The IBP investments at Mangla provided the basis for a major hydroelectric scheme. This came at a time when Pakistan was desperately short of

power, and faced by enormous demand increases, not least from the new tubewell development. The power available from Mangla is a direct function of the level of water retained. At full head, the power available from each unit is 100 MW, while at minimum head this falls to 45 MW. This relationship influenced the operation of Mangla. In the future, when the power supply will be more plentiful (particularly when Tarbela power enters the system), Mangla operation might be expected more closely to reflect agricultural needs. Annex 2 Section H reviews the power investments at Mangla in detail.

Agriculture

4.06 In the 15-year period under review, the gross value of agricultural production in the project area almost doubled (see Annex 4). Three main factors contributed to this growth: in the middle and late 1960s, high yielding varieties of wheat and rice were introduced, and widely adopted; secondly, and intimately linked with the spread of HYVs, fertilizer consumption increased fivefold between 1964-65 and 1972-73. The final major factor in the increased agricultural production has been the very rapid growth in the water supply, primarily from private tubewells.

Data Base for the Analysis

4.07 Agriculture and Water Supply: Data were collected from 11 canal command groups 1/ which were chosen as separable by virtue of having different agricultural and/or water supply characteristics. The data consisted of yields and areas for various crops, sales of fertilizer and monthly water deliveries (by source) for each season between 1960-61 and 1973-74 (see Annex 4). Since the agricultural data were organized by administrative districts, which sometimes overlapped the boundaries between canal groups, considerable work was involved in reorganizing the data for the purpose of this report.

4.08 Power: Peak demand and annual sent-out power from Mangla was available by year, and from this the size, timing and cost of alternative thermal sources of energy which would have been necessary to supply the same power were estimated (see Annex 2, Section H).

4.09 Costs and Prices: The actual expenditures on IBP were available from the Quarterly Accounts. 2/ The cost of alternative thermal power stations were based on experience of the Lyallpur plant. All costs were converted to 1975 Rupees. Average world prices for the 1967-74 period, expressed in 1975 Rupees, were used to value agricultural output and inputs.

1/ These areas, designated Canal Command Groups (CCG), are natural groupings of the various canal commands according to commonly recognized geographic units in Pakistan. The 11 CCGs are shown on the map which accompanies this report, and include one in the North West Frontier Province, six in the Punjab and four in the Sind and part of Baluchistan.

2/ Based on data furnished by Comptroller, IBP, from the Quarterly Financial Statements. Source: Budget Officer, Office of the Comptroller, IBP, WAPDA.

Methodology

4.10 The economic assessment presented here is a cost-effectiveness study of IBP, rather than a rate of return calculation for the following reasons:

- the project was undertaken for reasons which were in large part political--the avoidance of a major dispute between India and Pakistan, the results of which, in human and economic terms, are unquantifiable;

- while Pakistan has received the benefits of power supplies from Mangla and replacement of the water diverted, India also has benefitted from increased availability of irrigation water.

However, the time period for analysis is short and the river flows have been exceptional, so only estimates of the final impact of IBP have been possible.

4.11 The data collected enabled the calculation of several key variables which have been used to evaluate IBP:

- the unit cost of rabi replacement water;

- the unit cost of kharif replacement water;

- the savings resulting from the Mangla power scheme compared to the thermal alternative;

- the economic value of production per hectare;

- the value of water.

Results of the Analysis

4.12 The Unit Cost of Rabi Replacement Water: Rabi water is replaced by means of Mangla dam and some of the link canals and barrages. The Indus links, and Chasma barrage will be effective in rabi only when Tarbela is operational. Therefore, the costs attributable to the replacement of rabi water was taken as the cost of Mangla less the cost of the thermal power alternative to Mangla, plus a proportion 1/ of the cost of the links and barrages used to distribute the Mangla water. Using a discount rate of 10%, the unit cost per acre-foot of water was found to be Rs 170 per acre-foot at the dam (equivalent to Rs 260 at the water course head regulator).

1/ Taken as one-half.

4.13 The Unit Cost of Kharif Water: Kharif water was replaced by means of the links (including the Indus links) and all the barrages. The cost stream includes half the cost of all links and barrages. The relevant "benefit" stream has been estimated on the assumption that the average replacement has to date been equal to the average reduction in Ravi/Sutlej inflows, and will in future equal almost complete diversion (achieved in 1974/75 on the Sutlej). The unit cost of water, calculated as described above, comes to Rs. 80 per acre foot (Rs. 120 at the water course head regulator).

Savings in Power Generation Costs

4.14 Table 23 (Annex 2) summarizes the cost of power investments at Mangla and the costs of alternative thermal plants. The savings are substantial, amounting to over Rs.800 million annually at full development. When compared to the total cost of Mangla, it was found that the savings justified almost 70% of the investment at an opportunity cost of capital of 10%.

The Economic Value of Production per Acre

4.15 Using 1967-74 average world prices for major crops, adjusted to reflect transport and processing costs, and expressed in 1975 rupees, the gross economic value of production was calculated (see Annex 4). After deducting the cost of inputs, the average net economic value of production since 1967 was calculated (Table 18, Annex 4). This amounted to Rs. 740 per cropped acre (Rs. 870 in rabi).

The Value of Water

4.16 October-November Deliveries: By means of regression analysis, the relationship between water supplies and production was estimated using the data for the 11 canal command groups. The most significant relationship was between the deliveries in October-November and the cropped acreage. At the margin it was found that one extra acre foot resulted in 0.4 extra acres of crop. 1/ It can, therefore, be estimated that water delivered at this time is worth about Rs. 350 per acre foot. 2/ This value agrees closely with the corresponding value of Rs. 350-400 per acre foot deduced by linear programming analysis. 3/

4.17 Average Value at Other Times in the Year: The net economic value of production in the irrigated areas affected by IBP is Rs. 740 per acre

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1/ This is a marginal relationship--the average relationship was much higher (1.6 acres per acre foot). Other constraints, probably draft power, clearly reduce the marginal effect.

2/ 0.4 acres/acre foot x 870 Rs./acre = Rs. 348/acre foot.

3/ Food Research Institute Studies, Vol. XIV, No. 1, 1975.

(Annex 4). Water deliveries average 3-4 feet per cropped acre. 1/ To estimate the value of production attributable to water, it is assumed that without irrigation the yields 2/ would be reduced by a factor of three and the cropping intensity would be halved. Thus, the comparable value of production per acre would be at most Rs. 130 (since inputs are not reduced by the same amount). The benefit attributable to water 3/ is thus about Rs. 175 per acre foot.

Conclusions

4.18 The Indus Basin works have fulfilled their basic replacement objective and on average provide a very small increment. In the future, the works should on average continue to provide replacement after full diversion of the Ravi, Beas and Sutlej.

4.19 The cost of the replacement water (at the watercourse head regulator) is Rs. 260 per acre foot for rabi water and Rs. 120 per acre foot for kharif water. The weighted average cost (Rs. 170) compares favorably with other irrigation projects. 4/

4.20 The cost of water at a 10% cost of capital supplied by IBP is comparable to its value as presently used. As farming methods and usage of HYVs and fertilizers increase, the value of the water will increase.

4.21 The main developmental impact to date of IBP has been from the power generated at Mangla. Savings over the thermal alternative justify 70% of the cost of Mangla at a 10% opportunity cost of capital.

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1/ See Special Agricultural Sector Reivew, Vol. II.

2/ Ibid, Vol. IV.

3/ Rs. (740-130) - 3.5 ft. = 174 Rs. per acre foot.

4/ The comparable figure for a recent irrigation project is about Rs. 200 per acre foot.

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A REVIEW OF THE INDUS BASIN PROJECT, 1960-1975

Objectives of the Indus Basin Project

1. The objectives were articulated in Annexure D of the Indus Basin Development Fund Agreement entitled "Project Description", which reads as follows:

> "The Project consists of a system of works to be constructed by Pakistan which will:
>
> "(a) transfer water from the three Western Rivers of the Indus system (Indus, Jhelum and Chenab), to meet existing irrigation in Pakistan which have hitherto depended upon the waters of the three Eastern Rivers (Ravi, Beas and Sutlej), thereby releasing the whole flow of the three Eastern Rivers for irrigation developments in India;
>
> "(b) provide substantial additional irrigation development in West Pakistan;
>
> "(c) develop 300,000 KW of hydro-electric potential for West Pakistan;
>
> "(d) make an important contribution to soil reclamation and drainage in West Pakistan by lowering groundwater levels in water-logged and saline areas; and
>
> "(e) afford a measure of flood protection in West Pakistan.

2. The system of works includes:

		Location	Capacity
"A. Dams & Related Works	(1)	Jhelum River	Live storage of 4.75 million acre
		a. Hydro-electric generating facilities	300,000 KW
	(2)	Indus River	Live storage of 4.2 million acre feet

	Location	Capacity
"B. Link Canals (Construction and Remodelling)	Rasul-Qadirabad	19,000 cusecs
	Qadirabad-Balloki	18,600 cusecs
	Balloki-Suleimanke	18,500 cusecs
	Marala-Ravi	22,000 cusecs
	Bambanwala-Ravi-Bedian-Dipalpur	5,000 cusecs
	Trimmu-Islam	11,000 cusecs
	Kalabagh-Jhelum	22,000 cusecs
	Taunsa-Panjnad	12,000 cusecs
"C. Barrages	Qadirabad Ravi River Sutlej River	

"D. Tubewells and Drainage Works

(1) About 2,500 tubewells to contribute to a lowering of the water table, some of which will yield additional water supplies for irrigation use; and

(2) A system of open drains to lower the water table in about 2.5 million acres of land now under cultivation but seriously threatened by water-logging and salinity.

"E. Other Works

Ancillary irrigation works directly related to the foregoing, including remodelling of existing works."

Note: As a result of the Supplementary Agreement of 1964, item A(2) Indus River Storage and Item D Tubewells and Drainage Works were omitted from the project.

PAKISTAN

A REVIEW OF THE INDUS BASIN PROJECT, 1960-1975

Surface Water Availability and Use

A. Introduction

1. In order to determine the impact of Mangla dam storage and the IBP link canal distribution capability on the canal commanded area in the Jhelum/Chenab zone of the Punjab, three discrete periods have been analyzed:

(i) 1936/37 to 1946/47 - a period immediately before partition which serves as a notional base from which to judge the replacement requirements;

(ii) 1960/61 to 1965/66 - a period immediately before Mangla and the IBP links came into effective operation but during which the post-partition Pakistan links, BRBD, MR and BS1 1/ were in use;

(iii) 1967/68 to 1973/74 - the period since Mangla and the IBP links effectively came into operation.

Data for the year 1974/75 has also been studied in view of the limited period of record since Mangla became operational and because in the rabi period of this year unusually low river inflow conditions prevailed. Separate analyses have therefore been included in the text of this annex where appropriate to illustrate the effect of the year 1974/75 on average flows for the period since 1967/68 although, due to lack of supporting agricultural data, the overall analysis has necessarily been restricted to the period up to 1973/74.

2. For the purpose of the overall analyses in this report eleven sub-regional areas were selected. All deal with canal irrigated areas only in order to adhere to the central purpose of the study, i.e. to look at the outcome of the Indus Basin Project. For the purpose of presenting a useful picture of the water supply situation, and of agricultural production, certain data is presented on the basis of the canal command groups; other information or summaries of data, are given at a larger level of aggregation, either by province or by Northern and Southern Zone. The Northern Zone includes canal command groups one to seven inclusive, i.e. the irrigated areas of NWFP and Punjab; the Southern Zone includes the irrigated areas of the Sind and small areas of Baluchistan served by canal water from the Gudu and Sukkur barrages, i.e. canal command groups eight to eleven. The CCGs are shown on the map

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1/ BRBD - Bombanwala-Ravi-Bedian-Dipalpur link.
MR - Marala-Ravi link
BS - Balloki-Suleimanke link

which accompanies this report. To accomplish the detailed analysis of the Jhelum/Chenab zone, five of the six canal command groups in the Punjab have been used; 1/

CCG 3 Chaj Doab - the area between the Chenab and Jhelum rivers;
CCG 4 Rechna Doab - the area between the Ravi and Chenab rivers;
CCG 5 Bari Doab - the area between the Sutlej and Ravi rivers;
CCG 6 Sutlej Left Bank - the area on the left bank of the Sutlej river formerly served from the Suleimanke and Islam barrages; and
CCG 7 Panjnad Left Bank - the area served from the Panjnad barrage.

B. Inflows to the Jhelum/Chenab Zone

3. The inflows of the Jhelum River above Mangla Dam and of the Chenab River above Marala are presented in Tables 1 and 2. The average flows at the rim stations for the three periods used in the analysis are shown in the two following tables.

Jhelum River at Rim Station (Mangla Above)
Average Monthly Flows (MAF)

	1936/37 to 1946/47	1960/61 to 1965/66	1967/68 to 1973/74	1967/68 to 1974/75
April	2.58	2.27	2.48	2.44
May	3.65	3.34	3.36	3.23
June	3.49	3.53	3.78	3.68
July	3.11	3.63	3.18	3.16
August	2.43	2.33	2.57	2.45
September	1.31	1.29	1.40	1.31
Sub-total Kharif	16.57 (11.83/19.98)	16.39 (11.90/22.24)	16.77 (10.05/22.37)	16.27 (10.05/22.37)
October	0.67	0.72	0.81	0.76
November	0.45	0.51	0.59	0.55
December	0.42	0.47	0.50	0.48
January	0.52	0.50	0.50	0.48
February	0.66	0.63	0.70	0.68
March	1.46	1.16	1.57	1.58
Sub-total Rabi	4.18 (3.03/5.83)	3.99 (3.20/4.37)	4.67 (3.02/7.23)	4.53 (3.02/7.23)
Annual Total	20.75 (15.37/25.64)	20.38 (16.16/26.47)	21.44 (13.39/26.67)	20.80 (13.39/26.67)

1/ The area of the Rangpur canal command, situated on the right bank of the Chenab River below its confluence with the Jhelum, has for simplicity been excluded from the analysis. This area is non-perennial and has shown no significant increase in rabi withdrawals during the 1967/68 to 1973/74 period.

Chenab River at Rim Station (Marala Above)
Average Monthly Flows (MAF)

	1936/37 to 1946/47	1960/61 to 1965/66	1967/68 to 1973/74	1967/68 to 1974/75
April	1.37	1.36	1.26	1.22
May	2.39	1.92	1.94	1.85
June	3.63	3.46	3.63	3.46
July	5.47	5.56	5.07	4.96
August	5.38	5.33	5.21	5.08
September	2.49	2.89	2.51	2.40
Sub-total Kharif	20.73 (16.36/24.70)	20.52 (17.82/24.56)	19.62 (15.82/27.57)	18.97 (14.39/27.57)
October	0.79	0.97	0.77	0.74
November	0.42	0.55	0.42	0.40
December	0.40	0.48	0.44	0.44
January	0.54	0.57	0.48	0.47
February	0.58	0.66	0.57	0.60
March	1.98	1.02	0.92	0.98
Sub-total Rabi	3.71 (2.30/5.03)	4.25 (3.95/4.48)	3.60 (2.66/5.17)	3.63 (2.66/5.17)
Annual Total	24.44 (18.66/28.86)	24.77 (22.30/28.88)	23.22 (18.82/30.95)	22.60 (18.27/30.95)

The figures in brackets given against the seasonal and annual totals indicate the variation in flows during the periods. It is interesting to note that for the Jhelum, and also generally for the Chenab, the extremes of flow are in the recent period 1967/68 to 1974/75 reflecting the very poor inflow years of 1969/70 through 1971/72 and 1974/75 and the high inflow years of 1967/68 and 1972/73 through 1973/74 including the devastating floods of kharif 1973. Flows in the Jhelum in 1974/75 were very low, only 76% of the average of the preceding seven years, and for the Chenab kharif inflows were only 66% of the long-term average since 1936/37. Rabi inflows in the Chenab were low in October/November but improved late in the season.

4. In addition to the flows of the Jhelum and Chenab rivers, other significant inflows to the system arise from the eastern rivers, the Ravi and Sutlej. Detailed inflows for these rivers are found in Tables 3 and 4. The points at which these flows are measured, are above Balloki barrage on the Ravi and above Suleimanke barrage on the Sutlej. The tables below present the average flows for the three periods used in the analysis.

Ravi River Inflow Above Balloki
Average Monthly Flows (MAF)

	1936/37 to 1946/47	1960/61 to 1965/66	1967/68 to 1973/74	1967/68 to 1974/75
April	0.17	0.43	0.12	0.12
May	0.19	0.60	0.15	0.15
June	0.21	0.80	0.18	0.16
July	0.82	1.23	0.92	0.97
August	1.38	2.02	2.05	1.94
September	0.53	1.50	0.72	0.64
Sub-total Kharif	3.30	6.58	4.14	3.98
October	0.07	0.30	0.18	0.17
November	0.05	0.10	0.11	0.10
December	0.04	0.10	0.13	0.13
January	0.14	0.09	0.14	0.13
February	0.14	0.14	0.13	0.14
March	0.17	1.20	0.15	0.16
Sub-total Rabi	0.61	0.93	0.83	0.83
Annual Total	3.91	7.51	4.97	4.81

The flow records show a nominal reduction from 1960/61 - 1965/66 to 1967/68 - 1973/74 probably reflecting increased upstream withdrawals in India. There are no storages on the Ravi in India at present although a dam 14 miles upstream of Madhopur involving a storage volume of 1.9 MAF is under investigation but could not be commissioned for at least eight years. The significant increase in rabi and kharif flows in the 1960/61-1965/66 period relative to 1936/37-1946/47 may reflect a change in measurement techniques following partition since there is no evidence of a corresponding difference in flows in the adjacent Sutlej and Chenab catchments or indeed in the flows in the Ravi above Madhopur. Furthermore, flows in the immediate post-partition period 1946/47-1959/60 for the Ravi above Balloki show an even greater increase in rabi, with kharif flows at about the 1960/61-1965/66 level.

5. Sutlej River Inflow Above Suleimanke
Average Monthly Flows (MAF)

	1936/37 to 1946/47	1960/61 to 1965/66	1967/68 to 1973/74	1967/68 to 1974/75
April	0.32	0.24	0.07	0.06
May	0.55	0.18	0.09	0.08
June	1.22	0.46	0.37	0.32
July	3.91	2.50	1.64	1.45
August	6.20	4.59	3.82	3.38
September	2.77	2.99	1.38	1.21
Sub-total Kharif	14.97	10.96	7.37	6.50
October	0.59	0.63	0.18	0.16
November	0.29	0.26	0.12	0.10
December	0.24	0.27	0.11	0.10
January	0.30	0.24	0.07	0.06
February	0.26	0.28	0.07	0.06
March	0.30	0.30	0.11	0.10
Sub-total Rabi	1.98	1.98	0.66	0.58
Annual Total	16.95	12.94	8.03	7.08

This table reflects the reduction in flows passing to Pakistan from the Sutlej river on account of the increased withdrawals in the Indian irrigation systems upstream of the border and the construction of the Bhakra dam on the Sutlej with a live storage capacity of 5.72 MAF (commissioned in 1958). The flows entering Pakistan for the 1936/37 to 1946/47 period would in fact have been higher than those shown in the table on account of withdrawals at the Ferozepore barrage for the non-perennial Dipalpur canal now fed through the BRBD and BSI link canals. A further storage development on the Beas river, a tributary of the Sutlej but more significant in terms of flow volumes, was commissioned in 1974. This storage, at the Pong Dam, amounts to 5.5 MAF. Major reductions in the flow of the Sutlej river occurred in 1974/75. During kharif the inflow was only 0.37 MAF, concentrated in July and August, against an average of 7.37 MAF in the preceding 1967/68-1973/74 period. In rabi there was virtually no flow, 0.03 MAF against an average of 0.66 MAF over the preceding seven-year period.

6. Under the terms of the Indus Waters Treaty of 1960 India was obliged to supply an appropriate level of flows from the Eastern Rivers (Ravi and Sutlej) to the Pakistan irrigation systems during the period in which the IBP works, were under construction. This transition period ended in 1970 but India has been unable to utilize her full entitlement to the Eastern

River flows so that Pakistan has benefitted by receiving flows from this source in excess of those which could have been anticipated under the Treaty. This situation is likely to persist until some storage facility is constructed in India to divert the flows of the Ravi River.

7. Contribution of the Indus Links: The TP (Taunsa-Panjnad) Link canal, which conveys water from the Taunsa barrage, was commissioned at the end of May 1970 and first supplied rabi water from the Indus for use in the Panjnad canal commands in the winter of 1970/71. The CJ (Chasma-Jhelum) Link canal offtaking from the newly constructed Chasma barrage was commissioned at the end of May 1971 and passed initial rabi supplies in the winter of 1971/72. A gross storage volume of about 0.9 MAF was provided at Chasma by constructing the barrage higher than required to divert Indus flows through the CJ link canal. The cost of the additional works was met from a special fund established by the Government of Pakistan so that benefits arising from use of this stored water should not be credited to the Indus Basin Project.

8. Tables 5 and 6 show, respectively, the detailed use of the Indus Links since they were commissioned, and the operation of Chasma barrage storage. The table below summarizes the contribution of the Indus links in transferring water from the Indus to the Jhelum/Chenab zone and also shows the amount of this transfer in the rabi season which has been provided from Chasma storage.

Contribution of the Indus Links and Chasma Storage
Average Monthly Flows in MAF

	CJ Link[/a]	TP Link[/b]	Chasma Storage to Jhelum/Chenab Zone[/c]
April	0.08	0.18	-
May	0.03	0.32	-
June	0.16	0.41	-
July	0.51	0.53	-
August	0.71	0.28	-
September	0.57	0.32	-
Sub-Total Kharif	2.06	2.04	-
October	0.15	0.23	0.11
November	0.16	0.10	0.18
December	0.12	0.05	0.10
January	0.04	0.04	0.01
February	0.07	0.05	0.07
March	0.05	0.06	0.10
Sub-total Rabi	0.59	0.53	0.57
Annual Total	2.18	2.57	-

/a Average of two years flow for April, 3 years for May to March.

/b Average of 3 years flow for April and May, 4 years for June to March.

/c Average of 3 years operation.

The Indus link canals are, of course, primarily intended to transfer stored water from Tarbela into the Jhelum/Chenab zone and thus there should be a substantial increase in the level of rabi supplies passed when Tarbela is commissioned.

C. Operation of Mangla 1967-1975

9. The initial filling of Mangla reservoir commenced in February 1967 and stored water supplies for the rabi season were first available in the winter of 1967/68. The reservoir was filled to capacity in all but three of the eight years under study, 1970/71 and 1971/72, when kharif flows were significantly lower than average. The total inflow in kharif 1971/72 was in fact the lowest during the period of published data (since 1936). The live storage volume of the reservoir (5.34 MAF) was almost fully utilized in three of the years under analysis - 1969/70, 1970/71 and 1973/74. In the other years

between one and two MAF of live storage remained in the reservoir at the end of the rabi season. The net storage utilization in the rabi period amounted, on average, to about 3.7 MAF. Allowing for withdrawals to storage in Mangla reservoir at times of high inflow or low demand in the rabi season and subsequent releases of such stored water, the average gross storage utilization was about 4.0 MAF. The following table shows the most important characteristics of Mangla operation during the period whilst Table 7 details the monthly operation statistics including the effects of regulation on Jhelum river flows.

MANGLA RESERVOIR

Storage Utilization 1967/68 - 1974/75

(MAF)

1	2	3	4	5	6	7	8	9	10	
Year	Maximum Reservoir Content in Kharif	Reservoir content at start of Rabi	Reservoir content at end of Rabi	Minimum Reservoir content in year	Storage utilization in late Kharif (1)	Gross Kharif storage with-drawals (2)	Storage utilization in Rabi (3)	Gross Rabi storage with-drawals (4)	Annual Storage utilization (a) (6)+(8)	Annual Storage utilization (b) (7)+(9)
1967/68	5.88	5.82	2.52	2.45 (5)	0.06	0.14	3.30	3.92	3.36	4.06
1968/69	5.88	4.87	1.75	1.19	1.01	1.76	3.12	3.68	4.13	5.44
1969/70	5.88	5.47	0.72	0.66	0.41	0.50	4.75	4.75	5.16	5.25
1970/71	5.36	5.30	0.70	0.60	0.06	0.17	4.60	4.60	4.66	4.77
1971/72	4.79	4.62	1.56	1.31	0.17	0.28	3.06	3.34	3.23	3.62
1972/73	5.88	5.44	2.29	1.83	0.44	0.45	3.15	3.86	3.59	4.31
1973/74	5.88	5.87	0.79	0.79	0.01	0.88	5.08	5.08	5.09	5.96
1974/75	4.21	3.82	1.30	1.00	0.39	0.50	2.52	2.82	2.91	3.32
Average	-	5.15	1.45	-	0.32	0.59	3.70	4.01	4.02	4.59

(1) Difference between maximum reservoir content and reservoir content at beginning of Rabi

(2) As (1) but allowing for reservoir storage releases during filling period

(3) Reservoir content at beginning of Rabi minus reservoir content at end of Rabi

(4) As (3) but allowing for withdrawals to storage during drawdown period

(5) Not allowing for lower reservoir contents during initial filling

D. Use of the IBP Link Canals in the Jhelum/Chenab Zone

10. Considerable use has been made of the IBP link canals in the Jhelum/Chenab zone both to transfer additional supplies to the eastern river areas and also to utilize the flexibility they provide to the irrigation system as a whole. Table 8 details the seasonal use of the canals since Mangla was commissioned, both in terms of flow volumes passed and in terms of utilization of their transfer capability. These data are summarized below:

Utilization of IBP Link Canals in Jhelum/Chenab Zone
(as % of capability)

Link Canal	Rabi Season			Kharif Season			Annual		
	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
Rasul-Qadirabad (RQ)	56	77	43	35	49	9	45	58	30
Qadirabad-Balloki (QB)	60	76	49	61	79	52	61	78	53
Balloki-Suleimanke I (BSI)	35	48	25	67	78	54	51	57	41
Balloki-Suleimanke II (BSII)	9	21	0	36	48	21	22	29	16
Trimmu-Sidhnai (TS)	15	34	3	60	79	40	38	56	22
Sidhnai-Mailsi-Bahawal (SMB)	31	59	14	78	83	70	55	70	44

11. All the link canals have been operated at or very close to their design capacity during the period; indeed the TSMB 1/ system has regularly run at 5 to 10% over capacity in the kharif season. Total seasonal transfers have generally been higher in kharif than rabi as might be expected, except for RQ 2/ link due presumably to withdrawals for Mangla storage and availability of flows from the Chenab. Apart from 1967/68 when the RQBS 3/ system was not completed and 1972/73 when the natural flows in the Jhelum were over 50% above mean levels, the rabi flows in the TSMB system have not been particularly high. The main transfer of Mangla storage to the Eastern River areas has logically been through the RQBS system in order to give greater flexibility of distribution as there is a greater demand for water for the areas supplied by these links during rabi than for the area served by the TSMB links. However, apart from 1972/73, when the natural rabi Jhelum flows were particularly high and 1973/74 after the unprecedented floods of the preceding kharif, the total combined rabi transfer of the RQBS and TSMB systems has been less than the storage releases from Mangla. The relationship between rabi Mangla storage releases and IBP link canal transfers is shown in the table below:

1/ TSMB - Trimmu-Sidhnai-Mailsi-Bahawal link.

2/ RQ - Rasul-Qadirabad.

3/ RQBS - Rasul-Qadirabad-Balloki-Saleimanke.

Relationships between Rabi Mangla Storage Withdrawal and IBP Link Canal Transfers
(M ac-ft)

	1967/68	1968/69	1969/70	1970/71	1971/72	1972/73	1973/74
Mangla Rabi Storage Releases	3.92	3.68	4.75	4.60	3.34	3.86	5.08
TSMB Rabi Withdrawals	1.36	0.14	0.59	0.25	0.12	1.06	0.77
RQBS Rabi Withdrawals	-	3.48	3.10	3.56	2.97	5.30	4.74
Total IBP Link Withdrawals	1.36	3.62	3.69	3.81	3.09	6.36	5.51
Storage not transferred	2.56	0.06	1.06	0.79	0.25	-2.50	-0.43

12. Since rabi withdrawals on the Jhelum-fed canals have generally been at less than mean levels during the period, the above figures imply that for low water years the increase in water availability in rabi on account of Mangla storage has been partially offset by a reduction in regeneration in the Jhelum from bank storage. This loss in regeneration is illustrated by Table 9 which shows the relative gains/losses during the rabi period for the Jhelum/Chenab zone since 1960/61. These tables show that over the pre-Mangla period 1960/61 - 1965/66 the average gain to the Jhelum/Chenab system in rabi was about 2.7 MAF. The corresponding figure for the 1967/68 - 1973/74 period was 0.6 MAF indicating a net loss in regeneration flows of over two MAF - a loss which has to be made good from Mangla storage before water is available for replacement or development.

E. Canal Head Withdrawals by CCG

13. The monthly canal head withdrawals by CCG are detailed in Tables 10-20. In addition to the sub-areas of the Jhelum/Chenab zone listed in paragraph 2, on which the main focus of this report lies, data for the following CCGs are also included in these tables:

CCG1	Peshawar Vale
CCG2	Thal Doab and Indus Right Bank
CCG8	Gudu Barrage
CCG9	Sukkur Barrage Left Bank
CCG10	Sukkur Barrage Right Bank
CCG11	Kotri Barrage

14. A summary of the average canal head withdrawals for the Jhelum/Chenab zone CCGs is given in Table 21 for the three periods under analysis. The increase in canal head withdrawals from 1960/61 - 1965/66 to 1967/68 - 1973/74 following the introduction of Mangla and the IBP links is shown to amount in total to about one MAF in both the kharif and rabi seasons. In general these increases have been concentrated in two of the five sub-areas - Bari Doab and Sutlej Left Bank which were formally fed principally from the Eastern Rivers and subject to the known problems, particularly in the Sutlej, of over-development relative to the inflows available. For all the sub-areas in the Jhelum/Chenab zone canal withdrawals in 1974/75 were lower than the preceding seven year average - both for kharif and rabi. In rabi 74/75 the total withdrawals at canal head for Jhelum/Chenab were 9.97 MAF or only 72% of the preceding seven year average. For the critical October/November planting period withdrawals were 67% of the preceding seven year average.

F. Assessment of Development Effects of Mangla

15. Assessment of the development effects of Mangla in the rabi season has been made on the basis of average conditions prevailing over the period 1967/68-1973/74. The analysis has basically been carried out in three stages:

- Firstly, an assessment of the monthly canal head withdrawals in rabi which would have occurred in the 1967/68 - 1973/74 period by canal command on the basis of the relationship between river flows and canal withdrawals established in the 1936/37 - 1946/47 period.

- Secondly, an adjustment of the incremental canal head withdrawals determined from the above analysis to take account of natural development between 1936/37 - 1946/47 and 1960/61 - 1965/66 and the impact of the Pakistan link canals constructed in the intervening years - MR, BRBD, BSl and Haveli.

- Thirdly, having established from the two preceding parts of analysis the increment in canal head withdrawals above both replacement and development resulting from works other than the IBP, to deduct from the total monthly increments for the Jhelum/Chenab zone, inflows from the Eastern Rivers and transfers from the Indus through the Indus Link Canals (CJ and TP), with, of course, an appropriate allowance for flows passed to Sind below Panjnad.

16. The analysis is presented in Table 22 which shows that during the post Mangla period there have been increased canal head withdrawals in all rabi months except March. However, the increases can be accounted for by the continuation of Eastern River inflows and inflows through the Indus links in all months except November when Mangla appears to have had a development benefit over and above replacement amounting to about 0.3 MAF in volumetric

terms. It should be recognized that this analysis is necessarily somewhat less than sophisticated in view of the interacting influences between river flows and canal withdrawals, such as regeneration from bank storage and time lags in the river and canal systems and also because of the complex nature of the irrigation system under review. It could be subject to a considerable margin of error. Nevertheless the conclusion must be drawn from this analysis that Mangla has, on average, had only limited development effects in the rabi season and the principal use of storage releases has been (a) to provide replacement supplies to the Eastern River areas; and (b) to replace the reduction in regeneration from bank storage resulting from regulation of kharif flows in the Jhelum.

17. An additional analysis, carried out on the three lowest years of inflow since Mangla was commissioned, 1969/70 through 1971/72, indicated that the maximum development impact of Mangla was about 1.25 MAF at canal head in 1969/70. Again this figure must be qualified by the reservations expressed above but the indication is that the average impact of Mangla at canal head of 0.3 MAF represents a mean between the relatively higher storage releases for development in the three lowest inflow years 1969/70 through 1971/72, and low, possibly zero levels in the other four years under review.

G. Future Use of Mangla and IBP Works

18. As shown in the Table on page 8, the average volume of stored water retained in Mangla at the end of the rabi season for the seven years under analysis was about 1.5 MAF. Of this about 0.5 MAF is dead storage and not available for irrigation use. Allowing for the development use of 0.3 MAF at canal head - say 0.4 MAF at Mangla before losses - then it would appear that, on average, only about 1.4 MAF would be available in the future at Mangla to offset against the Eastern River flows presently passing into Pakistan when they are fully utilized in India, and even this figure presupposes hindsight in operation of the reservoir and a reduction in the head available for power generation.

19. Over the period of analysis the Eastern Rivers rabi inflow averaged 1.5 MAF and it would therefore appear that ultimately, when India fully controls the Eastern Rivers, Mangla will be barely able to provide full replacement. This conclusion must be viewed within the context of the limited accuracy of the analysis made but nevertheless this review is based on average flows over the seven year period and conditions in individual years could be even more crucial.

20. Thus, from a comparison of rabi river supplies and canal withdrawals it would appear that the net effect of Mangla storage releases in increasing overall water availability has not been very great. This is partly due to the use of the Mangla reservoir to regulate flood discharges which reduced bank storage in the kharif season with a consequent reduction in the amount of regeneration in the rabi season of the order of 2 MAF (Table 9).

H. Mangla Power Facilities

Installed Capacity at Mangla

21. Provision was made in the design of the Mangla dam for a power station with an ultimate installed capacity of 8 x 100 MW. At present six of the eight units have been installed in accordance with the following schedule:

Units 1 and 2	July 1967
Unit 3	March 1968
Unit 4	June 1969
Unit 5	December 1973
Unit 6	March 1974

Tenders have been received for the supply and installation of units 7 and 8 and it is anticipated that these last two units will be commissioned by the end of 1978. Only the first three units were financed under IBP.

22. At the minimum reservoir operating level of 1,040 ft. the output of each unit falls from 100 MW to 45 MW. Thus,, the firm power output of the station is currently 270 MW and will rise to 360 MW when the last two units are in operation. With a full reservoir a peak load of 720 MW has been achieved from the present rated capacity of 600 MW but only for short periods.

Energy Generation at Mangla

23. The annual sent-out energy from Mangla for the period since the first units were commissioned in 1967 is given below:

1967	538 GWh
1968	1,471 GWh
1969	1,530 GWh
1970	1,909 GWh
1971	2,275 GWh
1972	2,664 GWh
1973	2,990 GWh
1974	3,108 GWh

The annual energy output from Mangla will not increase substantially when the last two units are commissioned. It is assumed that annual sent-out energy might ultimately rise to an average level of about 3,400 GWh.

24. On the basis of these figures, the costs of alternative thermal facilities have been estimated. Table 23 shows the two investments, and the savings which the facilities at Mangla make possible. At full development these savings amount to about Rs 800 million per annum.

PAKISTAN

JHELUM RIVER INFLOWS AT RIM STATION (ABOVE MANGLA)

Monthly Flows in MAF 1960-1975

	1960 /61	1961 /62	1962 /63	1963 /64	1964 /65	1965 /66	1966 /67	1967 /68	1968 /69	1969 /70	1970 /71	1971 /72	1972 /73	1973 /74	1974 /75
April	1.46	1.60	1.93	2.46	2.53	3.62	2.19	2.74	2.45	2.91	1.85	1.52	2.33	3.58	2.15
May	2.76	2.57	2.25	4.38	3.28	4.77	3.29	4.02	3.00	4.35	2.47	1.87	3.52	4.32	2.31
June	2.64	3.05	2.43	4.37	3.43	5.29	4.31	4.31	3.87	4.68	2.28	2.36	4.47	4.51	2.94
July	3.05	3.20	2.43	3.35	4.93	4.84	3.27	3.80	3.30	4.13	1.87	1.79	3.62	3.72	3.04
August	2.01	2.13	1.63	2.03	3.54	2.65	2.39	2.32	2.71	2.93	1.96	1.76	2.18	4.15	1.62
September	1.10	1.70	1.23	1.03	1.59	1.07	2.12	1.23	1.06	1.11	1.90	0.75	1.69	2.09	0.68
KHARIF	13.02	14.25	11.90	17.62	19.30	22.24	17.57	18.42	16.39	20.11	12.33	10.05	17.81	22.37	12.74
October	0.57	0.72	0.99	0.59	0.73	0.72	1.37	0.80	0.78	1.00	0.78	0.45	1.00	0.83	0.43
November	0.39	0.56	0.56	0.54	0.45	0.56	0.76	0.52	0.63	0.82	0.50	0.33	0.80	0.52	0.28
December	0.37	0.51	0.53	0.53	0.45	0.42	0.54	0.78	0.52	0.46	0.37	0.28	0.70	0.41	0.33
January	0.43	0.41	0.44	0.80	0.55	0.35	0.47	0.74	0.45	0.35	0.30	0.29	0.98	0.39	0.33
February	0.63	0.50	0.50	0.72	0.90	0.53	0.70	0.88	0.79	0.46	0.37	0.54	1.26	0.62	0.56
March	0.81	0.86	1.24	1.19	1.22	1.65	1.69	1.72	2.07	1.02	0.70	1.45	2.49	1.53	1.62
RABI	3.20	3.56	4.26	4.37	4.30	4.23	5.53	5.44	5.24	4.11	3.02	3.34	7.23	4.30	3.55
ANNUAL	16.22	17.81	16.16	21.99	23.60	26.47	23.10	23.86	21.63	24.22	15.35	13.39	25.04	26.67	16.29

ANNEX 2
Table 1

PAKISTAN

CHENAB RIVER INFLOWS AT RIM STATION (ABOVE MARALA)

Monthly Flows in MAF 1960-1975

	1960 /61	1961 /62	1962 /63	1963 /64	1964 /65	1965 /66	1966 /67	1967 /68	1968 /69	1969 /70	1970 /71	1971 /72	1972 /73	1973 /74	1974 /75
April	0.84	1.39	1.36	1.53	1.29	1.72	1.18	1.59	1.39	1.32	0.91	0.72	0.94	1.97	0.95
May	1.82	1.87	1.60	2.08	1.77	2.39	1.93	1.66	1.80	2.24	1.67	1.20	1.78	3.25	1.25
June	2.96	3.96	3.18	3.87	3.32	3.49	4.32	3.28	4.02	3.72	2.56	3.24	3.46	5.13	2.23
July	6.62	6.49	4.15	4.79	5.93	5.37	4.28	5.68	5.80	5.53	3.99	4.09	4.60	5.82	4.18
August	6.12	6.18	4.38	5.00	6.20	4.07	5.56	5.25	5.12	5.04	4.36	4.93	3.82	7.92	4.13
September	2.62	4.67	3.15	2.10	3.16	1.65	4.26	2.64	2.27	2.07	3.25	1.64	2.21	3.48	1.65
KHARIF	20.98	24.56	17.82	19.37	21.67	18.69	21.53	20.10	20.40	19.92	16.74	15.82	16.81	27.57	14.39
October	0.92	1.29	1.02	0.80	1.05	0.72	1.23	0.79	0.77	0.75	0.86	0.68	0.64	0.92	0.55
November	0.50	0.63	0.58	0.55	0.55	0.49	0.59	0.47	0.42	0.41	0.42	0.36	0.41	0.46	0.27
December	0.40	0.54	0.55	0.51	0.51	0.35	0.42	0.94	0.37	0.31	0.32	0.29	0.45	0.40	0.43
January	0.65	0.44	0.43	0.93	0.64	0.31	0.38	0.88	0.38	0.32	0.26	0.28	0.77	0.45	0.42
February	0.71	0.55	0.38	0.63	0.84	0.88	0.45	0.83	0.60	0.28	0.32	0.60	0.88	0.48	0.80
March	0.79	0.87	1.52	0.90	0.85	1.20	1.31	1.26	0.98	0.59	0.53	0.79	1.61	0.67	1.41
RABI	3.97	4.32	4.48	4.32	4.44	3.95	4.38	5.17	3.52	2.66	2.71	3.00	4.76	3.38	3.88
ANNUAL	24.95	28.88	22.30	23.69	26.11	22.64	25.91	25.27	23.92	22.58	19.45	18.82	21.57	30.95	18.27

ANNEX 2
Table 2

PAKISTAN

RAVI RIVER INFLOWS ABOVE BALLOKI

Monthly Flows in MAF 1960-1975

	1960 /61	1961 /62	1962 /63	1963 /64	1964 /65	1965 /66	1966 /67	1967 /68	1968 /69	1969 /70	1970 /71	1971 /72	1972 /73	1973 /74	1974 /75
April	0.06	0.67	0.45	0.50	0.42	0.48	0.31	0.27	0.20	0.22	0.05	0.00	0.07	0.03	0.14
May	0.42	0.82	0.50	0.82	0.49	0.56	0.50	0.17	0.13	0.32	0.06	0.11	0.14	0.12	0.12
June	0.88	1.05	0.75	0.78	0.76	0.60	0.92	0.04	0.27	0.35	0.17	0.18	0.02	0.23	0.03
July	1.56	1.48	1.15	0.88	1.53	0.75	1.03	1.14	1.03	0.69	0.31	0.87	0.85	1.52	1.31
August	1.88	3.15	1.49	1.86	2.59	1.14	1.93	1.81	2.15	1.45	1.47	3.24	0.50	3.71	1.16
September	1.16	2.68	2.05	0.75	1.96	0.42	1.96	0.88	0.19	0.38	1.38	0.75	0.47	0.99	0.10
KHARIF	5.96	9.85	6.39	5.59	7.75	3.95	6.65	4.31	3.97	3.41	3.44	5.15	2.05	6.60	2.86
October	0.11	0.52	0.71	0.11	0.25	0.09	0.16	0.17	0.10	0.16	0.20	0.27	0.15	0.19	0.10
November	0.06	0.16	0.13	0.04	0.11	0.12	0.07	0.05	0.06	0.14	0.10	0.16	0.08	0.16	0.07
December	0.04	0.17	0.13	0.08	0.07	0.10	0.04	0.25	0.10	0.09	0.02	0.15	0.11	0.17	0.10
January	0.05	0.12	0.13	0.18	0.09	0.09	0.02	0.33	0.18	0.09	0.08	0.11	0.16	0.06	0.05
February	0.25	0.12	0.08	0.10	0.12	0.14	0.04	0.28	0.15	0.06	0.03	0.15	0.15	0.06	0.21
March	0.07	0.24	0.37	0.16	0.13	0.22	0.33	0.25	0.18	0.12	0.10	0.19	0.14	0.09	0.26
RABI	0.58	1.33	1.55	0.67	0.77	0.76	0.66	1.33	0.77	0.66	0.53	1.03	0.79	0.73	0.79
ANNUAL	6.54	11.18	7.94	6.26	8.52	4.71	7.31	5.64	4.74	4.07	3.97	6.18	2.84	7.33	3.65

ANNEX 2
Table 3

PAKISTAN

SUTLEJ INFLOWS ABOVE SULEIMANKE

Monthly Flows in MAF 1960-1975

	1960 /61	1961 /62	1962 /63	1963 /64	1964 /65	1965 /66	1966 /67	1967 /68	1968 /69	1969 /70	1970 /71	1971 /72	1972 /73	1973 /74	1974 /75
April	0.19	0.41	0.29	0.14	0.23	0.16	0.02	0.14	0.25	0.05	0.03	0.04	0.00	0.00	0.00
May	0.08	0.52	0.13	0.09	0.06	0.19	0.03	0.05	0.11	0.20	0.07	0.00	0.00	0.18	0.00
June	0.14	1.35	0.27	0.52	0.21	0.27	0.40	0.08	0.36	0.44	0.25	0.96	0.02	0.50	0.00
July	2.99	4.80	1.40	2.03	2.22	1.54	1.97	2.21	1.67	1.42	0.99	2.21	1.50	1.51	0.10
August	5.33	8.25	2.89	4.44	5.21	1.41	5.08	4.25	3.53	4.19	2.80	5.79	1.12	5.05	0.27
September	3.38	5.13	3.85	1.95	3.16	0.48	3.03	2.20	0.76	0.92	1.57	1.10	0.96	2.13	0.00
KHARIF	12.11	20.46	8.83	9.17	11.09	4.05	10.53	8.93	6.68	7.22	5.71	10.10	3.60	9.37	0.37
October	0.33	0.72	1.69	0.39	0.59	0.07	0.47	0.54	0.31	0.09	0.08	0.08	0.03	0.14	0.00
November	0.22	0.37	0.35	0.24	0.34	0.04	0.23	0.34	0.22	0.06	0.10	0.05	0.03	0.02	0.00
December	0.19	0.38	0.37	0.28	0.33	0.06	0.22	0.37	0.11	0.04	0.04	0.09	0.04	0.06	0.02
January	0.20	0.29	0.26	0.29	0.28	0.15	0.21	0.37	0.01	0.03	0.02	0.03	0.02	0.03	0.01
February	0.59	0.30	0.15	0.25	0.27	0.14	0.13	0.32	0.07	0.04	0.01	0.02	0.01	0.00	0.00
March	0.35	0.43	0.34	0.26	0.25	0.15	0.24	0.43	0.12	0.19	0.00	0.03	0.01	0.00	0.00
RABI	1.88	2.49	3.16	1.71	2.06	0.61	1.50	2.37	0.84	0.45	0.25	0.30	0.14	0.25	0.03
ANNUAL	13.99	22.95	11.99	10.88	13.15	4.66	12.03	11.30	7.52	7.67	5.96	10.40	3.74	9.62	0.40

ANNEX 2
Table 4

PAKISTAN

USE OF THE INDUS LINKS 1970-1975

Monthly Flows at Tail in MAF

	1970/71			1971/72			1972/73			1973/74			1974/75		
	CJ	TP[1]	TOTAL	CJ[2]	TP	TOTAL	CJ	TP	TOTAL	CJ	TP	TOTAL	CJ	TP	TOTAL
April	----	----	----	----	0.15	0.15	0.02	0.28	0.30	0.14	0.12	0.26	0.02	0.17	0.19
May	----	----	----	0.05	0.27	0.32	0.02	0.48	0.50	0.02	0.22	0.24	0.00	0.41	0.41
June	----	0.31	0.31	0.46	0.54	1.00	0.02	0.57	0.59	0.01	0.23	0.24	0.13	0.58	0.71
July	----	0.59	0.59	0.68	0.70	1.38	0.44	0.58	1.02	0.40	0.27	0.67	0.33	0.70	1.03
August	----	0.61	0.61	0.89	0.15	1.04	0.83	0.25	1.08	0.41	0.10	0.51	0.68	0.29	0.97
September	----	0.43	0.43	1.04	0.50	1.54	0.61	0.31	0.92	0.05	0.03	0.08	0.68	0.46	1.14
KHARIF	----	1.94	1.94	3.12	2.31	5.43	1.94	2.47	4.41	1.03	0.97	2.00	1.84	2.61	4.45
October	----	0.20	0.20	0.20	0.25	0.45	0.16	0.42	0.58	0.10	0.05	0.15			
November	----	0.11	0.11	0.13	0.09	0.22	0.13	0.09	0.22	0.21	0.09	0.30			
December	----	0.07	0.07	0.12	0.04	0.16	0.09	0.05	0.14	0.14	0.05	0.19			
January	----	0.04	0.04	0.05	0.04	0.09	0.03	0.04	0.07	0.04	0.05	0.09			
February	----	0.05	0.05	0.12	0.04	0.16	0.03	0.06	0.09	0.05	0.05	0.10			
March	----	0.03	0.03	0.03	0.07	0.10	0.03	0.08	0.11	0.08	0.08	0.16			
RABI	----	0.50	0.50	0.65	0.53	1.18	0.47	0.74	1.21	0.62	0.37	0.99			
ANNUAL	----	2.44	2.44	3.77	2.84	6.61	2.41	3.21	5.62	1.65	1.34	2.99			

1/ TP Link commissioned at end May 1970.

2/ CJ Link commissioned at end May 1971.

ANNEX 2
Table 5

PAKISTAN

OPERATION OF CHASMA BARRAGE STORAGE (1971-1973)
(MAF)

MONTH	GROSS RESERVOIR CONTENT	WITHDRAWALS TO STORAGE	STORAGE RELEASE TO PAHARPUR CANAL 1/	STORAGE RELEASE BELOW CHASMA (VIA INDUS)	STORAGE RELEASE TO (THELUM/CHENAB ZONE) (VIA C.J. LINK)	TOTAL STORAGE RELEASE
1971/72						
APRIL	0.04	0.04	-	-	-	-
MAY	0.23	0.19	-	-	-	-
JUNE	0.37	0.14	-	-	-	-
JULY	0.37		-	-	-	-
AUGUST	0.49	0.12	-	-	-	-
SEPTEMBER	0.87	0.38	-	-	-	-
KHARIF	-	0.87	-	-	-	-
OCTOBER	0.73	-	0.02	0.06	0.06	0.14
NOVEMBER	0.39	-	0.02	0.20	0.12	0.34
DECEMBER	0.22	-	0.01	0.07	0.09	0.17
JANUARY	0.19	-	0	0	0.03	0.03
FEBRUARY	0.05	-	0.01	0.03	0.10	0.14
MARCH	0.08	0.03	-	-	-	-
RABI	-	0.03	0.06	0.36	0.40	0.82
1972/73						
APRIL	0.08	0	-	-	-	-
MAY	0.22	0.14	-	-	-	-
JUNE	0.37	0.15	-	-	-	-
JULY	0.37	-	-	-	-	-
AUGUST	0.74	0.37	-	-	-	-
SEPTEMBER	0.87	0.13	-	-	-	-
KHARIF	-	0.79	-	-	-	-
OCTOBER	0.68	-	0.01	0.05	0.13	0.19
NOVEMBER	0.45	-	0.01	0.08	0.14	0.23
DECEMBER	0.34	-	-	0.05	0.06	0.11
JANUARY	0.34	-	-	-	-	-
FEBRUARY	0.38	0.04	-	-	-	-
MARCH	0.21	-	0.01	0.05	0.11	0.17
RABI	-	0.04	0.03	0.23	0.44	0.70
1973/74						
APRIL	0.08	-	-	0.04	0.09	0.13
MAY	0.12	0.04	-	-	-	-
JUNE	0.37	0.25	-	-	-	-
JULY	0.23	-	-	-	0.14	0.14
AUGUST	0.23	-	-	-	-	-
SEPTEMBER	0.76 2/	0.53	-	-	-	-
KHARIF	-	0.82	-	0.04	0.23	0.27
OCTOBER	0.71	-	0.01	-	0.04	0.05
NOVEMBER	0.58	-	0.01	-	0.12	0.13
DECEMBER	0.49	--	-	-	0.09	0.09
JANUARY	0.49	-	-	-	-	-
FEBRUARY	0.23	-	-	0.23	0.03	0.26
MARCH	0.06	-	0.01	0.11	0.05	0.17
RABI	-	-	0.03	0.34	0.33	0.70

1/ *Assumes rabi discharges additional to long-term mean canal head withdrawals of 0.07 MAF come from Chasma Barrage storage.*

2/ Lower gross storage volume assumed from September 1973 onwards on account of siltation.

PAKISTAN

MANGLA GROSS RESERVOIR CONTENT AND REGULATION OF JHELUM FLOWS BY MONTHS (1967-1975)
(MAF)

MONTH	1967/68		1968/69		1969/70		1970/71	
	GROSS RESERVOIR CONTENT[1]	NET JHELUM REGULATION[2]	GROSS RESERVOIR CONTENT	NET JHELUM REGULATION	GROSS RESERVOIR CONTENT	NET JHELUM REGULATION	GROSS RESERVOIR CONTENT	NET JHELUM REGULATION
APRIL	1.56	-0.16	2.99	-0.47	2.20	-0.45	0.98	-0.26
MAY	1.50	+0.06	2.24	+0.75	2.78	-0.58	1.39	-0.41
JUNE	2.57	-1.07	2.81	-0.57	2.80	-0.02	1.55	-0.16
JULY	4.32	-1.75	4.41	-1.60	5.21	-2.41	2.80	-1.25
AUGUST	5.72	-1.40	5.88	-1.47	5.88	-0.67	4.14	-1.34
SEPTEMBER	5.82	-0.10	4.87	+1.01	5.47	+0.41	5.30	-1.16
OCTOBER	4.46	+1.36	3.85	+1.02	4.11	+1.36	4.42	+0.88
NOVEMBER	3.96	+0.50	2.40	+1.45	2.93	+1.18	3.11	+1.31
DECEMBER	3.97	-0.01	2.10	+0.30	2.33	+0.60	2.43	+0.68
JANUARY	4.23	-0.26	1.70	+0.40	1.62	+0.71	1.88	+0.55
FEBRUARY	3.52	+0.71	1.20	+0.50	1.02	+0.60	1.39	+0.49
MARCH	2.52	+1.00	1.75	-0.55	0.72	+0.30	0.70	+0.69
	1971/72		1972/73		1973/74		1974/75	
APRIL	0.72	-0.02	2.22	-0.66	3.20	-0.91	0.68	+0.11
MAY	0.95	-0.23	3.72	-1.50	5.12	-1.92	0.69	-0.01
JUNE	2.37	-1.42	4.92	-1.20	4.55	+0.57	2.05	-1.36
JULY	3.46	-1.09	5.42	-0.50	5.04	-0.49	3.64	-1.59
AUGUST	4.60	-1.14	5.88	-0.46	5.84	-0.80	4.21	-0.57
SEPTEMBER	4.62	-0.02	5.44	+0.44	5.87	-0.03	3.82	+0.39
OCTOBER	3.34	+1.28	4.31	+1.13	4.71	+1.16	2.92	+0.91
NOVEMBER	2.30	+1.04	3.62	+0.69	3.33	+1.38	2.12	+0.79
DECEMBER	1.75	+0.55	2.81	+0.81	2.47	+0.86	1.61	+0.51
JANUARY	1.48	+0.27	2.81	0	1.95	+0.52	1.24	+0.37
FEBRUARY	1.31	+0.17	1.99	+0.82	1.33	+0.62	1.07	+0.17
MARCH	1.56	-0.25	2.29	-0.30	0.79	+0.54	1.30	-0.23

1/ Live storage is 0.54 MAF less than gross storage.

2/ Based on change in gross content; actual regulation will be affected by rainfall on the reservoir, evaporation and bank storage and releases, but will not differ significantly from figures given.

PAKISTAN

USE OF IBP LINK CANALS IN JHELUM/CHENAB ZONE FOLLOWING MANGLA COMMISSIONING

(1967 - 1974)

YEAR	RASUL-QADIRABAD (RQ)					QADIRABAD-BALLOKI (QB)					BALLOKI-SULEIMANKE I (BS I)					BALLOKI-SULEIMANKE II (BS II)					TRIMMU-SIDHNAI (TS)					SIDHNAI-MAILSI-BAHAWAL (SMB)				
	MAX. 10-DAY AVERAGE		TOTAL SEASONAL FLOWS			MAX. 10-DAY AVERAGE		TOTAL SEASONAL FLOWS			MAX. 10-DAY AVERAGE		TOTAL SEASONAL FLOWS			MAX. 10-DAY AVERAGE		TOTAL SEASONAL FLOWS			MAX. 10-DAY AVERAGE		TOTAL SEASONAL FLOWS			MAX. 10-DAY AVERAGE		TOTAL SEASONAL FLOWS		
	K	R	K	R	T	K	R	K	R	T	K	R	K	R	T	K	R	K	R	T	K	R	K	R	T	K	R	K	R	T
	LINK CAPACITY AT HEAD (MAF)																														
	0.38	0.38	6.88	6.88	13.76	0.37	0.37	6.73	6.73	13.46	0.37	0.37	6.70	6.70	13.40	0.13	0.13	2.35	2.35	4.70	0.22	0.22	3.98	3.98	7.96	0.20	0.20	3.66	3.66	7.32
	HEAD WITHDRAWALS, 1967 - 1973 (MAF)																														
1967/68	-	-	-	-	-	-	0.16	-	0.45	-	0.27	0.06	3.73	0.16	3.89	-	-	-	-	-	0.24	0.18	3.13	1.36	4.49	0.20	0.19	2.94	2.17	5.11
1968/69	0.35	0.30	3.36	3.48	6.84	0.31	0.32	3.90	3.85	7.75	0.32	0.23	5.21	2.42	7.63	0.11	0.09	0.89	0.49	1.38	0.24	0.06	3.10	0.14	3.24	0.22	0.08	3.03	0.75	3.78
1969/70	0.25	0.26	2.51	3.10	5.61	0.31	0.31	3.48	3.67	7.15	0.37	0.20	5.22	1.96	7.18	0.13	0	1.12	0	1.12	0.23	0.14	2.70	0.59	3.29	0.21	0.15	3.03	1.03	4.06
1970/71	0.16	0.33	0.60	3.56	4.16	0.29	0.30	3.71	3.50	7.21	0.37	0.20	3.83	1.69	5.52	0.11	0.06	0.49	0.28	0.77	0.22	0.04	1.97	0.25	2.22	0.20	0.14	2.57	0.92	3.49
1971/72	0.35	0.32	2.33	2.97	5.30	0.30	0.31	4.00	3.30	7.30	0.29	0.22	3.60	2.05	5.65	0.11	0.06	0.89	0.18	1.07	0.19	0.07	1.60	0.12	1.72	0.20	0.12	2.69	0.50	3.19
1972/73	0.40	0.39	2.73	5.30	8.03	0.35	0.37	5.34	5.13	10.41	0.35	0.31	4.30	3.24	7.54	0.11	0.06	0.76	0.29	1.05	0.22	0.22	2.27	1.06	3.33	0.22	0.20	2.87	1.34	4.21
1973/74	0.39	0.38	2.73	4.74	7.47	0.37	0.37	4.15	4.67	8.82	0.33	0.24	4.55	2.63	7.18	0.09	0	0.93	0	0.93	0.21	0.15	1.98	0.77	2.75	0.20	0.19	2.85	1.25	4.10
	HEAD WITHDRAWALS AS % OF CAPACITY																														
1967/68	-	-	-	-	-	-	43	-	7	-	73	16	56	2	29	-	-	-	-	-	109	82	79	34	56	100	95	80	59	70
1968/69	92	79	49	51	50	84	86	58	57	58	86	62	78	36	57	85	69	38	21	29	109	27	78	4	41	110	40	83	20	52
1969/70	66	68	36	45	41	84	84	52	55	43	100	54	78	29	54	100	0	48	0	24	105	64	68	15	41	105	75	83	28	55
1970/71	42	87	9	52	30	78	81	55	52	54	100	54	57	25	41	85	46	21	12	16	100	18	49	6	28	100	70	70	25	48
1971/72	92	84	34	43	39	81	84	59	49	54	78	59	54	31	42	85	46	38	8	23	86	32	40	3	22	100	60	73	14	44
1972/73	105	103	40	77	58	95	100	79	76	78	95	84	64	48	56	85	46	32	12	22	100	100	57	27	42	110	100	78	37	58
1973/74	103	100	40	69	54	100	100	62	69	66	89	65	68	39	54	69	0	40	0	20	95	68	50	19	35	100	95	78	34	56

ANNEX 2
TABLE 8

PAKISTAN

GAINS AND LOSSES - JHELUM/CHENAB ZONE

Rabi Season Only (in MAF)

Year	60/61	61/62	62/63	63/64	64/65	65/66	66/67	67/68	68/69	69/70	70/71	71/72	72/73	73/74	Average 1960/61 - 1965/66	Average 1967/68 - 1973/74
Jhelum above Mangla[1]	3.20	3.56	4.26	4.37	4.30	4.23	4.08	8.69	8.34	8.84	7.64	6.42	10.37	9.33	3.99	8.52
Chenab above Marala	3.97	4.32	4.48	4.32	4.44	3.95	4.38	5.17	3.52	2.66	2.71	3.00	4.76	3.38	4.25	3.60
Ravi above Balloki	0.58	1.33	1.55	0.67	0.77	0.76	0.66	1.33	0.77	0.66	0.53	1.03	0.79	0.73	0.94	0.83
Sutlej above Suleimanke	1.88	2.49	3.16	1.71	2.06	0.61	1.50	2.37	0.84	0.45	0.25	0.30	0.14	0.25	1.98	0.66
TP and CJ Link Tail	-	-	-	-	-	-	-	-	-	-	0.50	1.18	1.21	0.97	-	0.55
Total Inflow	9.63	11.70	13.45	11.07	11.57	9.55	10.62	17.56	13.47	12.61	11.63	11.93	17.27	14.66	11.16	14.16
Panjnad Below	0.14	1.11	3.10	0.41	0.98	0.11	0.33	2.67	0.10	0.02	0.05	0.19	0.29	1.22	0.98	0.65
Net Inflow	9.49	10.59	10.35	10.66	10.59	9.44	10.29	14.89	13.37	12.59	11.58	11.74	16.98	13.44	10.18	13.51
Canal Withdrawals	12.10	14.27	13.72	12.75	14.21	10.44	12.15	15.88	13.33	13.39	11.56	12.37	16.71	15.38	12.91	14.09
Gains(+) or losses(-)[2]	+2.61	+3.68	+3.37	+2.09	+3.62	+1.00	+1.86	+0.99	-0.04	+0.80	-0.02	+0.63	-0.27	+1.94	+2.73	+0.58

1. Below Mangla Dam after Commissioning

2. Should be adjusted for Indian Inflow from Madhopur via Upper Bari Doab Canal but figures not known (about 0.5 MAF).

ANNEX 2
Table 9

PAKISTAN

CANAL HEAD WITHDRAWALS IN PESHAWAR VALE

Monthly Flows in MAF 1960-1975

	1960 /61	1961 /62	1962 /63	1963 /64	1964 /65	1965 /66	1966 /67	1967 /68	1968 /69	1969 /70	1970 /71	1971 /72	1972 /73	1973 /74	1974 /75
April	0.16*	0.12*	0.16	0.16	0.17	0.12	0.14	0.14	0.18	0.17	0.23	0.18	0.50	0.20	0.21
May	0.19*	0.21*	0.20	0.14	0.21	0.14	0.19	0.21	0.19	0.18	0.23	0.21	0.19	0.21	0.21
June	0.18*	0.20*	0.20	0.18	0.20	0.20	0.21	0.23	0.21	0.21	0.22	0.20	0.19	0.22	0.22
July	0.19*	0.19	0.21	0.18	0.16	0.20	0.20	0.23	0.21	0.22	0.20	0.20	0.21	0.20	0.22
August	0.20*	0.18	0.21	0.17	0.21	0.18	0.21	0.17	0.15	0.19	0.19	0.47	0.23	0.21	0.23
September	0.20*	0.19	0.20	0.18	0.19	0.20	0.21	0.22	0.19	0.21	0.16	0.27	0.21	0.20	0.23
KHARIF	1.12*	1.09	1.18	1.01	1.14	1.04	1.16	1.20	1.13	1.18	1.23	1.53	1.53	1.24	1.32
October	0.20*	0.20	0.19	0.16	0.20	0.21	0.19	0.20	0.20	0.21	0.20	0.17	0.21	0.23	0.20
November	0.14*	0.14	0.15	0.13	0.14	0.14	0.15	0.16	0.14	0.16	0.15	0.15	0.17	0.18	0.17
December	0.13*	0.12	0.12	0.07	0.12	0.11	0.13	0.13	0.13	0.14	0.14	0.14	0.11	0.17	0.14
January	0.00*	0.01	0.01	0.00	0.01	0.01	0.04	0.00	0.02	0.01	0.02	0.12	0.07	0.09	0.08
February	0.08*	0.11	0.11	0.08	0.10	0.12	0.11	0.08	0.11	0.11	0.12	0.13	0.13	0.12	0.14
March	0.13*	0.14	0.13	0.13	0.16	0.13	0.13	0.15	0.18	0.15	0.20	0.30	0.15	0.21	0.16
RABI	0.68*	0.72	0.71	0.57	0.73	0.72	0.75	0.72	0.78	0.78	0.83	1.01	0.84	1.00	0.89
ANNUAL	1.80*	1.81	1.89	1.58	1.87	1.76	1.91	1.92	1.91	1.96	2.06	2.54	2.37	2.24	2.21

* Warsak Canals not commissioned.

ANNEX 2
Table 10

PAKISTAN

CANAL HEAD WITHDRAWALS IN THAL DOAB AND INDUS RIGHT BANK

Monthly Flows in MAF 1960-1975

	1960 /61	1961 /62	1962 /63	1963 /64	1964 /65	1965 /66	1966 /67	1967 /68	1968 /69	1969 /70	1970 /71	1971 /72	1972 /73	1973 /74	1974 /75
April	0.58	0.56	0.36	0.68	0.58	0.59	0.72	0.54	0.66	0.55	0.30	0.34	0.47	0.65	0.48
May	1.09	1.15	0.99	1.14	1.30	1.30	1.35	1.16	1.36	1.29	0.90	0.47	0.63	1.20	0.72
June	1.26	1.20	1.30	1.37	1.48	1.40	1.40	1.36	1.38	1.49	1.40	1.36	1.41	1.33	1.11
July	1.12	1.33	1.30	1.56	1.26	1.39	1.48	1.42	1.45	1.48	1.50	1.46	1.56	1.22	1.47
August	1.36	1.21	1.44	1.61	1.25	1.38	1.54	1.35	1.41	1.44	1.51	1.49	1.57	0.70	1.45
September	1.12	1.22	1.21	1.33	1.24	1.27	1.41	1.23	1.38	1.33	1.43	1.13	1.57	0.76	0.89
KHARIF	6.53	6.67	6.60	7.69	7.11	7.33	7.90	7.06	7.64	7.58	7.04	6.25	7.21	5.86	6.12
October	0.83	0.82	0.85	0.76	1.01	1.10	1.08	1.08	1.16	0.89	0.79	0.57	0.67	1.22	0.60
November	0.41	0.40	0.53	0.36	0.35	0.45	0.38	0.38	0.49	0.45	0.58	0.48	0.49	0.57	0.44
December	0.33	0.35	0.64	0.34	0.48	0.43	0.66	0.49	0.63	0.45	0.25	0.19	0.21	0.18	0.14
January	0.08	0.08	0.11	0.35	0.37	0.29	0.49	0.23	0.46	0.34	0.32	0.19	0.21	0.37	0.19
February	0.19	0.20	0.19	0.15	0.38	0.10	0.34	0.37	0.36	0.18	0.20	0.21	0.29	0.30	0.26
March	0.28	0.51	0.44	0.51	0.41	0.46	0.33	0.66	0.73	0.38	0.16	0.25	0.42	0.26	0.31
RABI	2.12	2.36	2.76	2.47	3.00	2.83	3.28	3.21	3.83	2.69	2.30	1.89	2.29	2.90	1.94
ANNUAL	8.65	9.03	9.36	10.16	10.11	10.16	11.18	10.27	11.47	10.27	9.34	8.14	9.50	8.76	8.06

ANNEX 2
Table 11

PAKISTAN

CANAL HEAD WITHDRAWALS IN CHAJ DOAB

Monthly Flows in MAF 1960-1975

	1960 /61	1961 /62	1962 /63	1963 /64	1964 /65	1965 /66	1966 /67	1967 /68	1968 /69	1969 /70	1970 /71	1971 /72	1972 /73	1973 /74	1974 /75
April	0.47	0.52	0.48	0.44	0.42	0.39	0.50	0.50	0.53	0.38	0.35	0.30	0.43	0.49	0.35
May	0.45	0.59	0.57	0.51	0.52	0.50	0.56	0.57	0.58	0.59	0.37	0.32	0.64	0.51	0.41
June	0.50	0.67	0.61	0.52	0.54	0.50	0.55	0.56	0.56	0.58	0.46	0.46	0.60	0.50	0.44
July	0.60	0.64	0.61	0.56	0.51	0.56	0.60	0.56	0.59	0.66	0.49	0.50	0.55	0.53	0.49
August	0.65	0.59	0.61	0.57	0.54	0.60	0.56	0.56	0.59	0.52	0.55	0.55	0.60	0.30	0.47
September	0.57	0.61	0.59	0.55	0.51	0.53	0.57	0.56	0.56	0.57	0.48	0.51	0.44	0.44	0.41
KHARIF	3.24	3.62	3.47	3.15	3.04	3.08	3.34	3.31	3.41	3.30	2.70	2.64	3.26	2.77	2.57
October	0.44	0.54	0.56	0.36	0.49	0.42	0.53	0.58	0.35	0.60	0.43	0.44	0.46	0.46	0.25
November	0.25	0.37	0.39	0.28	0.35	0.21	0.41	0.42	0.40	0.44	0.35	0.34	0.37	0.43	0.21
December	0.23	0.40	0.32	0.30	0.30	0.21	0.26	0.40	0.34	0.33	0.32	0.25	0.39	0.28	0.16
January	0.29	0.24	0.21	0.37	0.26	0.19	0.30	0.23	0.24	0.28	0.15	0.26	0.15	0.25	0.15
February	0.42	0.34	0.28	0.33	0.38	0.29	0.22	0.35	0.41	0.36	0.22	0.28	0.38	0.26	0.21
March	0.44	0.46	0.40	0.40	0.44	0.48	0.14	0.48	0.38	0.40	0.28	0.36	0.42	0.31	0.31
RABI	2.07	2.35	2.16	2.04	2.22	1.80	1.86	2.46	2.12	2.41	1.75	1.93	2.17	1.99	1.29
ANNUAL	5.31	5.97	5.63	5.19	5.26	4.88	5.20	5.77	5.53	5.71	4.45	4.57	5.43	4.76	3.86

ANNEX 2
Table 12

PAKISTAN

CANAL HEAD WITHDRAWALS IN RECHNA DOAB

Monthly Flows in MAF 1960-1975

	1960 /61	1961 /62	1962 /63	1963 /64	1964 /65	1965 /66	1966 /67	1967 /68	1968 /69	1969 /70	1970 /71	1971 /72	1972 /73	1973 /74	1974 /75
April	0.75	0.75	0.92	0.91	1.03	0.97	1.00	0.93	0.85	0.78	0.50	0.70	0.87	1.23	0.86
May	0.82	1.02	0.80	1.12	1.23	1.22	1.27	1.11	1.04	1.15	0.71	0.67	1.01	1.22	0.97
June	1.09	1.08	1.19	1.08	1.33	1.40	1.42	1.31	1.27	1.23	1.17	1.08	1.30	1.30	0.97
July	0.94	0.94	1.14	1.20	1.02	1.27	1.23	1.16	1.27	1.20	1.25	1.20	1.36	1.13	1.28
August	1.01	1.05	1.16	1.30	1.06	1.45	1.35	1.33	1.25	1.15	1.16	1.07	1.49	0.34	1.35
September	1.43	1.10	1.07	1.27	1.26	1.39	1.27	1.34	1.28	1.23	1.03	1.04	1.28	1.37	0.94
KHARIF	6.04	5.94	6.28	6.88	6.93	7.70	7.54	7.18	6.96	6.74	5.82	5.76	7.31	6.59	6.37
October	0.97	1.15	1.06	0.86	1.00	0.85	1.03	0.81	0.93	0.96	0.84	1.01	0.88	0.93	0.62
November	0.57	0.64	0.62	0.65	0.59	0.59	0.74	0.54	0.72	0.80	0.70	0.88	0.68	0.71	0.58
December	0.46	0.53	0.48	0.49	0.35	0.54	0.52	0.53	0.43	0.42	0.38	0.74	0.68	0.65	0.56
January	0.47	0.41	0.39	0.53	0.70	0.47	0.45	0.33	0.20	0.46	0.31	0.39	0.50	0.27	0.29
February	0.62	0.58	0.45	0.64	0.74	0.64	0.44	0.62	0.53	0.46	0.40	0.57	0.96	0.63	0.53
March	0.80	0.73	0.83	0.96	0.90	1.00	0.63	0.82	0.73	0.62	0.66	0.80	1.15	0.89	0.81
RABI	3.89	4.04	3.83	4.13	4.28	4.09	3.81	3.65	3.54	3.72	3.29	4.39	4.85	4.08	3.39
ANNUAL	9.93	9.98	10.11	11.01	11.21	11.79	11.35	10.83	10.50	10.46	9.11	10.15	12.16	10.67	9.76

ANNEX 2
Table 13

PAKISTAN

CANAL HEAD WITHDRAWALS IN BARI DOAB

Monthly Flows in MAF 1960-1975

	1960 /61	1961 /62	1962 /63	1963 /64	1964 /65	1965 /66	1966 /67	1967 /68	1968 /69	1969 /70	1970 /71	1971 /72	1972 /73	1973 /74	1974 /75
April	0.72	0.85	0.90	1.05	0.96	1.13	0.81	0.93	1.16	1.31	0.90	0.73	0.83	1.47	1.20
May	0.98	1.13	1.11	1.27	1.18	1.46	1.31	1.25	1.51	1.74	1.11	0.91	1.30	1.80	1.36
June	1.25	1.54	1.33	1.55	1.22	1.75	1.46	1.45	1.65	1.79	1.54	1.66	1.76	1.83	1.46
July	1.56	1.85	1.75	1.83	1.70	1.79	1.77	1.77	1.86	1.85	1.70	1.90	1.89	1.81	1.74
August	1.88	1.33	1.84	1.88	1.53	1.85	1.87	1.86	1.88	1.92	1.87	1.83	1.97	0.93	2.00
September	1.59	1.31	1.65	1.80	1.81	1.25	1.54	1.79	1.91	1.76	1.75	1.65	1.85	1.71	1.44
KHARIF	7.98	8.01	8.58	9.38	8.40	9.23	8.76	9.05	9.97	10.37	8.87	8.68	9.60	9.55	9.20
October	0.93	1.23	1.49	0.78	1.28	0.69	1.39	1.28	1.09	1.12	1.01	1.04	1.24	1.44	0.79
November	0.47	0.77	0.72	0.57	0.51	0.48	0.71	0.82	0.93	0.86	0.81	0.73	0.77	1.26	0.55
December	0.42	0.57	0.56	0.53	0.74	0.36	0.49	0.63	0.53	0.57	0.48	0.50	0.73	0.74	0.46
January	0.43	0.57	0.51	0.76	0.44	0.34	0.40	0.82	0.60	0.50	0.59	0.42	0.56	0.59	0.40
February	0.87	0.57	0.37	0.68	0.72	0.50	0.35	0.79	0.81	0.46	0.37	0.53	0.97	0.63	0.57
March	0.73	0.90	0.82	0.82	0.91	0.77	0.56	1.08	0.87	0.82	0.62	0.62	1.72	0.90	0.80
RABI	3.85	4.61	4.47	4.14	4.60	3.14	3.90	5.42	4.83	4.33	3.88	3.84	5.99	5.56	3.57
ANNUAL	11.83	12.62	13.05	13.52	13.00	12.37	12.66	14.47	14.80	14.70	12.75	12.52	15.59	15.11	12.77

ANNEX 2
Table 14

PAKISTAN

CANAL HEAD WITHDRAWALS IN SUTLEJ LEFT BANK

Monthly Flows in MAF 1960-1975

	1960 /61	1961 /62	1962 /63	1963 /64	1964 /65	1965 /66	1966 /67	1967 /68	1968 /69	1969 /70	1970 /71	1971 /72	1972 /73	1973 /74	1974 /75
April	0.12	0.26	0.33	0.31	0.30	0.34	0.17	0.37	0.47	0.43	0.32	0.25	0.15	0.48	0.40
May	0.29	0.29	0.23	0.38	0.23	0.42	0.34	0.48	0.60	0.66	0.38	0.36	0.47	0.62	0.45
June	0.32	0.62	0.39	0.51	0.33	0.57	0.46	0.55	0.71	0.68	0.60	0.69	0.63	0.69	0.53
July	0.62	0.83	0.72	0.68	0.73	0.82	0.72	0.75	0.72	0.83	0.80	0.78	0.67	0.71	0.67
August	0.87	0.66	0.85	0.85	0.81	0.83	0.88	0.80	0.79	0.88	0.85	0.89	0.87	0.33	0.79
September	0.54	0.83	0.80	0.79	0.79	0.55	0.82	0.77	0.87	0.83	0.81	0.75	0.83	0.71	0.52
KHARIF	2.76	3.49	3.32	3.52	3.19	3.53	3.39	3.72	4.16	4.31	3.76	3.72	3.62	3.54	3.36
October	0.28	0.52	0.73	0.29	0.47	0.15	0.56	0.51	0.39	0.43	0.45	0.47	0.55	0.63	0.27
November	0.17	0.27	0.25	0.16	0.25	0.13	0.24	0.36	0.36	0.38	0.35	0.30	0.31	0.43	0.17
December	0.09	0.22	0.26	0.16	0.19	0.08	0.18	0.30	0.20	0.28	0.19	0.23	0.35	0.33	0.00
January	0.14	0.20	0.14	0.19	0.19	0.11	0.14	0.41	0.18	0.23	0.24	0.21	0.23	0.25	0.02
February	0.36	0.19	0.11	0.15	0.17	0.09	0.10	0.33	0.29	0.20	0.14	0.17	0.43	0.24	0.22
March	0.23	0.29	0.29	0.19	0.19	0.27	0.20	0.44	0.32	0.34	0.24	0.22	0.60	0.34	0.26
RABI	1.27	1.69	1.78	1.14	1.46	0.83	1.42	2.35	1.74	1.86	1.61	1.60	2.47	2.22	0.94
ANNUAL	4.03	5.18	5.10	4.66	4.65	4.36	4.81	6.07	5.90	6.17	5.37	5.32	6.09	5.76	4.30

ANNEX 2
Table 15

PAKISTAN

CANAL HEAD WITHDRAWALS IN PANJNAD LEFT BANK

Monthly Flows in MAF 1960-1975

	1960 /61	1961 /62	1962 /63	1963 /64	1964 /65	1965 /66	1966 /67	1967 /68	1968 /69	1969 /70	1970 /71	1971 /72	1972 /73	1973 /74	1974 /75
April	0.33	0.39	0.35	0.33	0.45	0.37	0.51	0.43	0.32	0.21	0.12	0.05	0.16	0.42	0.15
May	0.52	0.64	0.61	0.57	0.58	0.54	0.63	0.61	0.58	0.63	0.30	0.27	0.44	0.57	0.41
June	0.61	0.69	0.68	0.68	0.62	0.61	0.66	0.66	0.71	0.68	0.57	0.37	0 62	0.63	0.51
July	0.47	0.65	0.72	0.60	0.61	0.64	0.67	0.69	0.71	0.69	0.69	0.67	0.70	0.68	0.63
August	0.62	0.57	0.68	0.54	0.62	0.64	0.63	0.65	0.67	0.60	0.70	0.64	0.70	0.43	0.68
September	0.46	0.59	0.57	0.64	0.62	0.51	0.52	0.65	0.61	0.62	0.67	0.62	0.69	0.35	0.61
KHARIF	3.01	3.53	3.61	3.36	3.50	3.31	3.62	3.69	3.60	3.43	3.05	2.62	3.31	3.08	2.99
October	0.35	0.53	0.54	0.26	0.45	0.21	0.46	0.50	0.29	0.29	0.43	0.27	0.47	0.52	0.46
November	0.16	0.17	0.17	0.12	0.16	0.09	0.22	0.33	0.20	0.17	0.20	0.08	0.10	0.37	0.09
December	0.11	0.10	0.07	0.10	0.06	0.07	0.11	0.16	0.14	0.12	0.14	0.04	0.05	0.05	0.05
January	0.09	0.28	0.27	0.35	0.17	0.05	0.07	0.13	0.10	0.13	0.04	0.05	0.16	0.10	0.04
February	0.32	0.10	0.08	0.13	0.25	0.07	0.05	0.24	0.07	0.07	0.10	0.04	0.14	0.15	0.06
March	0.15	0.20	0.16	0.15	0.29	0.22	0.08	0.34	0.12	0.09	0.06	0.05	0.09	0.15	0.08
RABI	1.18	1.38	1.29	1.11	1.38	0.71	0.99	1.70	0.92	0.87	0.97	0.53	1.01	1.34	0.78
ANNUAL	4.19	4.91	4.90	4.47	4.88	4.02	4.61	5.39	4.52	4.30	4.02	3.15	4.32	4.42	3.77

ANNEX 2
Table 16

PAKISTAN

CANAL HEAD WITHDRAWALS IN GUDU BARRAGE

Monthly Flows in MAF 1960-1975

	1960 /61	1961 /62	1962 /63	1963 /64	1964 /65	1965 /66	1966 /67	1967 /68	1968 /69	1969 /70	1970 /71	1971 /72	1972 /73	1973 /74	1974 /75
April	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.02	0.01	0.02
May	0.00	0.00	0.05	0.05	0.16	0.24	0.66	0.61	0.48	0.23	0.09	0.12	0.32	0.26	0.19
June	0.67	0.66	0.44	1.00	1.19	1.25	1.78	1.64	1.32	1.50	1.19	1.42	1.62	1.40	1.37
July	1.45	1.38	1.53	1.51	1.94	1.92	1.91	1.75	1.72	2.14	2.21	2.29	2.40	2.16	2.24
August	1.45	1.61	1.72	1.59	1.72	1.74	1.53	1.41	1.62	1.76	1.94	1.73	1.94	1.63	2.15
September	0.80	1.17	1.22	1.29	1.34	1.47	1.05	1.06	1.30	1.54	1.47	1.45	1.70	1.36	1.26
KHARIF	4.37	4.82	4.96	5.44	6.35	6.62	6.93	6.47	6.47	7.20	6.90	7.01	8.00	6.82	7.23
October	0.15	0.15	0.65	0.34	0.45	0.35	0.59	0.53	0.66	0.78	0.78	0.38	0.48	0.78	0.45
November	0.00	0.00	0.00	0.00	0.00	0.06	0.13	0.00	0.09	0.04	0.00	0.03	0.04	0.01	0.00
December	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.02	0.10	0.00	0.08	0.04	0.02	0.00
January	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.11	0.17	0.07	0.08	0.29	0.21	0.11
February	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.04	0.00
March	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.00
RABI	0.15	0.15	0.65	0.34	0.45	0.41	0.94	0.53	0.88	1.09	0.85	0.60	0.90	1.07	0.56
ANNUAL	4.52	4.97	5.61	5.78	6.80	7.03	7.87	7.00	7.35	8.29	7.75	7.61	8.90	7.89	7.79

ANNEX 2
Table 17

PAKISTAN

CANAL HEAD WITHDRAWALS IN SUKKUR BARRAGE RIGHT BANK

Monthly Flows in MAF 1960-1975

	1960 /61	1961 /62	1962 /63	1963 /64	1964 /65	1965 /66	1966 /67	1967 /68	1968 /69	1969 /70	1970 /71	1971 /72	1972 /73	1973 /74	1974 /75
April	0.05	0.06	0.05	0.09	0.09	0.06	0.12	0.01	0.00	0.02	0.00	0.00	0.03	0.10	0.12
May	0.32	0.28	0.36	0.32	0.40	0.35	0.46	0.51	0.49	0.47	0.27	0.14	0.32	0.34	0.22
June	0.87	0.95	1.01	1.01	1.22	1.21	1.22	1.26	1.35	1.38	1.22	1.17	1.29	1.27	1.03
July	1.06	1.10	1.23	1.26	1.29	1.35	1.29	1.23	1.35	1.47	1.49	1.55	1.50	1.45	1.37
August	1.03	1.01	1.03	1.10	1.11	1.13	1.12	0.98	1.16	1.26	1.21	1.25	1.34	0.90	1.41
September	0.79	0.75	0.84	0.79	1.05	0.97	0.79	0.78	0.88	0.93	1.01	1.01	1.10	1.06	1.05
KHARIF	4.12	4.15	4.52	4.57	5.16	5.07	5.00	4.77	5.23	5.53	5.20	5.12	5.58	5.12	5.20
October	0.51	0.42	0.41	0.43	0.44	0.44	0.48	0.41	0.52	0.55	0.65	0.53	0.65	0.71	0.64
November	0.46	0.39	0.37	0.42	0.37	0.43	0.42	0.45	0.45	0.43	0.43	0.37	0.39	0.39	0.38
December	0.30	0.39	0.28	0.31	0.32	0.34	0.32	0.34	0.40	0.35	0.38	0.31	0.31	0.38	0.31
January	0.26	0.15	0.22	0.16	0.15	0.22	0.23	0.13	0.26	0.22	0.33	0.21	0.22	0.19	0.15
February	0.33	0.27	0.26	0.36	0.33	0.28	0.27	0.32	0.33	0.37	0.21	0.25	0.39	0.32	0.25
March	0.30	0.22	0.30	0.27	0.36	0.36	0.30	0.36	0.31	0.32	0.24	0.28	0.42	0.39	0.28
RABI	2.16	1.84	1.84	1.95	1.97	2.07	2.02	2.01	2.27	2.24	2.24	1.95	2.38	2.38	2.01
ANNUAL	6.28	5.99	6.36	6.52	7.13	7.14	7.02	6.78	7.50	7.77	7.44	7.07	7.96	7.50	7.21

ANNEX 2
Table 18

PAKISTAN

CANAL HEAD WITHDRAWALS IN SUKKUR BARRAGE LEFT BANK

Monthly Flows in MAF 1960-1975

	1960 /61	1961 /62	1962 /63	1963 /64	1964 /65	1965 /66	1966 /67	1967 /68	1968 /69	1969 /70	1970 /71	1971 /72	1972 /73	1973 /74	1974 /75
April	1.11	1.10	1.20	1.43	1.48	1.36	1.45	1.28	1.44	1.55	1.50	1.28	1.57	1.56	1.45
May	1.31	1.39	1.36	1.26	1.76	1.64	1.73	1.51	1.64	1.66	1.68	1.71	1.79	1.77	1.78
June	1.31	1.42	1.40	1.40	1.44	1.65	1.65	1.59	1.57	1.72	1.64	1.76	1.86	1.90	1.85
July	1.38	1.46	1.53	1.60	1.47	1.71	1.81	1.65	1.62	1.86	1.81	1.94	1.89	1.97	1.81
August	1.50	1.46	1.50	1.63	1.62	1.80	1.88	1.62	1.86	1.86	1.85	2.01	2.04	1.98	2.12
September	1.28	1.18	1.46	1.51	1.54	1.61	1.49	1.50	1.83	1.74	1.70	1.94	2.07	1.86	1.98
KHARIF	7.89	8.01	8.45	8.83	9.31	9.77	10.01	9.15	9.96	10.39	10.18	10.64	11.22	11.04	10.99
October	1.43	1.41	1.46	1.79	1.72	1.74	1.66	1.66	1.79	1.75	1.66	1.45	1.65	1.77	1.31
November	1.36	1.36	1.39	1.64	1.39	1.50	1.53	1.54	1.60	1.67	1.52	1.42	1.49	1.57	1.36
December	0.75	0.92	0.96	1.12	1.10	1.22	1.23	1.15	1.33	1.27	1.17	1.19	1.18	1.61	1.24
January	0.67	0.48	0.74	0.73	0.46	0.68	0.74	0.73	0.70	0.72	0.76	0.76	0.67	0.62	0.51
February	1.28	1.04	0.92	1.33	1.26	1.08	1.00	1.27	1.16	1.08	0.96	0.96	0.97	1.08	0.92
March	1.08	0.95	1.02	1.26	1.33	1.33	1.26	1.40	1.24	1.12	0.93	1.11	1.38	1.20	0.96
RABI	6.57	6.16	6.49	7.87	7.26	7.55	7.42	7.75	7.82	7.61	7.00	6.89	7.34	7.85	6.30
ANNUAL	14.46	14.17	14.94	16.70	16.57	17.32	17.43	16.90	17.78	18.00	17.18	17.53	18.56	18.89	17.29

ANNEX 2
Table 19

PAKISTAN

CANAL HEAD WITHDRAWALS IN KOTRI BARRAGE

Monthly Flows in MAF 1960-1975

	1960 /61	1961 /62	1962 /63	1963 /64	1964 /65	1965 /66	1966 /67	1967 /68	1968 /69	1969 /70	1970 /71	1971 /72	1972 /73	1973 /74	1974 /75
April	0.03	0.23	0.14	0.20	0.23	0.25	0.59	0.46	0.21	0.47	0.11	0.05	0.22	0.38	0.25
May	0.49	0.56	0.34	0.49	0.58	0.58	0.82	0.70	0.64	0.69	0.48	0.23	0.89	0.94	0.48
June	0.95	1.17	0.91	1.36	1.04	1.33	1.39	1.10	1.30	1.17	1.50	1.33	1.70	1.88	1.00
July	1.43	1.10	1.53	1.79	1.18	1.64	1.60	1.18	1.66	1.24	1.56	1.86	1.80	1.71	1.97
August	1.57	1.15	1.44	1.50	1.09	1.67	1.65	0.36	1.38	1.22	1.01	1.67	1.76	1.50	1.94
September	1.17	0.30	0.90	1.19	0.99	1.26	0.92	0.79	1.11	0.87	0.60	1.22	1.38	1.16	1.58
KHARIF	5.64	4.51	5.26	6.53	5.11	6.73	6.97	4.59	6.30	5.66	5.26	6.36	7.75	7.57	7.22
October	0.48	0.23	0.60	0.60	0.62	0.25	0.69	0.62	0.71	0.61	0.54	0.50	0.55	0.64	0.24
November	0.15	0.07	0.11	0.12	0.24	0.14	0.44	0.43	0.27	0.50	0.25	0.24	0.18	0.42	0.13
December	0.05	0.05	0.04	0.07	0.06	0.07	0.13	0.16	0.12	0.16	0.10	0.13	0.12	0.17	0.09
January	0.05	0.09	0.10	0.19	0.22	0.67	0.41	0.47	0.56	0.55	0.48	0.29	0.64	0.47	0.43
February	0.06	0.06	0.05	0.10	0.13	0.11	0.11	0.28	0.12	0.10	0.08	0.12	0.17	0.31	0.10
March	0.04	0.05	0.10	0.10	0.21	0.09	0.06	0.28	0.07	0.11	0.07	0.07	0.09	0.13	0.05
RABI	0.83	0.55	1.00	1.18	1.48	1.33	1.84	2.24	1.85	2.03	1.52	1.35	1.75	2.14	1.04
ANNUAL	6.47	5.06	6.26	7.71	6.59	8.06	8.81	6.83	8.15	7.69	6.78	7.71	9.50	9.71	8.26

ANNEX 2
Table 20

PAKISTAN

CANAL HEAD WITHDRAWALS BY CCG, JHELUM/CHENAB ZONE

AVERAGE MONTHLY FLOWS IN MAF

	CHAJ DOAB				RECHNA DOAB				BARI DOAB				SUTLEJ LEFT BANK				PANJNAD LEFT BANK				TOTAL JHELUM/CHENAB ZONE			
North	1936/37-1946/47	1960/61-1965/66	1967/68-1973/74	1967/68-1974/75	1936/37 1946/47	1960/61-1965/66	1967/68-1973/74	1967/68-1974/75	1936/37 1946/47	1960/61-1965/66	1967/68-1973/74	1967/68-1974/75	1936/37-1946/47	1960/61-1965/66	1967/68-1973/74	1967/68-1974/75	1936/37-1946/47	1960/61-1965/66	1967/68-1973/74	1967/68-1974/75	1936/37-1946/47	1960/61-1965/66	1967/68-1973/74	1967/68-1974/75
April	0.29	0.45	0.42	0.41	0.57	0.88	0.85	0.85	0.69	0.93	1.04	1.06	0.17	0.28	0.35	0.36	0.13	0.37	0.24	0.23	1.85	2.91	2.90	2.91
May	0.36	0.52	0.51	0.50	0.91	1.04	0.99	0.99	1.03	1.18	1.38	1.38	0.23	0.30	0.52	0.51	0.37	0.58	0.49	0.48	2.90	3.62	3.89	3.86
June	0.41	0.55	0.53	0.52	0.95	1.19	1.23	1.21	1.27	1.43	1.67	1.64	0.43	0.45	0.64	0.63	0.48	0.65	0.60	0.59	3.54	4.27	4.69	4.59
July	0.38	0.58	0.55	0.54	0.90	1.09	1.24	1.25	1.60	1.75	1.81	1.80	0.76	0.74	0.75	0.74	0.49	0.61	0.69	0.68	4.13	4.77	5.04	5.01
August	0.37	0.59	0.53	0.52	0.95	1.17	1.12	1.15	1.50	1.72	1.76	1.79	0.73	0.81	0.78	0.78	0.46	0.61	0.63	0.64	4.01	4.90	4.82	4.86
September	0.40	0.57	0.51	0.50	0.99	1.25	1.24	1.20	1.56	1.58	1.78	1.74	0.69	0.72	0.79	0.75	0.46	0.57	0.60	0.60	4.10	4.69	5.22	5.75
KHARIF	2.21	3.26	3.05	2.99	5.27	6.62	6.69	6.65	7.65	8.59	9.44	9.41	3.01	3.30	3.83	3.77	3.39	3.39	3.25	3.22	20.53	25.16	26.26	26.04
October	0.36	0.47	0.48	0.45	0.76	0.98	0.90	0.87	0.97	1.06	1.17	1.12	0.34	0.41	0.49	0.46	0.39	0.39	0.40	0.41	2.82	3.31	3.44	3.31
November	0.21	0.31	0.39	0.37	0.52	0.62	0.72	0.70	0.53	0.59	0.87	0.83	0.20	0.21	0.36	0.34	0.11	0.15	0.20	0.19	1.57	1.88	2.34	2.43
December	0.29	0.29	0.33	0.31	0.39	0.48	0.55	0.55	0.39	0.53	0.59	0.57	0.15	0.17	0.26	0.23	0.06	0.08	0.10	0.09	1.28	1.55	1.83	1.75
January	0.15	0.20	0.22	0.21	0.42	0.49	0.35	0.34	0.46	0.51	0.58	0.56	0.17	0.16	0.25	0.22	0.06	0.20	0.10	0.09	1.26	1.62	1.58	1.42
February	0.27	0.34	0.32	0.31	0.44	0.60	0.59	0.58	0.45	0.62	0.65	0.64	0.16	0.17	0.26	0.25	0.08	0.16	0.12	0.11	1.40	1.89	1.84	1.89
March	0.31	0.44	0.38	0.37	0.67	0.86	0.81	0.81	0.65	0.83	0.94	0.92	0.18	0.24	0.35	0.34	0.10	0.19	0.13	0.12	1.91	2.56	2.61	2.56
RABI	1.59	2.11	2.18	2.02	3.20	4.03	3.92	3.85	3.45	4.14	4.80	4.64	1.20	1.36	1.97	1.84	0.80	1.17	1.05	1.01	10.24	12.81	13.86	13.36
ANNUAL	3.80	5.37	5.17	5.61	8.47	10.65	10.61	10.50	11.10	12.73	14.24	14.05	4.21	4.66	5.80	5.61	3.19	4.56	4.30	4.23	30.77	37.97	40.12	39.40

Note 1: Figures for the 1936/37-1946/47 period for the Rechna Doab sub-area and for the Jhelum/Chenab zone as a whole exclude any allowance for MR Link internal uses since this canal was not commissioned until later. Similarly, no allowance is made for internal uses of the Haveli Canal since this canal was commissioned part way through the period.

PAKISTAN

IRRIGATION WATER SUPPLY EFFECTS ATTRIBUTABLE TO THE IBP

Monthly Flows in MAF

Month	Incremental canal head withdrawals 1967/68-1973/74 relative to 1936/37-1946/47						Incremental canal head withdrawals adjusted to allow for development up to 1965/66						Deduct		Add	Net Effect of Mangla	Net Effect of IBP 2/
	Chaj Doab	Rechna Doab	Bari Doab	Sutlej Left Bank	Panjnad Left Bank	Total	Chaj Doab	Rechna Doab	Bari Doab	Sutlej Left Bank	Panjnad Left Bank	Total	Eastern River Inflow	Inflow 1/ through Indus Links	Panjnad Below		
												(1)	(2)	(3)	(4)		
October	+0.07	+0.02	+0.19	+0.17	-0.01	+0.44	+0.02	0	+0.18	+0.12	+0.03	+0.35	0.36	0.20	0.07	-0.14	+0.06
November	+0.10	+0.10	+0.31	+0.17	+0.08	+0.76	+0.05	+0.08	+0.28	+0.17	+0.06	+0.64	0.22	0.12	0.01	+0.31	+0.43
December	+0.02	+0.12	+0.19	+0.10	+0.04	+0.47	+0.02	+0.07	+0.06	+0.08	+0.02	+0.25	0.23	0.08	0.05	-0.01	+0.07
January	+0.08	-0.06	+0.14	+0.05	+0.01	+0.22	-0.02	-0.06	+0.13	+0.06	-0.02	+0.09	0.22	0.04	0.17	0.00	+0.04
February	+0.02	+0.11	+0.09	+0.09	+0.04	+0.35	0	+0.01	+0.02	+0.09	-0.03	+0.09	0.19	0.06	0.07	-0.09	-0.03
March	+0.04	+0.06	+0.15	+0.09	+0.04	+0.38	-0.07	-0.13	-0.01	+0.04	-0.12	-0.29	0.26	0.06	0.11	-0.50	-0.44
Rabi	+0.33	+0.35	+1.07	+0.67	+0.20	+2.62	0	-0.03	+0.66	+0.56	-0.06	+1.13	1.48	0.56	0.48	-0.43	+0.13

1/ Flows since 1970 and 1971 averaged over 7 year period since 1967/68.

2/ Including Chasma storage.

ANNEX 2
Table 22

PAKISTAN

POWER BENEFITS

(1975 Rs.Million)

	Mangla Power Investment and O&M Costs				Thermal Alternative Investment O&M and Fuel Costs				
	Investment								Saving
	Local (1)	Foreign (2)	O&M (3)	Total (4)	Investment[1/] (5)	O&M (6)	Fuel (7)	Total (8)	(8-4)
FY65	29.25	101.48	0.0	130.7	303.9			303.9	173.2
FY66	121.44	441.18	0.0	562.6	1,257.4			1,257.4	894.8
FY67	156.40	576.24	0.0	732.6	1,404.9			1,404.9	672.3
FY68	115.90	414.50	2.1	532.5	561.1	43.0	112.4	716.5	184.0
FY69	59.40	210.70	4.0	274.1	226.8	73.0	132.2	432.0	157.9
FY70	12.76	42.50	4.4	59.7	302.6	73.0	151.6	527.2	467.5
FY71	9.24	29.20	5.0	43.4	302.6	87.2	188.2	578.0	534.6
FY72	46.55	69.30	4.6	120.5	201.9	96.9	275.9	574.7	454.2
FY73	73.90	113.10	5.1	192.1	168.2	95.2	315.9	579.3	387.2
FY74	43.16	68.80	4.9	116.9	134.4	77.4	382.7	594.5	477.6
FY75	7.20	13.60	4.7	25.5	33.7	73.6	764.4	871.7	846.2
FY76	7.00	16.50	4.7	28.2		73.6	770.7	844.3	816.1
FY77	35.00	82.50	4.7	122.2		73.6	770.7	844.3	722.1
FY78	56.00	132.00	4.7	192.7		73.6	770.7	844.3	651.6
FY79	35.00	82.50	5.2	122.7		73.7	770.7	844.3	721.6
FY80-90	7.00	16.50	6.0	29.5		73.6	770.7	844.3	814.8

1/ Including cost of delivery pipeline from Sui Gas field.

2/ Assuming fuel cost equivalent to US$2.10 per million Btu (on basis of cost of imported oil), consumption 11,000 Btu/kwh.

ANNEX 2
Table 23

PAKISTAN

A REVIEW OF THE INDUS BASIN PROJECT, 1960-1975

Tubewells and Groundwater

A. Introduction

1. The public tubewell program was launched in the late 1950's and the early 1960's with strong Government support and by substantial assistance from outside donors. The momemtum held through the inception and various stages of the construction of Scarps I, II, III and IV in the Punjab and the Khairpur unit in the Sind.

2. As early as 1965 things began to change. Scarp I had been in operation for some time and was suffering difficulties caused by incrustation of the well screens. The Government was furnishing tubewell water to the cultivators at subsidized rates. The resulting strain on the Government's budget for Scarp I project operation and maintenance costs, coupled with the prospect of additional costs coming from ensuing projects, became a major concern to Government officials. Concurrently, the private sector, realizing the profits to be made from pumped well water, began installing wells at an increasing rate until it reached a maximum of 12,000 per year in 1968. This has since declined to about 6,000 wells per year of which 1/3 are probably replacements.

3. The Government's proposed program for the rapid development of Scarp projects was supported and endorsed by the Bank's ISS study 1/ which proposed acceleration of the Government program. The ISS recommendations are shown below along with actual accomplishments to 1975.

Public Tubewells Energized

Year	Pre-1965	By 1970	By 1975
ISS Projection	2200	9450	20,040
Actual	2206 /a	4682	8,255

/a Includes wells installed by Irrigation Department prior to formation of Scarp I.

1/ ISS is the Bank's Indus Special Study of 1966.

4. The uncertainty over the issue of public versus private tubewell development and, primarily, the shortage of local currency virtually stopped the construction of new public tubewell projects in the early 1970's. Only those projects under way were belatedly completed. Delays in finalizing these projects were related to the lack of electrical transmission, distribution and generating facilities, the construction of which was stretched out due to the lack of funds and contractual difficulties. The Scarp program has since been reviewed, and the Government is now formulating a comprehensive new program for completing the needed works.

B. Tubewell Pumpage

5. For the purpose of this report the groundwater pumpage has been estimated on a monthly basis and proportioned to the canal command groups (one in NWFP, six in the Punjab and four in the Sind) in accordance with the number of private tubewells in each area. Published data on the amount of groundwater pumped by private tubewells are estimates based on sample surveys which showed that the average private tubewell had a capacity of 1.2 cubic feet per second and was used 20 percent of the time. On this basis the annual pumpage was calculated as shown in Table 1. Tables 2 through 12 give the total pumpage by months for each of the canal command groups over the period 1960-1975. They include the groundwater pumped from SCARP wells. The net amount for the private wells can be obtained by subtracting from the monthly totals the amounts shown for the SCARPS in Tables 13 through 18.

6. Public tubewell development, commonly referred to as Salinity Control and Reclamation Projects (SCARPs), has provided the major portion of the pumped groundwater in the public sector. The volume of groundwater pumped from each of the SCARP areas by months is shown on Tables 13 through 18. (A relatively small amount is obtained from other publicly financed wells installed by the Irrigation Department or some other Government agency mainly on private farms. This amount is not included with the public wells, but is shown separately in the tabulation for private wells.)

C. Tubewell Costs and Investments

(a) Public Wells

7. Contract prices for the construction of public tubewells and the pertinant electrical works, including distribution lines, was fairly stable through the mid-sixties. There was actually a decline in the cost per cusec per well during this period. Since then construction costs have escalated until present prices are more than double the mid-1960 costs.

Present Construction Costs-Public Tubewells

Capacity cusecs	1.0	1.5	2.0	2.5	3.0
Cost /a	116.6	128.9	181.3	198.5	224.3

/a Cost per well in thousands of Rupees, excluding transmission and distribution costs.

8. The cost of electrification varies with projects and the average size of tubewell. Electrification of projects with a small average size well, say 2.0 cusecs, will cost considerably more than one averaging 4 cusecs per well. On projects now being designed the cost of electrification appears to exceed the cost of the well. As an illustration, one pilot scheme of 92 wells had an average cost of 167.9 thousand Rupees per well for construction and 214.3 thousand Rupees per well for electrification.

9. Investments in the public tubewell program by years since 1960 were supplied by WAPDA. They are shown on Table 19 corrected to present prices.

(b) Private Tubewells

10. The costs of private diesel and electric powered tubewells were also fairly stable until the late 1960's. Various estimates priced the diesel powered well at anywhere from 7,500 to 12,000 each and the electrically powered well between 5,000 and 7,000 Rupees. All of the estimates appear to have neglected the electrical connection charge so the electrically powered wells were always under-priced. The estimates of well costs by the Bank's Review Mission report of 1970 were considerably higher than those above and placed the cost of an electrically powered well higher than its diesel counterpart.

11. Private tubewell costs have since escalated. The Planning Department of the Government now estimates the present average cost of diesel powered wells at 50,000 Rupees. We estimate that the private electrically-powered well will cost the same when a proper connection charge is added to the cost of the well. We have calculated the investment costs of private tubewells over the study period and adjusted them to present prices. The results are shown on Table 20.

(c) Energy Requirements - Electrified Wells

12. Private tubewell energy consumption is based on the estimated annual volume of water pumped by electrified wells through an average total pumping head of 32 feet. We estimate that the private sector, in the area studied in this report, used about 612 GWH's of electrical energy in

1974/75. Public tubewell energy consumption is based on the annual volumes of pumped water shown in Table 1 and an average total pumping head of 40.5 feet. The estimated annual consumption in the public sector during 1974/75 is about 672 GWH's. The estimated energy consumption and peak loads are shown in Table 21.

(d) Power Requirements

13. Peak loads were calculated from the number of wells and their average installed capacities. The private tubewell peak load is only for those wells located in the canal command groups and will be less than the national total. The peaks for SCARP wells in both the Punjab and the Sind are lumped even though the two systems are, as yet, not connected.

14. As of June 1974, WAPDA records show a total of 63,730 tubewell connections both public and private. They estimate the total connected country-wide load at 758 megawatts with diversity factors of 80 percent for public wells and 63 percent for private wells. On the assumption that 7,221 SCARP tubewells with an average capacity of 3.45 cusecs were operative in 1974 we estimate the connected public tubewell load at 206 megawatts, leaving a total country-wide private tubewell connected load of 552 megawatts compared to 352 megawatts in the ten canal commanded areas. The total peak load during 1975 in the canal commanded area is about 394.6 megawatts -- 221.7 in the private sector and 172.9 in the public.

15. The rate at which private tubewells are being installed has fallen considerably during the last two years indicating that saturation may not be far away. This will not affect the growth rate of the private power load for some time since less than 50 percent of the present private wells are electrified. WAPDA has a large backlog of outstanding requests for connections. The limiting factors seem to be distribution, transmission and generating facilities.

16. Government control of all SCARP projects makes it possible to shed the tubewell load during the periods of peak demand on the power system, i.e., 17 hours to 21 hours. This practice has been adopted on SCARP I. The Pakistan Power Sector Review dated January 1973 strongly recommended interruption of power to SCARP projects for anywhere between two and three hours per day wherever necessary. Under present conditions there is no direct control over the operating hours of private tubewells. It does not appear probably that a system for such control will become practicable in the foreseeable future so the interruption of power to private tubewells does not appear feasible.

(e) Energy Costs and Subsidies - Electrified Wells

17. We understand that private tubewell energy in the Sind and the Punjab is about 40 percent subsidized and that a considerably subsidy over and above the 7,500 rupees subsidy presently allowed for a connection charge also exists. The average connection charge according to WAPDA is about 20,000 rupees per well. Deducting the 7,500 rupee subsidy leaves 12,500 rupees as part of the cultivator's direct cost for installing a well. it appears that WAPDA's estimate of 20,000 rupees for a connection chage may be low, but for the lack of a better number, we have added 20,000 rupees to the tubewell construction costs to establish the present day investment costs of private tubewells.

18. The true annual cost of energy without subsidy can be estimated by multiplying the true cost of energy, 0.27 rupees per KWH, by the number of kilowatt hours shown in Table 21.

(f) Diesel Powered Wells

19. Assuming that the diesel powered wells operate 20 percent of the time, then each well will be operated about 1,752 hours per year. The average consumption of diesel fuel is about 1 gallon per hour of running time. The cost of lubricating oil is variously estimated at 2.5 to 10 percent of the fuel cost. Using the higher figure the Government estimates fuel and oil costs at 4.40 rupees per hour, making the annual operating cost per well about 7,700 rupees for only fuel and lubricants.

20. The total annual costs in the study area are as follows:

Annual Energy Costs - Diesel Powered Wells

Year	60-61	61-62	62-63	63-64	64-65	65-66	66-67	67-68
	50.9	61.4	90.8	123.6	163.4	190.1	215.6	273.1
Year	68-69	69-70	70-71	71-72	72-73	73-74	74-75	
	288.5	365.7	416.6	462.6	534.9	590.6	596.8	

D. Depth to Groundwater

21. The necessity for groundwater exploitation and the ability of tubewells, both public and private, to lower the groundwater level and thus alleviate the problems of waterlogging and salinity have been amply demonstrated over the last decade. The question now requiring attention is whether this exploitation is tending to increasse the depth to groundwater to an inordinate degree so that the cost of extraction becomes uneconomic.

22. We have therefore attempted to present an overall picture for those canal command groups where a significant amount of groundwater exploitation has taken place, namely: 1/

CCG 2 - Thal Doab and Indus Right Bank (includes SCARP III)
CCG 3 - Chaj Doab (includes SCARP II)
CCG 4 - Rechna Doab (includes SCARPS I and IV)
CCG 5 - Bari Doab
CCGs 6 & 7- Sutlej and Panjnad Left Bank

23. Figures 1 to 5 illustrate the average depth to the watertable and its variation for each canal command group in the Punjab together with the annual quantities of groundwater pumped by private and public tubewells.

24. It will be noticed that for all canal command groups a rise in average groundwater level occurred between June and October 1973. While this rise generally occurs to some degree because of heavy applications of irrigation water during the kharif season, the rise in 1973 was particularly marked in the case of CCGs 3, 4 and 5 probably because of the extensive flooding in that year. This has tended to distort the pattern of groundwater movement and makes it difficult to determine the overall trend. However the following observations can be made:

CCG 2 For those areas where the depth of groundwater is less than 20′ the average depth in June 1974 was of the order of 11′, and the rate of extraction averaged about 0.6′ per year. While the rate of decline of groundwater depth between October 1973 and June 1974 is somewhat greater than the overall trend, it is not high. However, groundwater development, which is divided almost equally between public and private tubewells, is increasing at a rapid rate.

CCG 3 The average depth of groundwater in June 1974 was of the order of 11′ and the rate of extraction averaged about 1′ per year. While the rate of decline of groundwater depth between October 1973 and June 1974 is appreciably higher than in the corresponding period of the previous year, the level of extraction has been of the same order for a number of years during which time no appreciable change in the average depth to groundwater occurred. It therefore seems unlikely that the area is being over-exploited. Groundwater development, which is mostly by public tubewells and therefore more easily controlled, took an upturn in 1973/74 after a period of slow growth.

1/ For CCGs 2 through 7 we have relied on information supplied to us in November 1975 by WAPDA's Central Monitoring Organization (CMO) and shown on Table No. 22. Planimetered areas within various groundwater depth ranges are given for the period June 1969 to June 1974. CCGs 1, and 8 through 11 were not included because of lack of definitive data.

CCG 4 The average depth to groundwater in June 1974 was of the order of 13′ and the rate of extraction averaged about 1.4′ per year. A sharp decline of groundwater depth has occurred between October 1973 and June 1974, particularly when compared with the anomalous rise in the corresponding period of the previous year. However, the level of extraction has been high for a number of years without an appreciable decline in the water table and it is probable that this area has good recharge characteristics. Public tubewell development is static, but private tubewell development is increasing rapidly and the total extraction rate may be tending towards the limit at which a more pronounced decline could occur.

CCG 5 The average depth to groundwater in June 1974 was of the order of 22′ and the rate of extraction averaged about 1′ per year. Thus present groundwater depths are well below the level necessary to guard against waterlogging and salinity problems. A sharp decline in groundwater depth is evident prior to the 1973 rise, and the subsequent rate of decline between June 1973 and October 1974 is of the same order. While groundwater extraction was at a fairly high level between 1969 and 1972, during which period the average level fell by only about 2′, the rate of extraction is continuing to rise and present indications are that a more pronounced decline could well occur in the near future. The area is developed almost entirely by private tubewells, and should such a decline occur the situation will be difficult to control.

CCGs 6 & 7 The average depth to groundwater in June 1974 was of the order of 15′ and the rate of extraction about 0.3′ per year. Variations in depth to groundwater since October 1974 have not been sufficient to indicate the overlying trend, but it appears unlikely that the area is anywhere near approaching over-exploitation, although present levels are already low in comparison with all other areas with the exception of Group 5. Groundwater development has been almost entirely by private tubewells with slow rate of growth.

25. The above review is on a regional basis. With regard to individual SCARP projects WAPDA has provided area data for the pre-project and post-project (June 1974) periods as shown in Table No. 23. We have used this information to derive average depths to groundwater in a similar manner to that described above, with the results shown in Table No. 24. Based on these values it would appear that groundwater depths may be approaching uneconomic depths in the Khadir sub-project area of SCARP II and in the Mangtanwala sub-project area of SCARP IV, and that the situation should be reviewed in SCARP I, the Lalian sub-project area of SCARP II and the Muridke sub-project area

of SCARP IV. Data for June 1975 will be of great interest when this becomes available.

26. The highest concentration of tubewells and the largest volume of groundwater pumped per acre of land occurs in the Bari, Rechna and Chaj Doabs. Here an average of 1.11 acre feet per acre is being extracted from a gross commanded area of 19.8 million acres. Based on cultivable commanded areas, which supply the bulk of the recharge, the rate is 1.74 acre feet per acre. The highest occurs in the Rechna Doab where the rate is 1.3 acre feet on G.C.A. and 2.18 on C.C.A.

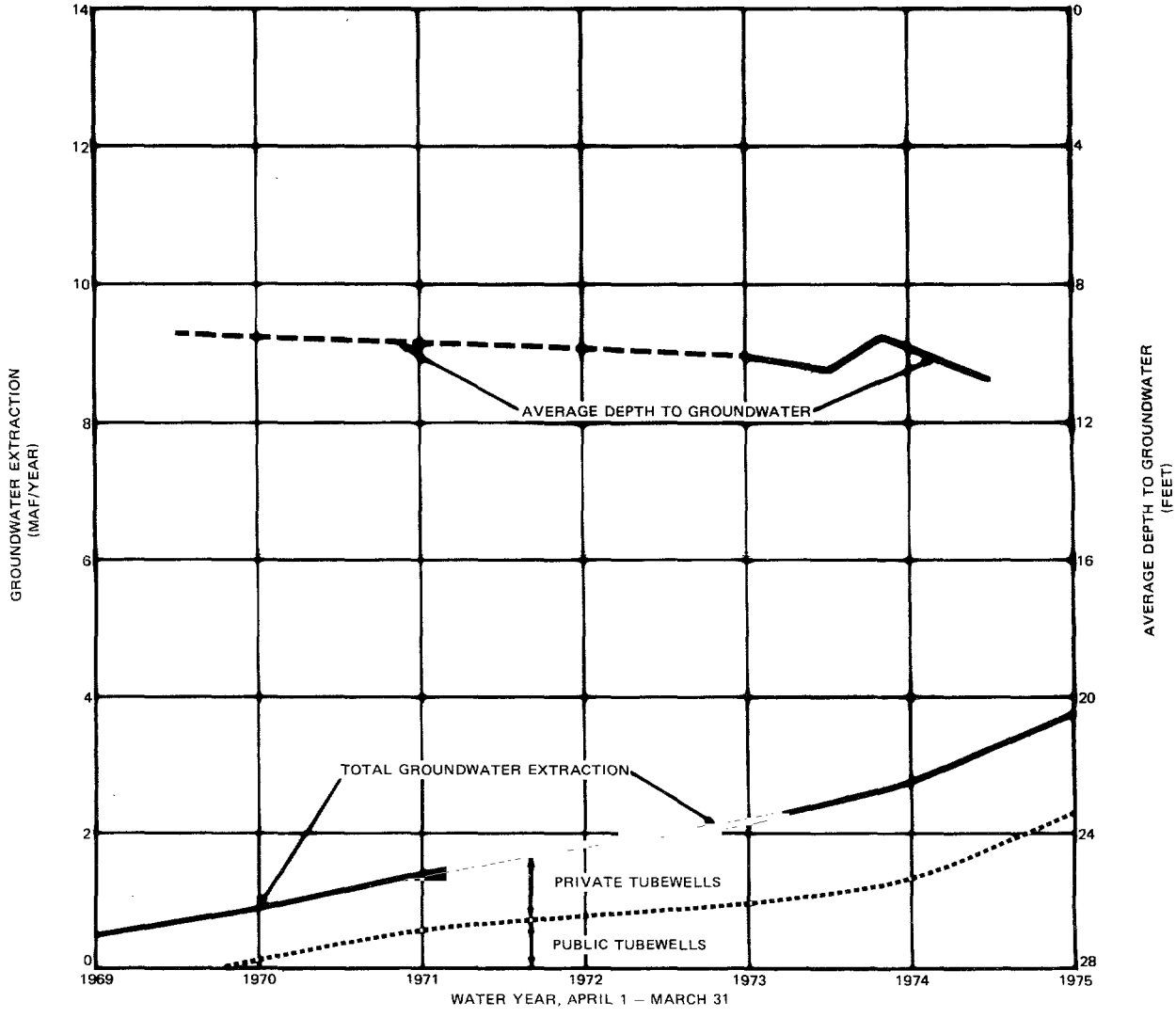
27. Various estimates of recharge to groundwater have been made for the irrigated areas of the Punjab. Messrs. Maasland, Priest and Malik estimated recharge at about 1.53 acre feet per acre over 23 million acres of total farm area. The Government once recommended 1.2 acre feet per acre of project G.C.A. for planning purposes and figures for SCARP I over a one year period indicated 1.9 acre feet per acre on about 1.2 million acres of area. Irrespective of the choice on recharge it appears that mining is occuring in Bari Doab and extraction may be approaching recharge levels in Rechna Doab. Overall implications are that further development of groundwater in the Punjab without mining may be limited; it may be of the order of 8.0 million acre feet per year.

28. There is some concern about future pumping from existing public and private tubewells and the development of new wells in areas that will receive substantial increases in water supply from Tarbela Dam. In perennial canal areas the amounts of supplementary irrigation water required from tubewells will decrease on average. In cases where a non-perennial system receives substantial increases in rabi, or where a non-perennial system is converted to a full perennial system, the dependence on tubewell water will diminish. The consequences on groundwater levels of increased surface supplies and decreased tubewell pumping will need to be assessed, particularly if there is not a marked increase in cropping intensity to make use of the additional water supplies.

29. A considerable portion of the remaining SCARP development is likely to be directed toward pumping saline groundwater. At the moment there is no disposal area except the rivers or the canals; the volume that could be disposed of is dependent on the standards of water quality set by the Government. A Bank review of 1974 indicated the volume of saline water to be moved out of the area would exceed acceptable amounts which could be absorbed by either the canals or rivers and would need to be transported out of the area. This problem and the problem of maintaining the salt balance are related and must be faced.

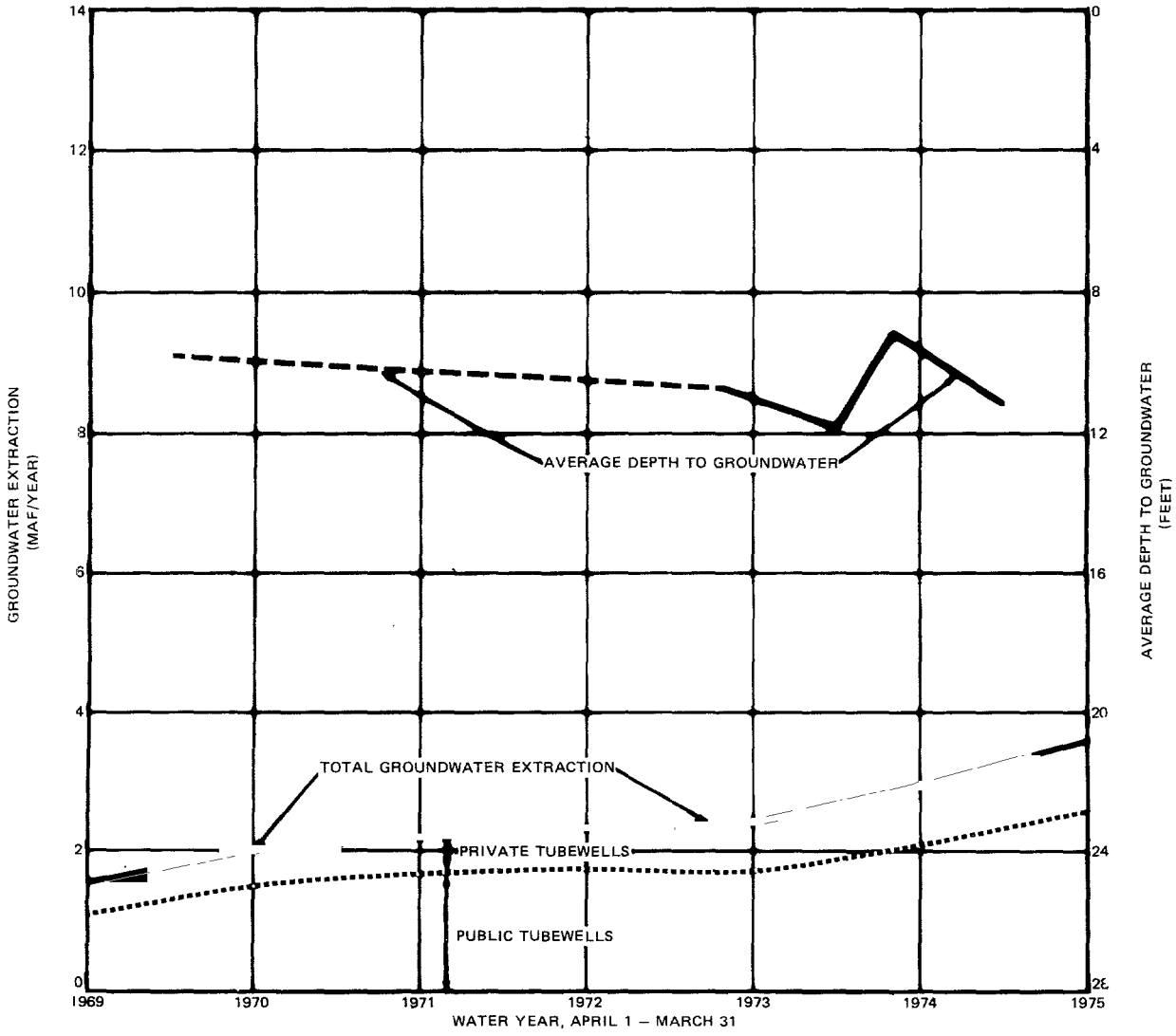
30. It appears from the records of groundwater pumpage that the salinization of soils, at least in the Punjab, due to waterlogging is rapidly being overcome, but salinization due to under irrigation continues. Lowering of the water table will not reclaim saline land; it only makes it possible to reclaim such areas by leaching.

A REVIEW OF THE INDUS BASIN PROJECT
1960–1975
GROUNDWATER
CANAL COMMAND GROUP 2 – THAL AND INDUS RIGHT BANK
5.5 MILLION ACRES (EXCLUDING AREAS WITH GROUNDWATER DEPTH > 20 FT.)



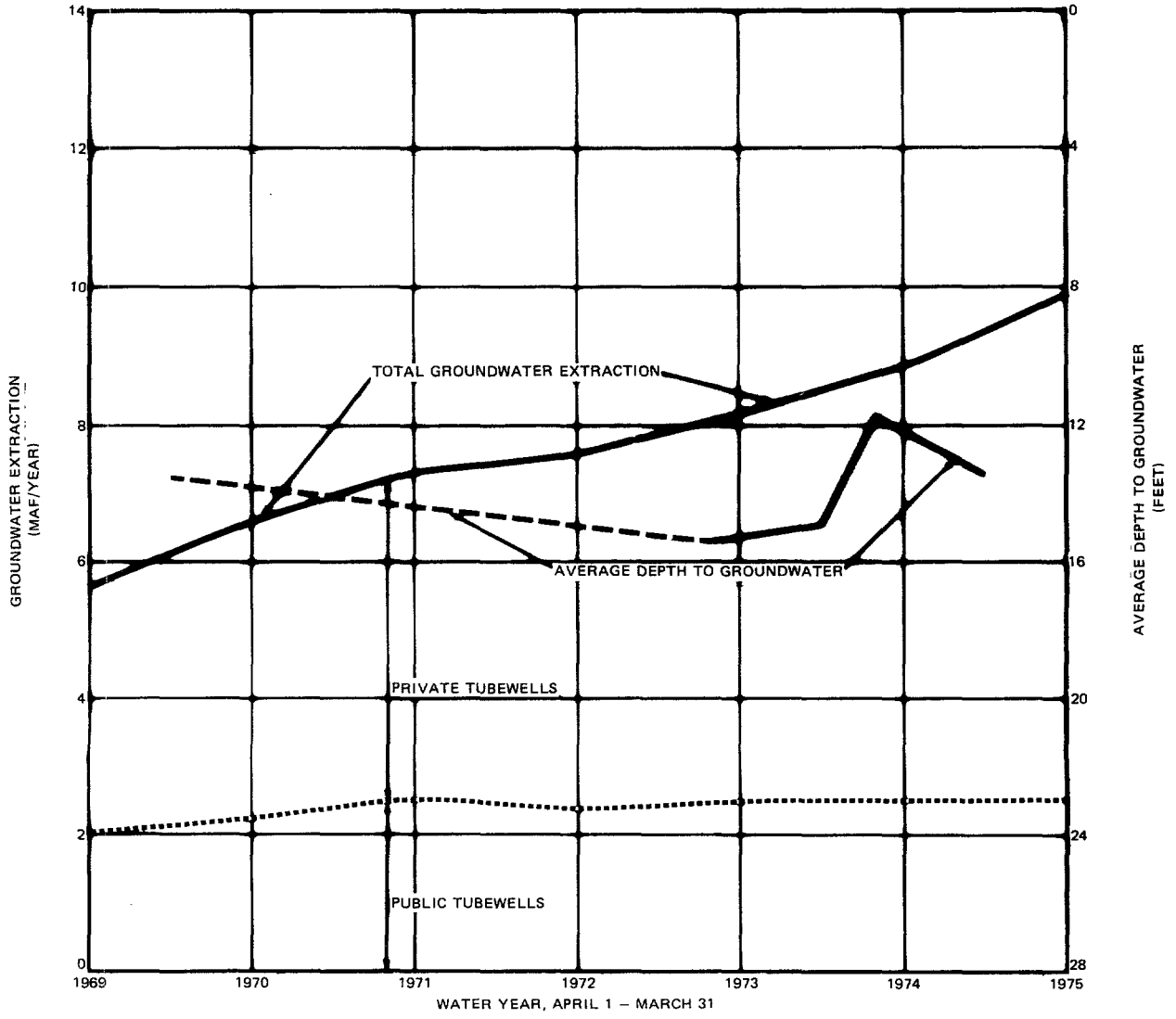
World Bank–15773

A REVIEW OF THE INDUS BASIN PROJECT
1960 – 1975
GROUNDWATER
CANAL COMMAND GROUP 3 - CHAJ DOAB
2.8 MILLION ACRES



World Bank–15774

A REVIEW OF THE INDUS BASIN PROJECT
1960 – 1975
GROUNDWATER
CANAL COMMAND GROUP 4 – RECHNA DOAB
6.4 MILLION ACRES



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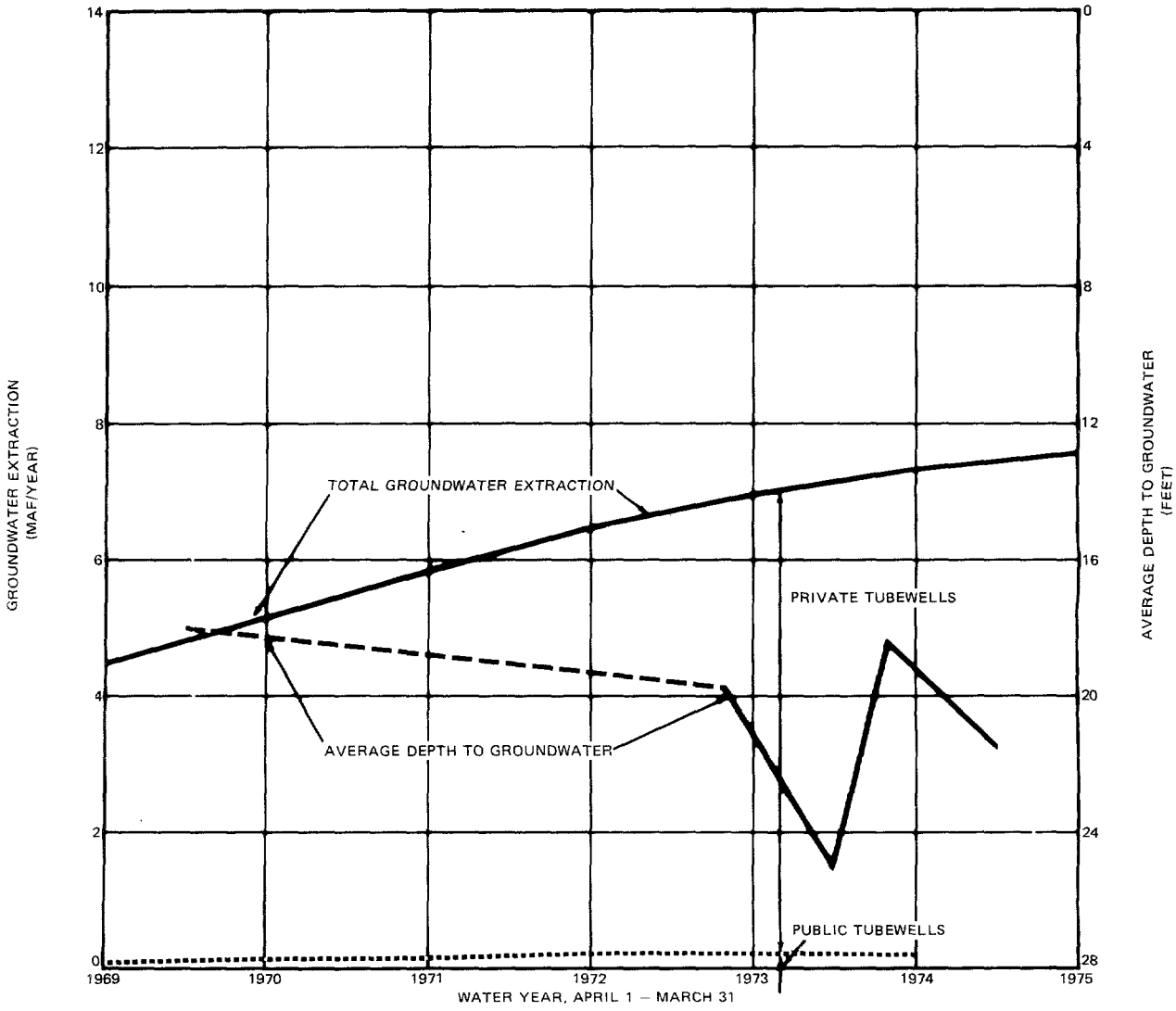
A REVIEW OF THE INDUS BASIN PROJECT
1960 – 1975
GROUNDWATER
CANAL COMMAND GROUP 5 – BARI DOAB
7.2 MILLION ACRES



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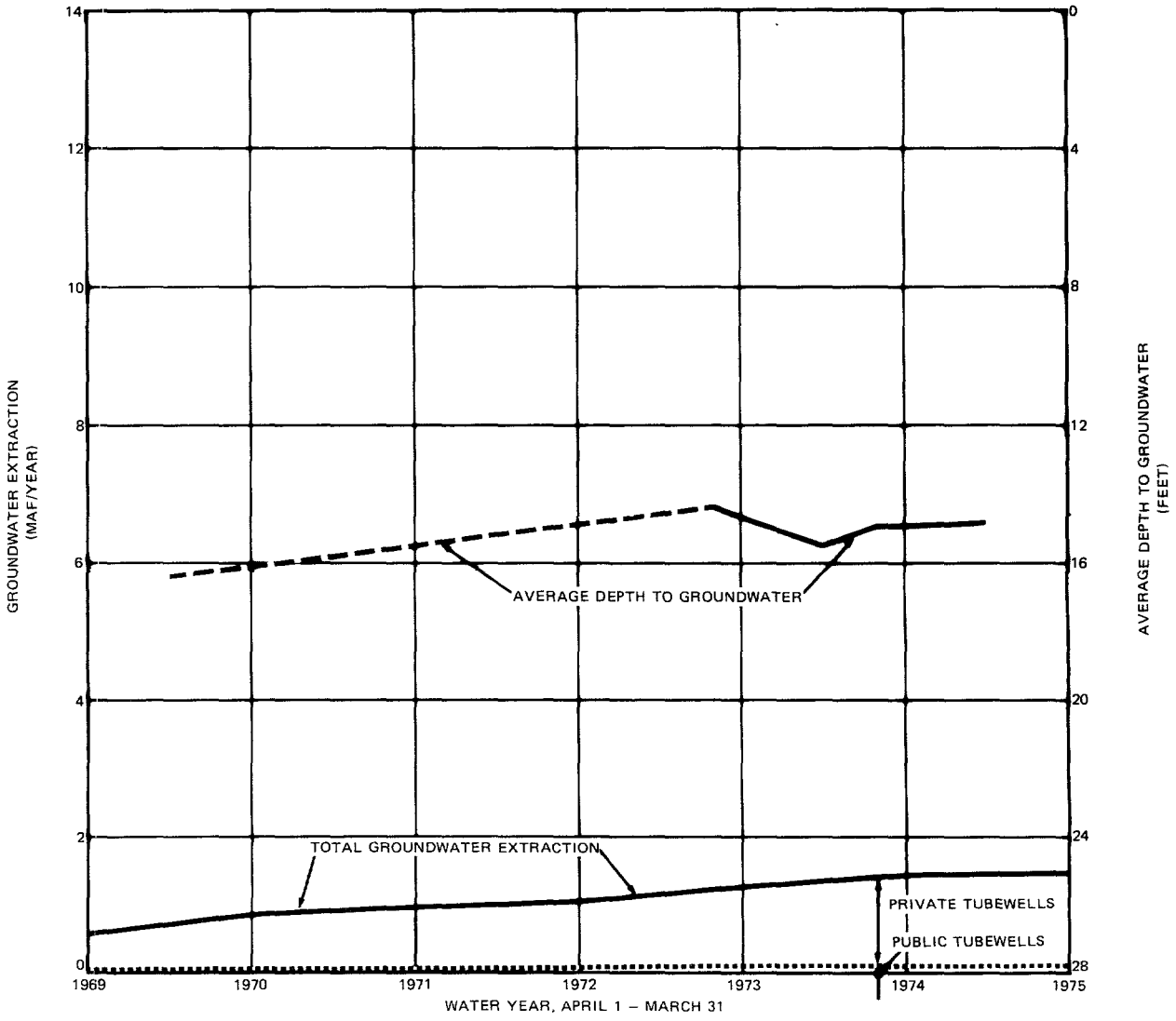
A REVIEW OF THE INDUS BASIN PROJECT
1960 – 1975
GROUNDWATER
CANAL COMMAND GROUP 6 & 7 SUTLEJ AND PANJNAD LEFT BANK
5.3 MILLION ACRES



World Bank–15777

PAKISTAN

ANNUAL VOLUME OF PUMPED GROUNDWATER

PUBLIC AND PRIVATE TUBEWELLS-INDUS BASIN CANAL COMMANDS (M.A.F.)

PROJECT / YEAR	60-61	61-62	62-63	63-64	64-65	65-66	66-67	67-68	68-69	69-70	70-71	71-72	72-73	73-74	74-75
Scarp I	--	0.66	2.26	2.51	2.43	2.49	1.69	1.86	1.96	1.95	1.93	1.67	1.63	1.43	1.43 [1]
Scarp II	--				0.30	0.36	0.27	0.31	1.03	1.47	1.61	1.69	1.63	2.02	2.59
Scarp III	--								0.02	0.18	0.62	0.81	0.98	1.32	2.24
Scarp IV	--									0.20	0.54	0.61	0.75	0.96	0.99
Khairpur	--								0.02	0.14	0.24	0.31	0.31	0.29	0.19 SGW [5]
								0.08	0.19	0.23	0.12	0.18	0.21	0.17	0.19 FGW
Rohri N.	--													0.04	0.50
Pilot Scarps Sind	--													--	0.02
Peshawar and D. I. Khan Scarps	--													--	0.02
Total Scarps		0.66	2.26	2.51	2.73	2.85	1.96	2.25	3.22	4.17	5.06	5.27	5.51	6.23	8.17
Punjab P.T.W. [2]	1.17	1.81	2.53	3.79	4.99	6.18	7.53	9.25	10.45	12.75	14.26	15.53	17.21	19.04	19.65 [3]
D. I Khan P.T.W.		0.01	0.02	0.02	0.03	0.04	0.06	0.08	0.10	0.12	0.14	0.16	0.17	0.21	0.24
Sind P.T.W.	0.03	0.04	0.05	0.08	0.11	0.16	0.22	0.28	0.35	0.43	0.54	0.64	0.75	0.84	0.98
Peshawar T.W.	--	0.01	0.01	0.01	0.02	0.03	0.03	0.04	0.05	0.07	0.07	0.10	0.11	0.12	0.14
Irr. Dept. & Others	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.18	0.23	0.25	0.35	0.41	0.36	0.38
Totals	1.29	2.62	4.96	6.50	7.97	9.35	9.89	11.99	14.35	17.77	20.32	22.05	24.16	26.80	29.56
N.C. Areas [4]	0.14	0.14	0.18	0.23	0.29	0.46	0.59	0.76	0.91	1.23	1.43	1.48	1.63	1.84	1.93

1/ All 1974-75 amounts are estimated.

2/ P.T.W. - Private tubewells.

3/ Based on increase of 3% New T.W. in commanded areas.

4/ Amounts for non-commanded areas included in above totals.

5/ SGW - Saline groundwater, FGW - Fresh groundwater

ANNEX 3
Table 1

PAKISTAN

CCG I PESHAWAR VALE

Volume Pumped Groundwater (M.A.F.)

Year	60-61	61-62	62-63	63-64	64-65	65-66	66-67	67-68	68-69	69-70	70-71	71-72	72-73	73-74	74-75
A	.0003	.0005	.0008	.0011	.0014	.0021	.0028	.0035	.0043	.0054	.0058	.0078	.0089	.0102	.0119
M	.0003	.0005	.0008	.0011	.0014	.0021	.0029	.0036	.0045	.0055	.0060	.0081	.0093	.0105	.0125
J	.0003	.0005	.0009	.0011	.0015	.0022	.0030	.0037	.0046	.0057	.0062	.0083	.0095	.0108	.0128
J	.0004	.0005	.0009	.0012	.0015	.0022	.0030	.0038	.0047	.0057	.0062	.0084	.0096	.0109	.0129
A	.0004	.0005	.0009	.0012	.0015	.0022	.0030	.0038	.0047	.0057	.0062	.0085	.0096	.0109	.0129
S	.0003	.0005	.0009	.0011	.0015	.0022	.0030	.0038	.0047	.0057	.0062	.0085	.0096	.0109	.0130
O	.0004	.0006	.0009	.0012	.0015	.0023	.0031	.0039	.0048	.0059	.0064	.0086	.0098	.0112	.0135
N	.0004	.0006	.0010	.0012	.0016	.0024	.0033	.0041	.0050	.0062	.0068	.0092	.0105	.0120	.0143
D	.0004	.0005	.0009	.0011	.0015	.0022	.0030	.0038	.0047	.0057	.0062	.0085	.0096	.0110	.0132
J	.0003	.0005	.0007	.0010	.0013	.0018	.0024	.0032	.0039	.0048	.0054	.0070	.0080	.0094	.0113
F	.0002	.0004	.0006	.0008	.0011	.0016	.0022	.0028	.0034	.0042	.0047	.0062	.0071	.0083	.0100
M	.0003	.0004	.0007	.0009	.0012	.0017	.0023	.0030	.0037	.0045	.0049	.0059	.0075	.0089	.0107
TOTAL	.004	.006	.010	.013	.017	.025	.034	.043	.053	.065	.071	.095	.109	.125	.149

ANNEX 3
Table 2

PAKISTAN

CCG II THAL DOAB AND INDUS RIGHT BANK

Volume of Pumped Groundwater-Monthly (M.A.F.)

Year	60-61	61-62	62-63	63-64	64-65	65-66	66-67	67-68	68-69	69-70	70-71	71-72	72-73	73-74	74-75
A	0.005	0.008	0.011	0.017	0.023	0.026	0.038	0.043	0.055	0.093	0.121	0.195	0.237	0.280	0.393
M	0.005	0.009	0.013	0.018	0.024	0.028	0.040	0.042	0.059	0.096	0.124	0.214	0.254	0.209	0.344
J	0.005	0.008	0.011	0.017	0.023	0.026	0.038	0.043	0.055	0.091	0.124	0.147	0.177	0.178	0.303
J	0.004	0.007	0.011	0.014	0.018	0.022	0.032	0.036	0.046	0.080	0.116	0.104	0.117	0.165	0.254
A	0.004	0.007	0.009	0.013	0.017	0.020	0.028	0.033	0.041	0.074	0.116	0.093	0.104	0.155	0.264
S	0.003	0.006	0.009	0.011	0.016	0.019	0.026	0.030	0.038	0.067	0.103	0.094	0.096	0.189	0.267
O	0.004	0.007	0.009	0.014	0.018	0.021	0.029	0.034	0.044	0.078	0.124	0.179	0.168	0.214	0.356
N	0.005	0.009	0.013	0.018	0.023	0.029	0.041	0.047	0.060	0.101	0.135	0.196	0.225	0.283	0.398
D	0.005	0.008	0.014	0.018	0.022	0.026	0.039	0.045	0.059	0.100	0.154	0.211	0.244	0.321	0.372
J	0.004	0.007	0.009	0.012	0.017	0.020	0.028	0.032	0.042	0.074	0.147	0.154	0.242	0.270	0.312
F	0.004	0.007	0.010	0.014	0.018	0.020	0.028	0.035	0.048	0.082	0.152	0.180	0.236	0.326	0.303
M	0.004	0.007	0.011	0.014	0.021	0.023	0.033	0.040	0.063	0.094	0.184	0.233	0.270	0.390	0.414
TOTAL	0.03	0.09	0.13	0.18	0.24	0.28	0.40	0.46	0.61	1.03	1.60	2.00	2.37	2.98	3.98
N.C. Area							.010	.014	.017	.030	0.050	0.050	0.060	0.07	0.08

ANNEX 3
Table 3

PAKISTAN

CCG III CHAJ DOAB

Volume of Pumped Groundwater-Monthly (M.A.F.)

YEAR	60-61	61-62	62-63	63-64	64-65	65-66	66-67	67-68	68-69	69-70	70-71	71-72	72-73	73-74	74-75
A	0.008	0.009	0.012	0.013	0.040	0.045	0.052	0.060	0.121	0.161	0.182	0.247	0.181	0.201	0.269
M	0.009	0.010	0.013	0.014	0.038	0.045	0.053	0.061	0.116	0.153	0.160	0.186	0.204	0.270	0.317
J	0.008	0.009	0.012	0.013	0.039	0.045	0.053	0.060	0.118	0.158	0.165	0.146	0.217	0.257	0.273
J	0.007	0.008	0.010	0.011	0.036	0.042	0.048	0.054	0.112	0.151	0.190	0.148	0.181	0.209	0.270
A	0.006	0.007	0.009	0.010	0.038	0.044	0.047	0.054	0.120	0.162	0.173	0.208	0.203	0.238	0.260
S	0.006	0.007	0.008	0.009	0.038	0.044	0.046	0.053	0.120	0.162	0.163	0.190	0.185	0.247	0.295
O	0.007	0.007	0.010	0.011	0.050	0.059	0.059	0.068	0.158	0.215	0.185	0.283	0.253	0.344	0.349
N	0.009	0.010	0.013	0.014	0.041	0.049	0.056	0.065	0.128	0.171	0.175	0.159	0.193	0.281	0.339
D	0.009	0.010	0.013	0.014	0.034	0.039	0.048	0.056	0.103	0.135	0.135	0.168	0.166	0.168	0.269
J	0.006	0.007	0.009	0.010	0.034	0.040	0.044	0.050	0.106	0.143	0.205	0.154	0.149	0.178	0.263
F	0.007	0.007	0.010	0.010	0.038	0.045	0.047	0.054	0.116	0.157	0.205	0.153	0.199	0.220	0.266
M	0.008	0.008	0.011	0.012	0.044	0.053	0.057	0.065	0.142	0.192	0.192	0.228	0.229	0.297	0.340
TOTAL	0.09	0.10	0.13	0.14	0.47	0.55	0.61	0.700	1.460	1.96	2.13	2.27	2.36	2.91	3.51
Basul T.W.	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
N.C. Area	0.02	0.02	0.02	0.03	0.03	0.03	0.07	0.09	0.10	0.11	0.12	0.13	0.18	0.23	0.25

ANNEX 3
Table 4

PAKISTAN

CCG IV RECHNA DOAB

Volume of Pumped Groundwater Monthly (M.A.F.)

YEAR	60-61	61-62	62-63	63-64	64-65	65-66	66-67	67-68	68-69	69-70	70-71	71-72	72-73	73-74	74-75
A	0.038	0.053	0.264	0.319	0.266	0.380	0.356	0.449	0.479	0.550	0.635	0.653	0.718	0.775	0.786
M	0.042	0.057	0.280	0.348	0.358	0.424	0.383	0.482	0.525	0.601	0.675	0.688	0.761	0.812	0.814
J	0.039	0.055	0.276	0.333	0.371	0.406	0.373	0.458	0.450	0.585	0.643	0.664	0.733	0.810	0.827
J	0.034	0.048	0.267	0.319	0.423	0.383	0.346	0.422	0.440	0.538	0.629	0.600	0.671	0.690	0.723
A	0.031	0.044	0.241	0.291	0.362	0.349	0.319	0.389	0.435	0.503	0.589	0.602	0.635	0.654	0.704
S	0.032	0.045	0.283	0.333	0.384	0.383	0.344	0.426	0.463	0.544	0.593	0.605	0.649	0.737	0.729
O	0.036	0.050	0.311	0.374	0.399	0.430	0.386	0.476	0.515	0.594	0.654	0.682	0.721	0.790	0.822
N	0.043	0.060	0.254	0.314	0.336	0.394	0.375	0.468	0.513	0.585	0.638	0.683	0.741	0.814	0.841
D	0.039	0.214	0.216	0.272	0.299	0.374	0.320	0.415	0.457	0.567	0.578	0.619	0.620	0.679	0.707
J	0.030	0.204	0.219	0.257	0.276	0.343	0.291	0.360	0.434	0.484	0.513	0.515	0.554	0.580	0.608
F	0.031	0.208	0.221	0.270	0.252	0.309	0.299	0.369	0.405	0.482	0.536	0.548	0.603	0.627	0.628
M	0.035	0.217	0.268	0.320	0.364	0.355	0.348	0.426	0.474	0.527	0.577	0.631	0.674	0.733	0.731
TOTAL	0.43	1.255	3.10	3.75	4.09	4.53	4.14	5.14	5.59	6.56	7.26	7.49	8.08	8.70	8.92
Irr. Dept. &Rasul	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
N.C. Area	0.08	0.10	0.13	0.15	0.19	0.35	0.41	0.54	0.64	0.94	1.10	1.13	1.20	1.31	1.35

NOTE: Irrigation Dept. wells and wells in N.C. Area of Doab not included in monthly totals.

ANNEX 3
Table 5

PAKISTAN

CCG V BARI DOAB

Volume of Pumped Groundwater Monthly (M.A.F.)

YEAR	60-61	61-62	62-63	63-64	64-65	65-66	66-67	67-68	68-69	69-70	70-71	71-72	72-73	73-74	74-75
A	0.052	0.072	0.102	0.157	0.201	0.251	0.293	0.340	0.379	0.434	0.494	0.537	0.580	0.619	0.638
M	0.056	0.078	0.111	0.170	0.224	0.272	0.317	0.367	0.410	0.480	0.535	0.580	0.627	0.670	0.691
J	0.053	0.074	0.105	0.161	0.212	0.258	0.300	0.348	0.388	0.444	0.506	0.549	0.593	0.634	0.653
J	0.047	0.065	0.091	0.141	0.186	0.226	0.263	0.304	0.340	0.389	0.443	0.480	0.519	0.554	0.571
A	0.043	0.060	0.086	0.132	0.174	0.211	0.246	0.284	0.318	0.364	0.414	0.449	0.486	0.518	0.533
S	0.048	0.066	0.093	0.143	0.188	0.229	0.266	0.308	0.344	0.384	0.448	0.487	0.526	0.562	0.580
O	0.056	0.079	0.111	0.172	0.227	0.275	0.320	0.371	0.415	0.474	0.540	0.587	0.634	0.677	0.697
N	0.055	0.082	0.117	0.179	0.236	0.287	0.334	0.387	0.432	0.495	0.563	0.611	0.661	0.706	0.728
D	0.050	0.071	0.100	0.154	0.202	0.246	0.286	0.332	0.370	0.424	0.483	0.524	0.566	0.605	0.623
J	0.044	0.060	0.086	0.132	0.174	0.211	0.246	0.284	0.318	0.364	0.414	0.449	0.486	0.518	0.535
F	0.046	0.064	0.090	0.139	0.183	0.223	0.259	0.301	0.335	0.384	0.437	0.474	0.512	0.547	0.563
M	0.050	0.069	0.098	0.150	0.197	0.241	0.280	0.324	0.361	0.414	0.473	0.513	0.550	0.590	0.608
TOTAL	0.60	0.84	1.19	1.83	2.41	2.93	3.41	3.95	4.41	5.05	5.75	6.24	6.74	7.20	7.41
Irr. Dept.									0.08	0.12	0.14	0.22	0.22	0.18	0.19
N.C. Area	0.012	0.02	0.03	0.05	0.07	0.08	0.10	0.12	0.15	0.15	0.16	0.17	0.19	0.23	0.25

NOTE: Irrigation Dept. wells and wells in N.C. area of Doab not included in monthly totals.

ANNEX 3
Table 6

PAKISTAN

CCG VI SUTLEJ-LEFT BANK

Volume of Pumped Groundwater Monthly (M.A.F.)

YEAR	60-61	61-62	62-63	63-64	64-65	65-66	66-67	67-68	68-69	69-70	70-71	71-72	72-73	73-74	74-75
A	0.001	0.003	0.005	0.009	0.012	0.017	0.021	0.028	0.033	0.034	0.036	0.038	0.047	0.057	0.059
M	0.002	0.003	0.006	0.010	0.013	0.019	0.023	0.030	0.035	0.037	0.039	0.041	0.051	0.061	0.063
J	0.001	0.003	0.005	0.010	0.012	0.018	0.022	0.028	0.033	0.035	0.037	0.039	0.048	0.058	0.060
J	0.001	0.002	0.005	0.008	0.011	0.015	0.019	0.025	0.029	0.031	0.032	0.034	0.042	0.051	0.053
A	0.001	0.002	0.003	0.008	0.010	0.014	0.018	0.023	0.027	0.029	0.030	0.032	0.040	0.048	0.049
S	0.001	0.002	0.005	0.009	0.011	0.016	0.020	0.025	0.030	0.031	0.033	0.034	0.043	0.051	0.053
O	0.002	0.003	0.006	0.010	0.013	0.019	0.023	0.030	0.036	0.038	0.039	0.041	0.052	0.062	0.064
N	0.002	0.003	0.006	0.011	0.014	0.020	0.025	0.031	0.037	0.039	0.042	0.043	0.054	0.065	0.066
D	0.001	0.003	0.005	0.009	0.012	0.017	0.022	0.027	0.032	0.034	0.036	0.037	0.046	0.055	0.057
J	0.001	0.002	0.004	0.008	0.010	0.014	0.018	0.023	0.028	0.029	0.030	0.032	0.040	0.048	0.049
F	0.001	0.002	0.005	0.008	0.011	0.015	0.019	0.024	0.029	0.030	0.032	0.033	0.042	0.050	0.052
M	0.001	0.002	0.005	0.010	0.011	0.016	0.020	0.026	0.031	0.033	0.034	0.036	0.045	0.054	0.055
TOTAL	0.015	0.03	0.06	0.11	0.14	0.20	0.25	0.32	0.38	0.40	0.42	0.44	0.55	0.66	0.68
Irr. Dept.									0.010	0.020	0.02	0.04	0.10	0.09	0.10

ANNEX 3
Table 7

PAKISTAN

CCG VII PANJNAD-ABBASIA

Volume of Pumped Groundwater-Monthly (M.A.F.)

YEAR	60-61	61-62	62-63	63-64	64-65	65-66	66-67	67-68	68-69	69-70	70-71	71-72	72-73	73-74	74-75
A	---	0.002	0.002	0.008	0.010	0.011	0.014	0.015	0.019	0.041	0.048	0.052	0.060	0.069	0.067
M	---	0.002	0.002	0.008	0.011	0.012	0.015	0.016	0.020	0.044	0.051	0.055	0.064	0.069	0.071
J	---	0.002	0.002	0.007	0.010	0.011	0.013	0.014	0.018	0.040	0.046	0.049	0.058	0.062	0.064
J	---	0.001	0.001	0.006	0.008	0.008	0.012	0.012	0.014	0.032	0.037	0.040	0.046	0.050	0.052
A	---	0.001	0.001	0.005	0.007	0.008	0.009	0.010	0.013	0.028	0.032	0.035	0.040	0.043	0.044
S	---	0.001	0.001	0.005	0.007	0.007	0.009	0.009	0.012	0.027	0.032	0.034	0.040	0.043	0.044
O	---	0.002	0.002	0.007	0.009	0.010	0.013	0.014	0.017	0.037	0.043	0.047	0.054	0.059	0.061
N	---	0.002	0.002	0.008	0.011	0.012	0.015	0.016	0.020	0.044	0.051	0.055	0.064	0.069	0.070
D	---	0.002	0.002	0.007	0.010	0.011	0.014	0.015	0.018	0.041	0.047	0.051	0.059	0.063	0.065
J	---	0.001	0.001	0.006	0.008	0.009	0.011	0.012	0.015	0.033	0.038	0.040	0.047	0.051	0.052
F	---	0.002	0.002	0.006	0.009	0.010	0.012	0.013	0.016	0.036	0.040	0.044	0.052	0.055	0.057
M	---	0.002	0.002	0.007	0.010	0.011	0.013	0.014	0.018	0.037	0.045	0.048	0.056	0.061	0.063
TOTAL		0.02	0.02	0.08	0.11	0.12	0.15	0.16	0.20	0.44	0.51	0.55	0.64	0.69	0.71

ANNEX 3
Table 8

PAKISTAN

CCG VIII GULU BARRAGE

Canals-Ghotki, Beggri Sind, Desert, Pat

Volume of Pumped Groundwater-Monthly (M.A.F.)

YEAR	60-61	61-62	62-63	63-64	64-65	65-66	66-67	67-68	68-69	69-70	70-71	71-72	72-73	73-74	74-75
A	.0007	.0010	.0014	.0022	.0033	.0047	.0060	.0072	.0084	.0109	.0142	.0168	.0199	.0223	.0264
M	.0008	.0011	.0016	.0025	.0040	.0055	.0069	.0084	.0098	.0127	.0165	.0196	.0232	.0260	.0306
J	.0007	.0010	.0014	.0022	.0039	.0047	.0061	.0072	.0084	.0109	.0142	.0168	.0199	.0223	.0262
J	.0010	.0013	.0018	.0029	.0046	.0063	.0080	.0096	.0112	.0145	.0189	.0224	.0266	.0298	.0354
A	.0011	.0015	.0020	.0032	.0050	.0071	.0090	.0108	.0126	.0163	.0212	.0252	.0300	.0335	.0396
S	.0012	.0016	.0020	.0032	.0051	.0071	.0090	.0108	.0126	.0163	.0212	.0252	.0300	.0334	.0395
O	.0010	.0013	.0018	.0029	.0045	.0063	.0080	.0096	.0112	.0145	.0189	.0224	.0266	.0298	.0355
N	.0008	.0011	.0016	.0025	.0039	.0055	.0069	.0084	.0098	.0127	.0165	.0196	.0231	.0260	.0312
D	.0009	.0012	.0016	.0025	.0040	.0056	.0069	.0084	.0098	.0126	.0165	.0196	.0232	.0259	.0312
J	.0012	.0016	.0023	.0036	.0056	.0079	.0100	.0120	.0140	.0181	.0236	.0280	.0332	.0373	.0437
F	.0013	.0016	.0022	.0036	.0057	.0078	.0100	.0120	.0140	.0180	.0236	.0280	.0331	.0379	.0447
M	.0016	.0021	.0030	.0047	.0074	.0102	.0130	.0156	.0182	.0235	.0307	.0364	.0432	.0491	.0582
TOTAL	.0123	.0164	.0227	.0361	.0570	.0787	.0998	.120	.140	.181	.236	.280	.332	.3733	.4422

NOTE: Shikarpur Pilot and Sukkur Pilot Projects only Public Projects in these canal commands.

ANNEX 3
Table 6

PAKISTAN

CCG IX SUKKUR BARRAGE-LEFT BANK

Canals-Khairpur West, Khairpur East, Rohri, East Nara

Volume of Pumped Groundwater-Monthly (M.A.F.)

YEAR	60-61	61-62	62-63	63-64	64-65	65-66	66-67	67-68	68-69	69-70	70-71	71-72	72-73	73-74	74-75
A	.0007	.0008	.0013	.0018	.0023	.0033	.0047	.0067	.0145	.0331	.0393	.0466	.0599	.0623	.0717
M	.0008	.0010	.0015	.0021	.0027	.0039	.0055	.0078	.0179	.0418	.0334	.0501	.0597	.0525	.0703
J	.0007	.0008	.0013	.0017	.0023	.0032	.0047	.0067	.0215	.0471	.0224	.0586	.0549	.0453	.0687
J	.0009	.0011	.0017	.0024	.0031	.0044	.0063	.0160	.0284	.0535	.0344	.0665	.0655	.0607	.0720
A	.0009	.0013	.0020	.0027	.0035	.0050	.0071	.0221	.0338	.0562	.0530	.0680	.0743	.0639	.1186
S	.0010	.0013	.0020	.0026	.0036	.0049	.0072	.0221	.0328	.0542	.0625	.0640	.0773	.0789	. 1056
O	.0009	.0011	.0017	.0024	.0031	.0044	.0063	.0210	.0294	.0505	.0514	.0635	.0675	.0627	.1090
N	.0007	.0010	.0015	.0020	.0028	.0039	.0055	.0198	.0279	.0418	.0433	.0571	.0657	.0635	.0923
D	.0008	.0010	.0015	.0021	.0027	.0039	.0055	.0188	.0309	.0268	.0384	.0571	.0607	.0645	.1263
J	.0011	.0014	.0022	.0030	.0039	.0055	.0079	.0162	.0392	.0369	.0435	.0474	.0611	.0701	.1162
F	.0010	.0015	.0023	.0029	.0039	.0054	.0080	.0172	.0362	.0379	.0685	.0684	.0731	.0861	.1232
M	.0014	.0018	.0028	.0038	.0051	.0072	.0103	.0196	.0465	.0580	.0717	.0887	.0895	.1037	.1661
TOTAL	.0109	.0141	.0218	.0295	.0390	.0550	.0790	.1940	.3590	.5378	.5618	.7360	.8092	.8142	1.2400

ANNEX 3
Table 10

PAKISTAN

CCG X SUKKUR BARRAGE-RIGHT BANK

Canals-Northwest, Rice, Dadu

Volume of Pumped Groundwater-Monthly (M.A.F.)

YEAR	60-61	61-62	62-63	63-64	64-65	65-66	66-67	67-68	68-69	69-70	70-71	71-72	72-73	73-74	74-75
A	.0002	.0003	.0005	.0007	.0009	.0013	.0019	.0025	.0031	.0038	.0048	.0057	.0065	.0076	.0098
M	.0003	.0004	.0006	.0008	.0011	.0015	.0022	.0029	.0036	.0045	.0056	.0067	.0076	.0088	.0115
J	.0002	.0004	.0005	.0007	.0009	.0013	.0019	.0025	.0031	.0038	.0048	.0056	.0065	.0076	.0098
J	.0003	.0004	.0007	.0010	.0012	.0018	.0025	.0034	.0042	.0051	.0064	.0076	.0087	.0101	.0131
A	.0003	.0005	.0007	.0011	.0014	.0020	.0028	.0038	.0047	.0058	.0072	.0086	.0098	.0113	.0148
S	.0003	.0005	.0007	.0011	0013	.0020	.0028	.0038	.0047	.0058	.0072	.0086	.0098	.0113	.0148
O	.0003	.0004	.0007	.0010	.0012	.0018	.0025	.0034	.0042	.0051	.0064	.0076	.0087	.0101	.0131
N	.0002	.0004	.0006	.0008	.0010	.0015	.0027	.0029	.0036	.0045	.0056	.0067	.0076	.0088	.0115
D	.0002	.0004	.0006	.0008	.0011	.0015	.0022	.0029	.0036	.0045	.0056	.0067	.0077	.0088	.0115
J	.0005	.0005	.0007	.0012	.0014	.0022	.0030	.0042	.0052	.0064	.0080	.0095	.0109	.0135	.0164
F	.0004	.0006	.0008	.0012	.0015	.0022	.0031	.0042	.0052	.0064	.0080	.0096	.0110	.0137	.0166
M	.0005	.0007	.0011	.0016	.0020	.0029	.0040	.0055	.0668	.0083	.0104	.0123	.0142	.0176	.0214
TOTAL	.0037	.0055	.0082	.0120	.0150	.0220	.0310	.0420	.0520	.0640	.0800	.0950	.1090	.1292	.1643

Larkana Pilot Project only
Public Project in these Canal Commands

ANNEX 3
Table 11

PAKISTAN

CCG XI KOTRI BARRAGE

Canals-Kalri Baghar Feeder, Pinjari, Fuleli, Akram-nahr

Volume of Pumped Groundwater-Monthly (M.A.F.)

YEAR	60-61	61-62	62-63	63-64	64-65	65-66	66-67	67-68	68-69	69-70	70-71	71-72	72-73	73-74	74-75
A	---	---	.0001	.0001	.0002	.0004	.0004	.0006	.0008	.0009	.0010	.0013	.0014	.0017	0.0020
M	---	---	.0001	.0002	.0003	.0004	.0005	.0007	.0010	.0011	.0012	.0015	.0017	.0020	0.0023
J	---	---	.0001	.0001	.0002	.0004	.0004	.0006	.0008	.0009	.0010	.0013	.0014	.0017	0.0020
J	---	---	.0001	.0002	.0003	.0005	.0006	.0008	.0011	.0012	.0014	.0017	.0019	.0022	0.0025
A	---	---	.0001	.0002	.0003	.0005	.0006	.0009	.0013	.0014	.0015	.0018	.0022	.0025	0.0028
S	---	---	.0002	.0002	.0003	.0005	.0006	.0009	.0013	.0013	.0015	.0019	.0022	.0025	0.0028
O	---	---	.0001	.0002	.0003	.0005	.0006	.0008	.0011	.0012	.0014	.0017	.0019	.0022	0.0025
N	---	---	.0001	.0001	.0003	.0004	.0005	.0007	.0010	.0011	.0012	.0015	.0017	.0020	0.0023
D	---	---	.0001	.0002	.0003	.0004	.0005	.0007	.0010	.0011	.0012	.0015	.0017	.0020	0.0023
J	---	---	0.001	.0002	.0004	.0006	.0007	.0010	.0014	.0014	.0017	.0020	.0024	.0028	0.0031
F	---	---	0.0002	.0002	.0004	.0006	.0007	.0010	.0014	.0015	.0017	.0021	.0024	.0028	0.0031
M	---	---	.0002	.0003	.0005	.0008	.0009	.0013	.0018	.0019	.0022	.0027	.0031	.0036	0.0039
TOTAL	.0007	.0010	.0015	.0022	.0038	.0060	.0070	.0100	.0140	.0150	.0170	.0210	.0240	.0280	0.0316

ANNEX 3
Table 12

PAKISTAN

SCARP 1

Volume of Pumped Groundwater-Monthly (M.A.F.)

YEAR	61-62	62-63	63-64	64-65	65-66	66-67	67-68	68-69	69-70	70-71	71-72	72-73	73-74	74-75 1/
A	2/	0.19	0.21	0.12	0.20	0.14	0.16	0.16	0.16	0.18	0.15	0.16	0.13	0.13
M	2/	0.20	0.23	0.20	0.23	0.15	0.17	0.18	0.18	0.18	0.15	0.16	0.12	0.11
J	2/	0.20	0.22	0.22	0.22	0.15	0.16	0.12	0.18	0.17	0.15	0.16	0.13	0.13
J	2/	0.20	0.22	0.29	0.22	0.15	0.16	0.15	0.17	0.18	0.12	0.15	0.10	0.11
A	2/	0.18	0.20	0.24	0.20	0.14	0.15	0.17	0.16	0.17	0.15	0.14	0.13	0.13
S	2/	0.22	0.24	0.26	0.23	0.16	0.18	0.19	0.19	0.17	0.15	0.15	0.13	0.12
O	2/	0.24	0.27	0.26	0.26	0.18	0.20	0.21	0.19	0.19	0.18	0.17	0.15	0.15
N	2/	0.17	0.19	0.17	0.19	0.13	0.14	0.15	0.13	0.13	0.13	0.13	0.13	0.13
D	0.160	0.14	0.16	0.15	0.19	0.10	0.12	0.13	0.15	0.12	0.12	0.07	0.09	0.09
J	0.163	0.16	0.17	0.16	0.20	0.12	0.13	0.18	0.15	0.14	0.10	0.09	0.09	0.09
F	0.124	0.16	0.18	0.13	0.16	0.12	0.13	0.14	0.14	0.15	0.12	0.12	0.10	0.11
M	0.168	0.20	0.22	0.23	0.19	0.15	0.16	0.18	0.15	0.15	0.15	0.13	0.13	0.13
TOTAL	0.655	2.26	2.51	2.43	2.49	1.69	1.86	1.96	1.95	1.93	1.67	1.63	1.43	1.43

1/ No data available for 1974-75; same volume and distribution assumed as for previous year.

2/ Partial year operations; beginning month not made available and assumed.

ANNEX 3
Table 14

PAKISTAN

SCARP II

Volume of Pumped Groundwater-Monthly (M.A.F.)

YEAR	64-65	65-66	66-67	67-68	68-69	69-70	70-71	71-72	72-73	73-74	74-75
A	0.024	0.028	0.021	0.024	0.081	0.116	0.134	0.194	0.114	0.120	0.184
M	0.021	0.026	0.019	0.022	0.073	0.104	0.109	0.129	0.132	0.182	0.225
J	0.023	0.027	0.020	0.024	0.078	0.112	0.117	0.092	0.149	0.173	0.188
J	0.023	0.027	0.021	0.024	0.079	0.113	0.148	0.103	0.124	0.140	0.201
A	0.026	0.031	0.023	0.027	0.090	0.128	0.137	0.166	0.150	0.175	0.195
S	0.027	0.032	0.024	0.028	0.092	0.130	0.128	0.152	0.139	0.189	0.235
O	0.037	0.044	0.033	0.038	0.126	0.178	0.146	0.240	0.198	0.277	0.280
N	0.024	0.030	0.022	0.025	0.084	0.121	0.122	0.100	0.119	0.190	0.244
D	0.018	0.021	0.016	0.018	0.061	0.087	0.085	0.112	0.095	0.082	0.180
J	0.022	0.027	0.020	0.023	0.076	0.109	0.170	0.113	0.098	0.116	0.198
F	0.025	0.030	0.022	0.025	0.084	0.121	0.167	0.110	0.145	0.154	0.198
M	0.030	0.037	0.028	0.032	0.106	1.151	0.147	0.179	0.167	0.222	0.262
TOTAL	0.30	0.360	0.270	0.310	1.03	1.47	1.61	1.69	1.63	2.02	2.59

PAKISTAN

SCARPS III and IV

Volume of Pumped Groundwater-Monthly (M.A.F.)

	SCARP III								SCARP IV						
YEAR	68-69	69-70	70-71	71-72	72-73	73-74	74-75		69-70	70-71	71-72	72-73	73-74	74-75
A	--	.01384	0.030	0.084	0.108	0.125	0.231	A	0.0022	0.0338	0.0452	0.0556	0.0899	0.0841
M	--	.011822	0.025	0.096	0.116	0.044	0.172	M	0.0023	0.0399	0.0434	0.0604	0.0929	0.0871
J	--	.012346	0.033	0.036	0.048	0.024	0.140	J	0.0042	0.0367	0.0398	0.0538	0.1061	0.1059
J	--	.014241	0.040	0.011	0.008	0.036	0.117	J	0.0147	0.0663	0.0632	0.0648	0.0852	0.0929
A	--	.014376	0.047	0.010	0.007	0.039	0.142	A	0.0206	0.0682	0.0720	0.0787	0.0627	0.0986
S	--	.012135	0.039	0.017	0.006	0.081	0.154	S	0.0234	0.0642	0.0644	0.0716	0.1343	0.1221
O	--	.013764	0.050	0.090	0.063	0.089	0.225	O	0.0336	0.0623	0.0644	0.0726	0.1095	0.1257
N	--	.015209	0.035	0.075	0.082	0.114	0.220	N	0.0140	0.0286	0.0316	0.0416	0.0526	0.0610
D	--	.017417	0.062	0.095	0.109	0.160	0.202	D	0.0200	0.0264	0.0304	0.0368	0.0210	0.0320
J	--	.015162	0.078	0.071	0.145	0.155	0.192	J	0.0250	0.0381	0.0486	0.0653	0.0478	0.0626
F	0.004	.018779	0.079	0.092	0.134	0.203	0.175	F	0.0200	0.0361	0.0484	0.0670	0.0664	0.0434
M	0.013	.023613	0.102	0.133	0.154	0.250	0.270	M	0.0200	0.0394	0.0586	0.0818	0.0916	0.0746
TOTAL	0.017	0.18	0.62	0.81	0.98	1.32	2.24		0.200	0.540	0.610	0.750	0.960	0.990

NOTE: Monthly totals to the sixth place do not indicate accuracy; they were used only to facilitate matching yearly totals.

ANNEX 3
Table 15

PAKISTAN

SCARP-KHAIRPUR-SIND

Volume of Pumped Groundwater-Monthly (M.A.F.)

	Saline Groundwater							Fresh Groundwater							
YEAR	68-69	69-70	70-71	71-72	72-73	73-74	74-75	67-68	68-69	69-70	70-71	71-72	72-73	73-74	74-75
A	---	0.007	0.026	0.022	0.030	0.028	0.025	---	0.006	0.016	0.001	0.010	0.013	0.015	0.019
M	---	0.012	0.019	0.023	0.027	0.023	0.024	---	0.008	0.018	---	0.010	0.013	0.007	0.016
J	---	0.017	0.007	0.031	0.024	0.019	0.020	---	0.013	0.020	0.001	0.013	0.014	0.007	0.020
J	---	0.018	0.007	0.031	0.027	0.022	0.019	0.007	0.017	0.022	0.011	0.016	0.016	0.013	0.018
A	---	0.017	0.018	0.030	0.028	0.019	0.020	0.012	0.021	0.024	0.015	0.016	0.021	0.016	0.018
S	---	0.016	0.028	0.027	0.030	0.026	0.015	0.012	0.020	0.023	0.016	0.015	0.022	0.018	0.016
O	0.001	0.016	0.025	0.029	0.029	0.024	0.014	0.012	0.017	0.021	0.010	0.015	0.016	0.010	0.018
N	0.002	0.009	0.022	0.027	0.028	0.026	0.013	0.012	0.016	0.021	0.007	0.013	0.018	0.011	0.015
D	0.004	0.002	0.016	0.024	0.023	0.027	0.013	0.011	0.017	0.013	0.008	0.016	0.018	0.011	0.014
J	0.004	0.001	0.009	0.007	0.012	0.014	0.005	0.005	0.021	0.019	0.014	0.016	0.021	0.018	0.009
F	0.005	0.009	0.030	0.024	0.025	0.027	0.010	0.006	0.017	0.012	0.018	0.020	0.020	0.020	0.011
M	0.007	0.018	0.030	0.033	0.031	0.030	0.013	0.005	0.021	0.018	0.015	0.024	0.022	0.024	0.014
TOTAL	0.023	0.142	0.237	0.308	0.314	0.285	0.191	0.082	0.194	0.227	0.116	0.184	0.214	0.170	0.188

ANNEX 3
Table 16

ANNEX 3
Table 17

PAKISTAN

SCARP PROJECTS - SIND

Volume of Pumped Groundwater-Monthly (M.A.F.)

	Rohri North		Shikarpur Pilot		Sukkur Pilot		Larkana 2/ Pilot
YEAR	73-74	74-74	73-74	74-75	73-74	74-75	
A		0.006		0.001		0.00045	
M		0.005		0.001		0.00044	
J		0.007		0.001		0.00021	
J		0.006		0.002		---	
A		0.048		0.002		0.0001	
S	0.006	0.042		0.002		---	
O	0.003	0.048		0.002		0.00013	
N	0.004	0.039		0.002		1/	
D	0.004	0.074		0.002		1/	
J	0.006	0.066		0.002	0.00015	1/	
F	0.007	0.066	0.001	0.003	0.00065	1/	
M	0.008	0.092	0.001	0.004	0.00067	1/	
TOTAL	0.038	0.499	0.002	0.024	0.00147	0.00124	

1/ No further data available.

2/ No data available. Estimated annual pumpage 0.009 M.A.F. Operational years not made available.

ANNEX 3
Table 18

PAKISTAN

N.W.F.P. SCARPS

Volume Pumped Groundwater (M.A.F.)

Year	Pabbi Unit 1974/75	Narranji Unit 1974/75	Khanwand Unit 1973/74	Khanwand Unit 1974/75
A				.0004
M	.002			.0004
J	.002			.0004
J	.002			.0004
A	.002			.0004
S	.002			.0005
O	.002	.0002	.0001	.0005
N	.001	.0002	.0002	.0006
D	.001	.0002	.0002	.0006
J	.001	.0002	.0002	.0006
F	.001	.0002	.0003	.0006
M	.002	.0002	.0004	.0006
TOTAL	.018	.0012	.0014	.0060

ANNEX 3
Table 19

PAKISTAN

PUBLIC TUBEWELL INVESTMENT PROGRAM
ADJUSTED TO 1975 PRICES

(Millions of Rupees)

YEAR	1960 -61	1961 -62	1962 -63	1963 -64	1964 -65	1965 -66	1966 -67	1967 -68	1968 -69	1969 -70	1970 -71	1971 -72	1972 -73	1973 -74	1974 -75	1975
Scarp I	39.75	13.77	4.03	.501	--	.032	--	.065	.171	.060	--	--	11.311	--	--	
Rechna	111.3	37.18	10.88	1.3	--	0.077		1.49	0.38	0.13			18.1			
Scarp II		3.40	13.99	26.98	28.06	47.87	62.04	38.31	53.74	44.05	67.71	34.74	35.15	24.71	35.18	
Chaj		9.18	37.77	70.15	70.15	114.89	142.69	88.11	118.23	96.91	142.19	66.0	56.24	32.12	35.18	
Scarp III and Khanwand				.784	11.56	6.53	44.85	60.44	49.25	30.21	42.65	28.43	25.87	17.26	8.72	
Thal				2.04	28.09	15.67	103.15	139.01	108.35	66.46	89.57	54.02	41.39	22.44	8.72	
Scarp IV					8.3	19.4	21.98	31.93	35.37	30.14	15.99	28.93	12.21	10.37	3.06	
Rechna					20.75	46.56	50.55	73.44	77.81	66.31	33.58	54.97	19.54	13.48	3.06	
Pilot Shikarpur														1.97	--	
Guddu														2.56		
Pilot Larkana														2.40	5.10	
Sukkur R.B.														3.12	5.10	
Rohri N.								0.29	9.32	29.06	24.81	43.10	32.71	36.69	73.09	
Sukkur L.B.								0.67	20.50	63.93	52.10	81.89	42.52	47.69	73.09	
Khairpur				5.13	14.74	19.33	30.62	31.05	30.43	20.47	4.75	95.37	2.75	.07	--	
Sukkur R.B.				13.34	36.85	46.39	69.60	71.42	66.95	45.03	9.96	181.2	4.4	0.09		
Pilot Sukkur															2.55	
Guddu															2.55	
Peshawar												0.89	1.19	1.67	3.83	
												1.69	1.9	2.17	3.83	

PAKISTAN

PRIVATE TUBEWELL INVESTMENT PROGRAM

ADJUSTED TO 1975 PRICES
(Millions of Rupees)

YEAR	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Peshawa	0.7	0.7	0.9	.08	.08	1.8	2.6	2.6	2.8	3.0	3.7	4.9	3.9	4.0
Chaj	0.6	10.9	5.7	8.6	5.8	54.6	20.1	14.4	20.1	11.5	20.1	57.5	60.4	9.6
Rechna	54.7	77.5	120.7	132.1	155.3	135.0	276.2	129.0	310.0	155.1	129.3	163.8	204.0	65.8
Thal														
Bari	71.3	103.5	189.6	172.4	152.3	144.7	168.9	140.8	183.9	204.1	143.6	149.4	143.8	64.0
Sutleg R.B.	4.3	8.7	14.3	8.7	17.2	14.3	20.2	17.2	5.8	5.7	5.4	31.7	31.5	5.8
Panjnad Abbassi	2.2	2.5	17.3	8.6	2.9	8.6	2.9	11.5	68.9	20.1	11.6	25.8	14.3	6.0
Gudu	1.2	1.8	3.9	6.0	5.2	7.0	5.9	5.7	11.8	15.8	11.6	15.0	11.2	3.5
Sukkur L.B.	1.0	2.2	2.1	2.8	4.6	6.9	8.9	11.5	5.7	8.6	14.4	11.5	5.8	14.3
Sukkur R.B.	0.5	0.7	0.7	1.3	2.0	2.6	3.2	2.9	3.4	4.6	4.3	4.0	5.8	10.1
Kotri	0.1	0.1	0.2	0.5	0.6	0.3	0.8	1.2	0.3	0.6	1.2	0.8	1.2	1.0

ANNEX 3
Table 20

PAKISTAN

ENERGY REQUIREMENTS AND PEAK LOADS -- PUBLIC AND PRIVATE TUBEWELLS

Canal Commanded Areas-Indus Basin (Excluding Peshawar)

Electrical Energy ---GWH

YEAR	60-61	61-62	62-63	63-64	64-65	65-66	66-67	67-68	68-69	69-70	70-71	71-72	72-73	73-74	74-75
Private	36.4	39.0	47.7	95.4	134.5	181.6	248.2	299.1	381.8	438.8	481.5	513.6	530.2	589.8	642.8
Public	0	54.4	183.3	206.7	225.0	234.7	161.5	178.7	246.3	359.0	416.9	431.1	454.0	513.3	671.5
TOTAL	36.4	93.4	231.0	302.1	359.5	416.3	409.7	477.8	628.1	797.8	898.4	944.7	984.2	1,103.1	1,314.3

Peak Loads-Megawatts

YEAR	60-61	61-62	62-63	63-64	64-65	65-66	66-67	67-68	68-69	69-70	70-71	71-72	72-73	73-74	74-75
Private	13.4	14.6	17.4	34.3	48.8	65.7	89.4	108.6	138.6	159.1	174.7	186.5	192.7	214.1	233.6
Public	--	47.2	47.2	56.2	56.2	56.2	59.7	81.2	89.3	103.7	106.1	108.5	158.4	168.2	172.9
TOTAL	13.4	61.8	64.6	90.5	105.0	121.9	149.1	189.8	227.9	262.8	280.8	295.0	351.1	382.3	406.5

NOTE: Peak loads as shown may occur at any time during the year. They are most apt to occur February-March or September-October depending on predominant cropping pattern.

Energy and peak loads are representative of magnitude only. Based on average public well of 3.45 cusecs having total pumping head of about 40.5 ft and private well at 1.2 cusecs having total pumping head of 33 feet.

ANNEX 3
Table 21

ANNEX 3
Table 22

PAKISTAN

DEPTHS TO WATER TABLE, RANGES IN PUNJAB

Name of Doab	Depth Ranges (feet)	Planimetered Area in Thousand Acres				
		June 1969	October 1972	June 1973	October 1973	June 1974
Rechna	0 - 5	41	112	43	623	129
	5 - 10	1401	1316	1001	2051	1479
	10 - 15	2621	1956	2143	2228	2564
	15 - 20	1802	1240	2012	857	1425
	Over 20	541	1782	1208	647	808
Chaj	0 - 5	262	172	67	652	167
	5 - 10	1466	1316	1122	1160	1185
	10 - 15	803	879	1022	729	958
	15 - 20	246	369	382	224	382
	Over 20	70	112	254	82	156
Bari	0 - 5	16	-	-	221	-
	5 - 10	721	316	188	696	675
	10 - 15	1884	1820	1275	1466	1107
	15 - 20	1671	1591	1081	1614	1360
	Over 20	2916	3481	4664	3211	4067
Bahawalpur	0 - 5	868	860	762	1239	745
	5 - 10	1409	1384	1253	1398	1270
	10 - 15	967	1245	1191	876	1180
	15 - 20	355	412	475	300	565
	Over 20	1720	1417	1638	1507	1560
Thal	0 - 5	860	532	606	795	360
	5 - 10	1679	1884	1483	1958	1638
	10 - 15	1114	1229	1499	975	1729
	15 - 20	647	770	860	786	819
	Over 20	2867	2752	2720	2654	2622
D. G. Khan	0 - 5	360	295	188	311	100
	5 - 10	352	459	385	401	478
	10 - 15	287	238	270	221	375
	15 - 20	164	188	139	147	131
	Over 20	4522	4506	4702	4604	4601

Information source: CMO, November 1975

PAKISTAN

DEPTHS TO WATER TABLE IN PUNJAB FOR THE SCARPS

	Planimetered gross area (1000 acres)	Percentage of Area Under Various Depths to Water Table									
		Pre-project Period					Post Project (June 1974)				
		0'-5'	5'-10'	10'-15'	15'-20'	Over 20'	0'-5'	5'-10'	10'-15'	15'-20'	Over 20'
SCARP I	1210	45.0	29.0	26.0	-	-	0.7	16.5	40.2	28.1	14.5
SCARP II											
Upper Jhelum	745	15.7	67.4	16.5	0.4	-	5.2	46.2	32.6	11.0	5.0
Lower Jhelum	540	0.3	37.6	54.2	6.6	1.3	0.9	35.1	56.7	6.9	0.4
Lalian	137	-	17.6	73.9	8.5	-	-	9.3	55.2	33.2	2.3
Khadir	170	-	8.6	40.5	38.5	12.4	-	4.8	30.7	37.8	26.7
Mona	110	35.3	53.1	11.6	-	-	3.3	58.7	31.5	4.9	1.6
SCARP III	1280	38.4	45.7	15.8	0.1	-	11.5	36.6	42.3	9.5	0.1
SCARP IV											
Muridke	385	-	38.5	55.3	6.2	-	-	6.4	56.0	32.0	5.6
Mangtanwala	177	-	9.6	71.4	19.0	-	-	6.0	23.2	38.6	32.2

Information Source: C.M.O. November, 1975

ANNEX 3
Table 23

PAKISTAN

ESTIMATED AVERAGE DEPTHS TO GROUNDWATER FOR PUNJAB SCARP PROJECTS (FEET)

	Pre- Project	Post-Project (June 1974)
SCARP I	5.9	14.3
SCARP II		
Upper Jhelum	7.9	10.8
Lower Jhelum	11.0	11.1
Lalian	12.6	14.1
Khadir	9.3	16.7
Mona	7.0	9.7
SCARP III	6.5	10.2
SCARP IV		
Muridke	11.0	14.4
Mangtanwala	12.8	17.3

PAKISTAN

A REVIEW OF THE INDUS BASIN PROJECT, 1960-1975

Agricultural Development

A. Area, Yield and Production

1. Between 1960/61 and 1973/74 the cropped area in the northern zone canal command groups rose from 19.6 M acres to 26.3 M acres, an increase of 25 percent. In the southern zone groups the increase was a modest 8-1/2 percent; 7 M acres to 7.6 M acres. Details are given in Table 1 and Figure 3, northern zone, and Table 2 and Figure 4, southern zone. The tables show that the increases in cropped area in the northern zone were achieved by almost equal increases in the kharif and rabi cropped areas; 3.5 M acres and 3.2 M acres respectively whereas in the southern zone the increase was largely confined to the kharif crops.

2. Cropping intensities of the individual canal command groups are given in Tables 3 and 4. The exceptionally high cropping intensities recorded in Peshawar Vale should be viewed with caution. It is probable that the official data includes some double counting where inter-cropping occurs, such as in orchards. The other canal command groups show a uniform increase in cropping intensities in both seasons. An exception is Thal Doab-Indus R.B. where the cropping intensities have increased more dramatically, doubling in kharif and showing a 50 percent increase in rabi; this area is still undergoing settlement and new develoment however.

3. The southern zone commands show a fairly static situation with the exception of the Gudu Barrarge command which has recorded a steady increase in the annual cropping intensity largely because it is still in the development stage. Overall, in the south, crop areas increased from 7.0 M acres to 7.8 M acres between 1960/61 and 1967/68, but thereafter fluctuated around a mean of 7.2 M acres.

4. Throughout the period under review the cropping pattern has shown little change. This is illustrated by Figures 1 and 2. Cotton, rice and coarse grains (bajra, jowar and maize) have remained the dominant kharif crops. Wheat, the dominant rabi crop has increased in importance at the expense of the pulses and oilseeds. Relatively, sugarcane has shown the most marked increase particularly in the southern zone.

5. Table 5 and Figures 5 and 6 provide data on the average crop yields obtained in the northern and southern zones. Data on yields obtained within individual canal command groups may be found in Tables 6 through 16. In

1966/67 through 1968/69 the impact of the introduction of high-yielding varieties (HYV) of wheat is clearly evident in the northern zone and to a lesser extent in the southern zone. Conversely, the effect of the introduction of high-yielding IRRI rice at about the same period is more evident in the south where these coarse rices form a much higher proportion of the rice crop than in the northern zone where the highly valued basmati rice is widely grown.

6. As a result of the increases in area of crops planted and of yields the volume of production, particularly of the major crops, has increased markedly. Examination of Tables 1 and 2 suggests that the review period can be subdivided into three sub-periods, 1960/61 to 1964/65, 1965/66 to 1969/70 and 1970/71 to 1973/74. Table 17 shows the percentage changes and growth rates for seven crops during these periods. The table shows that in the northern zone production in recent years has continued to be buoyant, albeit at a slower rate than during the period 1965/66 to 1969/70. On the other hand in the southern zone growth rates from 1970/71 to 1973/74 have, with the exception of rice, cotton and sugarcane, either stagnated or declined. The large growth rates achieved in the northern zone during the period ending 1969/70 in respect of rice, cotton and sugarcane did not occur in Sind until after that period. However, high growth rates in wheat production occurred almost simultaneously in both zones. The overall growth rates of rice, wheat and cotton have, since 1970/71 continued to exceed the rate of growth of the human population. However, the overall growth rates of sugarcane, oilseeds and pulses are a cause for concern, because they have been less than the rate of population growth. Similarly it is apparent that because of the stagnation of growth in Sind, the overall rate of growth in wheat production is only just keeping pace with population.

7. The increases in production can be divided into the increase due to changes in area (more intensive cropping) and the increae due to yield.

	Total Change (%)	Change due to Area (%)	Change due to Yield (%)
Sind	72	14	58
Punjab	95	40	55

The consistency of the change due to yield suggests that farmers have progressed similarly 1/ in terms of adoption of HYV's, use of fertilizers, etc. The inconsistency of the change due to area is probably explained by the large-scale development of groundwater which has occurred in Punjab (allowing more intensive cropping), but which has not occurred in the Sind. Figure 7 illustrates the record of production of the four main crops.

1/ The pace of progress, however, was noticeably different. In Sind, yield increases have been gradual and steady, while in Punjab, a major increase (accounting for two-thirds of the total) occurred between 1965/66 and 1967/68.

8. Table 18 shows the increase in value of production over the 1960/61-1973/74 period.. Crops included are cotton, wheat, rice, pulses, oilseeds, coarse grains and sugarcane. Prices for crops and fertilizers are average world prices for the period 1967-1974, expressed in 1975 rupees, and adjusted to reflect transport costs. Labor and animal requirements were calculated for four specific years (1960-61, 1966-67, 1970-71 and 1973-74), and estimated for the intervening years. The requirements were calculated from the Lower Indus Project farm survey data, which reflect the effect of increasing yield on labor demand. The economic cost of labor was taken as Rs. 3.5/day at present (in line with current appraisal reports), declining to Rs. 2.5/day in 1960/61. Animal power was valued at the labor rate multiplied by the ratio of the market cost of hired animals to the market cost of hired labor (i.e., it was assumed that this ratio correctly reflected relative scarcity). Up to 1967, seed costs were taken as 4% of gross value of production, and subsequently as 6% (to reflect the spread of HYV's).

9. The table shows that gross value of production rose by 72% in Sind and 95% in Punjab. Net value rose by 26% and 63% respectively.

10. In the regression analyses described in Annex VI, a very high correlation was found between wheat yield and fertilizer use - much higher than the correlation between wheat yield and water supply. The regression equation indicated that 1 ton of fertilizr gave an extra 10 tons of wheat. This is considerably higher than the usually accepted ratio of 6:1 or 7:1. This is explained by the initimate link between fertilizer usage and HYV's. The increase in fertiizer usage reflected a shift in technology to HYV's, thus the benefits which were observed reflect both the benefits of fertilizer and the benefits of HYV seeds.

B. Seeds

11. The introduction of high yielding cultivars of wheat and rice, introduced on a nationwide scale in 1967/68, was a major factor in bringing about the large increase in the production of these crops. The Government of Pakistan through the Ministry of Agriculture and the Agricultural Development Corporation oranized a major effort to ensure that these new cultivars were grown over as wide an area as possible in the shortest possible time. For example in the Punjab in 1969/70, 47 percent of the total wheat acreage was under high-yielding varieties and the proportion had risen to 59 percent by 1973/74; of the wheat under irrigation it is probable that the proportion was nearly 75 percent. Similar progress was made in Sind where the IRRI rices were particularly successful in the commanded areas on the right bank of the Indus.

12. In spite of the initial success in obtaining widespread adoption of improved seeds there have been serious deficiencies in ensuring that farmers have had access to a regular supply from official sources in subsequent years. There is ample observational evidence that the purity of wheat, rice and other seeds has deteriorated since the introduction of the initial import of seed. This has been recognized by the Government

of Pakistan. The Agricultural Enquiry Committee stated in their report that the "most hurtful of these (factors contributing to the stagnation of agriculture) has been the painful omission on the part of the Federal and Provincial Governments to arrange for multiplication and distribution of improved seed particularly of wheat, cotton, sugarcane and fodder crops." 1/

13. The seed requirements for Pakistan are very large. The order of magnitude is illustrated by the following table.

Optimal seed requirements for Irrigated Crops

Crop	Acreage (million acres)	Seed rate (lb/Acre)	Optimal renewal Rate	Tonnage needed ('000 tons)
Wheat	12.0	80	1 in 4 years	107
Rice	3.5	20	1 in 4 years	8
Cotton	4.7	30	Annual	63
Maize	0.8	20	1 in 3 years	2

The table below shows that the uptake of improved seeds fell far short of the optimal requirements. Both tables are applicable to the agricultural year 1973/74.

Reported distribution of improved seeds from official sources
(tons)

Crop	Tonnage distributed /a	Percent of tonnage needed /b
Wheat	12,221	12
Rice	2,597	34
Cotton	8,703	14

/a Total Punjab and Sind only.
/b For irrigated crops only.
Source: Punjab - Bureau of Statistics and Ministry of Agriculture Government of the Punjab.
Sind - Ministry of Agriculture, Sind.

1/ Report of the Agricultural Enquiry Committee, Government of Pakistan, Ministry of Food and Agriculture (Agricultural Wing) - June 1975.

14. An important factor that has contributed to the small purchases of seed by farmers from official sources is their generally held opinion that the seed supplied is only marginally better than that which they themselves can produce. On the other hand, there is no doubt that farmers appreciate the value of good quality seeds. The rapid adoption of imported seed in the mid 60's and again in 1974/75 demonstrate this. The latest import, consisting of 12,000 tons of imported wheat seed and sold at Rs. 70 per maund or about twice the market price for wheat, had no difficulty in finding buyers.

C. Fertilizers

15. Prior to 1965/66 the use of fertilizers was insignificant but expanded rapidly thereafter concomittant with the introduction of the high yielding cultivars of wheat and rice which depend on high fertility conditions for the full expression of their yield potential. Tables 19 and 20 give the sales of fertilizers for the northern and southern zone canal command groups respectively. The northern zone canal commands absorbed over 70 percent of the fertilizer used in the irrigated areas. Nitrogen is the main constituent of the fertilizers used and in 1965/66 it was virtually the only nutrient applied. In 1974/75 Nitrogen represented 87 percent in the northern zone and 82 percent in the southern zone.

16. In the northern zone canal command groups more fertilizer is applied in rabi than in kharif (55 percent of the nitrogent and 68 percent of the phosphate). In Sind kharif fertilizer applications are more important reflecting the greater importance of rice and cotton in Sind.

17. It is thought that virtually all the fertilizer purchased for the rabi season is applied to wheat. An analysis of the sales in the Punjab from September to January inclusive shows that the average application rate of nitrogen has risen from about 15 lbs. to 39 lbs. of nutrient per acre (Table 22). Throughout the period the ratio of nitrogen to phosphate has been variable and wider than desirable. For example the ISS recommended a ratio of N to P of between 1.1:1 and 1.5:1 for the cotton and rice areas of the Punjab respectively and predicted that in 1975 a ratio of between 1.4:1 and 2:1 would be achieved. This represents nitrogen and phosphate application rates on wheat of 50 lb.N and 35 lb.P in the cotton area and for the rice area 75 lb.N and 35 lb.P. 1/

18. Tables 21 and 22 indicate the current levels of fertilizer use. In 1974/75 consumption was about 413 thousand tons of nutrients in the irrigated areas and it is expected that consumption will reach one million tons in 1979/80. The heaviest applications appear to occur in the intensively cropped Peshawar Vale followed by the Bari Doab, Sukkur Left Bank and Kotri Barrage commands. Table 21 indicates that application rates

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1/ Programme for the Development of Irrigation and Agriculture in West Pakistan. IBRD, May 1966, Vol. 7, Table 2.23.

declined in Punjab between 1972 and 1974 (with a probable increase again in 1974/75). Tables 21, and 23 seem to indicate Punjab farmers are more inclined to reduce fertilizer application rates on the kharif crops rather than on wheat if they are forced by price or scarcity to curtail the use of fertilizers.

19. Actual application rates applied by individual farmers will be higher than those indicated in Tables 21, 22 and 23 because not all farmers use fertilizers, but no factual data on this subject is available.

20. There have been and there still remain some constraints to the use of fertilizers but the combination of local production capacity backed by imports has not, in most years, been a constraint. Most tenants and small farmers need credit from their landlords or from other private sources, or have to get their landlord to co-sign if credit is obtained from official sources. Small farmers, either tenants or owners have little cash and low repayment capacity. In many parts of the country fertilizer sales points are distant from the farms and a large proportion of all fertilizer has to be transported from the sales point to the farm either by bullock cart or pack animal because of the indequacy of the rural roads. The prevalence of saline and waterlogged soils keeps the overall fertilizer response rate low. Poorly levelled fields are a source of fertilizer loss because of leaching at the low spots when attempts are made to cover the highest point of the field with irrigation water. One authority has estimated that up to 60 percent of the fertilizer applied to a field may be lost in this way. 1/

21. At current prices of fertilizer and farm products the application of fertilizr is profitable but the value/cost ratio is generally lower than that in 1965/66. The profitability of fertilizer use has been analysed in the table below. It should be noted that the assumed rates of fertilizer response of 1:7 for grains and 1:100 for cane are low, certainly for irrigated agriculture. If farm management were improved the rates would increase considerably. Even at these response rates, the use of fertilizers pays.

1/ Water Management Alternatives for Pakistan, a Tentative Appraisal. Water Management Research, Colorado State University, Islamabad, Pakistan. Field Report No. 3 - June 1975, Page 36.

Profitability of Fertilizer Use

	1965/66		1970		1974/75	
Cost of fertilizer (Rp./50 kg nutrients) Nitrogen	40		80		160	
Phosphate	40		50		120	
Cost of mixture (N:P ≙ 5:1)	40		75		153	
Increased production value (R_p)						
Wheat (1:7)[1]	122[3]	(13)[2]	141	(15)[2]	328	(35)[2]
Coarse rice (1:7)	94	(10)	113	(12)	328	(35)
Basmati rice (1:7)	159	(17)	188	(20)	656	(70)
Sugar-cane (1:100)	200	(1.50)	241	(1.80)	670	(5)
Value/cost ratio						
Wheat	3.0		1.9		2.1	
Coarse rice	2.4		1.5		2.1	
Basmati	4.0		2.5		4.3	
Sugar-cane	5.0		3.2		4.4	

1) Fertilizer response in physical quantities, as applied by the Planning Commission

2) Farmgate price in Rp/maund

3) Increased production value resulting from 50 kg nutrients is 350 kg wheat at Rp. 13 per maund = Rp. 122

D. Crop Protection

22. Statistical data is available on the acreage treated for pest control but the data refer to a mixture of seed treatment, preventive and curative spraying and weed control. Moreover, when a crop is treated more than once the area given a repetitive spraying frequently is added to the acreage reported as treated. This makes it extremely difficult to assess the degree of crop protection that actually has been provided. There is a general consensus of opinion in Pakistan that crop protection has not been a success. The Agricultural Enquiry Committee 1/ reported that "there are some doubts whether coverage is as extensive as reported

1/ Ibid.

by the plant protection agencies. Furthermore, there are complaints that the treatment given is often inappropriate or the dosage is inadequate and consequently the measures are ineffective."

23. In the past emphasis has been given to treatment by aerial spraying in spite of the fact that the scattered nature of the crops, and the frequent isolated trees throughout much of the irrigated area renders effective aerial spraying very difficult. Some success, however, has been achieved in the rice growing areas and in the sugarcane areas in Sind. The operation of mechanical and hand operated ground sprayers has not been a success partially because of difficulties in maintaining the power units but also because the available water for diluting the active ingredients is generally silt-laden canal water resulting in frequent nozzle blockage. Virtually no attempt has been made to introduce hand operated ultra low volume sprayers as has been done in other countries with a predominantly peasant agricultural system.

E. Agricultural Extension

24. The large number of farmers served by each agricultural extension officer and his immobility due to lack of transport have been frequently reported throughout the fifteen year period under review. The situation has not improved in recent years. The area and number of farms in relation to field extension officers in the Punjab and Sind is set out below.

Area supervised by field extension officers in the Punjab and Sind

	Punjab	Sind
Net sown area. Million acres	24.5	8.5
Estimated No. of farms 1973 (thousands) /b	4,424	824
No. of Field assistants 1974 /c	2,642	788
No. of Agricultural assistants 1974 /c	368	213
Ratio between one Field assistant and:		
Net sown area, acres	9,270	10,800
No. of farms	1,600	1,000
Ratio between one Agricultural assistant and:		
Net sown area, acres	67,000	40,000
No. of farms	11,000	3,800

Sources:

/a For Punjab - Development statistics of the Punjab. October 1975.
For Sind - Crop acreage statistics kharif 1973, rabi 1973/74.

/b Estimated from data presented in World Bank's February 1973 Economic Mission Report Vol. II.

/c State Ministries of Agriculture. World Bank Irrigation and Drainage Review Draft Technical Note No. 4, 1975.

25. In the organization of the work of field extension officers great reliance has been placed on demonstration plots of which a large number are laid down each year. Details for the Punjab are given in the following table.

Demonstration Plots in Punjab

Crop	1969/70	1970/71	1971/72	1972/73	1973/74
Cotton	30,144	7,220	7,028	8,847	5,385
Sugarcane	32,640	8,304	4,436	7,204	5,708
Rice	33,293	4,700	4,311	16,100	7,012
Maize	23,381	6,144	5,212	12,105	7,006
Wheat	13,897	15,301	15,122	25,975	12,320
Grams	1,058	1,659	970	2,788	12,320
Oil seeds	1,288	1,559	2,723	4,275	1,727
Ground nut	-	2,180	4,229	336	112
Total	135,701	47,067	44,031	77,630	51,590

Source: Agriculture Department, Punjab.

26. In recent years radio broadcasts have become an increasingly important and effective means of extension work. Daily farmers' programmes broadcast in the Punjab are on the air morning and evening for a total of 45 to 70 minutes daily. An important duty of the field officers is to organize farmers radio clubs, of which 400 are reported to be in existance. At these clubs the extension workers function is to listen to the programmes with the farmer members, especially in the evening, and to lead a discussion on the programme. A recent report 1/ suggests that today radio broadcasts are the most effective means of agricultural extension work. The sample on which the survey was based was small (360 farmers), but appears to be statistically valid. Even though some of the evidence presented is contradictory there can be little doubt that today radio broadcasts on agricultural affairs are reaching a much larger audience and are more effective than the thinly spread and comparatively immobile field extension workers.

F. Agricultural Research

27. The main thrust of agricultural research has been in the field of developing improved crop cultivars and in their fertilizer requirements and to this extent, in spite of shortages of qualified research personnel and funds, the research programmes have been effective.

28. Research has tended to be crop oriented rather than farm oriented. Little attention has been given toward the effect that improved inputs applied to one or more crops has on the farming system as a unit. Very little work has been carried out to investigate the constraints on development imposed by the major power source, bullocks, and on associated implements.

1/ Grooming the Punjab Farmers for a Green Revolution. Zaheer Iqbal Qazi. The Punjab Board of Economic Inquiry, Lahore, August 1975.

G. Labor and Mechanization

29. The costs of draught animls and tractors have been compared with the wages of hired labor. It appears that they increased proportionately between 1965 and 1970, but in subsequent years the cost of tractor operation increased most while the labor wages increased least. In fact labor wages did not fully follow the general consumer price index.

30. Mechanization is a rather controversial issue in Pakistan. Many believe that further mechanization would displace manual labor. On the other hand periodical labor shortages are observed especially in the planting period of Kharif crops. Mechanization of land preparation and the threshing of the wheat crop would alleviate some of the competition for labor at this particular period in the crop year.

31. There is a strong demand for the tractors that are imported into Pakistan. Many are replacements for unserviceable machines so it is hard to judge how many tractors are in full use at any one time.

H. Land Tenure

32. The total farm area has been about 49 million acres throughout the period of review. The number of farm holdings counted was 4.86 million in 1960 and 3.76 million in 1972 (provisional). The overall cropping intensity increased from 0.76 to 0.87, so that the average cropped area per farm increased from 7.7 acres to 11.4 acres. Most of the decrease in the number of farms is observed in the category of holdings smaller than 7.5 acres.

33. The great demand for tractors observed in Pakistan at present in spite of the high cost involved (see page 19) may be an indication of a further consolidation of farm land. Whether or not this would lead to a decline in employment opportunities in the agricultural sector depends rather on cropping intensities and cropping patterns than on the number of tractors. A need for at least partial mechanization is being expressed by the Government in the Development Perspective 1975-1980. If further mechanization leads to an increase in production and to changes in cropping patterns, it may also create more employment opportunities not only for the landless agrarian population but also for the fast-growing non-agrarian population living in rural area. Increased production would normally lead to an expansion of processing industries and a greater demand for farm supplies.

34. Ownership of land did not change very much between 1960 and 1972. The number of farms operated by owners themselves were 41 and 42 percent of the total respectively. The latest land reform of March 1972 reduced the ceiling for individual holdings from 3,600 produce index units (PIU) to 1,200 PIU, which corresponds with about 500 and 150 acres respectively. Land in excess of the ceiling figure was taken over by the

State without compensation for free redistribution among landless and small tenants. Up to 31 March 1975, a total of 430,000 acres were distributed among 53,000 farmers.

Farm sizes and land tenure, 1960-1972

Acres	Cropping intensity		Number of farmers (x million)		Farm area (x million acres)		Average farm size		Percentage of owner-operators	
	1960	1972	1960	1972	1960	1972	1960	1972	1960	1972
Country										
< 7.5 acres	0.87		2.98	1.64	8.13	6.06	3.7	3.7		54
7.5 -- <12.5	0.88		0.76	0.92	7.36	9.02	9.7	9.7		29
12.5 - <25	0.85		0.73	0.79	12.53	13.22	17.2	16.7		31
25 - <50	0.78		0.29	0.29	9.47	9.33	32.7	32.5		38
50 - <150	0.59		0.09	0.10	6.54	7.49	72.7	73.0		49
≥ 150	0.34		0.01	0.016	4.90	4.54	.	280.-		63
Total	0.76	0.87	4.86	3.76	48.93	49.21	10.1	13.1	41	42
Punjab										
< 7.5			2.10	0.98	5.67	3.70	2.7	3.7		56
7.5 - <12.5			0.50	0.56	4.88	5.53	9.8	9.7		32
12.5 - <25			0.49	0.55	8.33	9.05	17.0	16.5		31
25 - <50			0.10	0.21	5.90	6.69	59.0	32.0		36
50 - <150			0.042	0.065	3.09	4.62	72.8	71.5		47
≥ 150			0.005	0.007	1.43	1.81	308.-	255.-		66
Total	0.83	1.02	3.33	2.38	29.21	31.40	8.8	13.2	41	42

Source: Agricultural Census 1960 and 1972 (provisional data)

I. Farm Prices and Costs

35. In 1975, wholesale prices of most food items were 3 to 4 times higher than they were in the early sixties. Those of sugar and milk increased most, they were, respectively, 4.6 and 4.5 times higher than former prices. The overall price index of food was 330 as against 100 in 1960. Farm prices have generally followed the pattern of wholesale prices although at a slower pace. Prices of both farm products and farm inputs in 1975 were about 3 to 4 times higher than in 1965. In the early seventies prie increases of farm products lagged behind those of farm inputs, but from 1974 to 1975 fertilizer prices for example, remained unchanged while prices of farm products continued to rise. The tables that follow indicate some relationships between costs, farm prices and market prices.

Market prices of major agricultural commodities (Rupees/maund)

	Wheat[1]	Basmati[1]	Irri-6[1]	Sugar-cane[3]	Gur[2]	Seed cotton[4] Desi	Seed cotton[4] AC	Delta pine
1960-1965	15	27	16[6]	2.20	20		31	
1967	17	31	18[6]	2.25	20		34.50	
1968 K		38	21	2.25	25		34.00	
R	17							
1969 K		35	21	2.50	25		37.50	
R	17							
1970 K		32	21	2.75	20		47.00	
R	17							
1971 K		38	21	2.50	16		50	
R	17							
1972 K		46	21	4.25	30		64.00	
R	20							
1973 K		62	27	4.25	60		94.00	
R	22.50							
1974 K		90	48	5.25	60	70	105	
R	37.00			5.50[5]				
1975 K		110[2]	55[2]	5.75	85	85	92	115
R	37.50			6.50[5]				

1) Government procurement prices

2) Market prices, which should be reduced by Rp. 2.- to arrive at farmgate prices

3) Notified minimum sugar-cane prices, fixed at factory gate*, which should be reduced by Rs 0.70 to arrive at farmgate prices
* (prices fixed at out-station are Rs 0.25 less)

4) Harvest prices at farmgate

5) Market price for chewing cane

6) Coarse rice

Note: Desi is local (cotton)
AC = American cotton
Delta pine = a newly introduced HYV of cotton
K = Kharif season
R = Rabi season

Market prices of chemical fertilizer (Rupees per bag of 50 kg)

	Urea 46%	Ammonium sulphate 21%	Single Super phosphate 18%	Triple Super phosphate 46%	Di-ammonium phosphate 18% N, 46% P_2O_5
1960-1964	24	11	10	14	
1965-1966	18	8.50	7.50	19	
1967	24	11	10	19	
1968	26	11.50	9.50	20	28
1969	29	13	9.50	20	28
1970	32	17	9.50	20	28
1971	35	17	9.50	20	28
1972	35	17	9.50	20	35
1973	55	25	15	34	57
1974	75	34	22	55	75
1975	75	34	22	55	75

Cost per 50 kg of nutrients

	N(Urea	N(AS)	P(SSP)	P(TSP)	N + P
1960-1964	52	53	56	30	
1965-1966	39	40	42	41	
1969-1971	76	81	53	43	76 + 31
1974-1975	163	162	122	120	162 + 100
Indices					
1960-1964	133	133	133	73	
1965-1966	100	100	100	100	100
1969-1971	195	203	126	105	134
1974-1975	418	405	290	293	328

Note: A rebate of 15% was given on fertilizers purchases from 19 December 1974 to 31 January 1975 in order to boost the wheat production. As a result 80 per cent of the 1974/75 sales took place in December and January.

Farmgate prices of major agricultural commodities (Rupees/maund)

	Wheat	Paddy		Sugar		Seed cotton (American)
		Basmati	Coarse	cane	gur	
Average 1960 - 1965	13.00	17.00	10.00	1.50	18	31.00
1966	13.00	18.20	10.00	1.55	18	34.00
1967	19.00	18.20	11.05	1.55	18	34.50
1968	15.50	24.50	12.00	1.55	23	34.00
1969	15.00	22.50	12.00	1.80	23	37.50
1970	15.00	20.50	12.00	2.05	18	47.00
1971	15.00	24.50	12.00	1.80	14	50.00
1972	18.00	29.00	12.00	3.55	28	64.00
1973	20.50	40.00	17.00	3.55	58	94.00
1974	35.00	58.00	30.00	4.55	58	105.00
1975	35.50	70.00	35.00	5.05	83	92.00
Indices						
1960 - 1965	100	100	100	100	100	100
1969 - 1971	115	132	120	126	100	144
1975	273	412	350	337	460	296

Market prices of livestock and dairy products (Rupees)

	1965	1970	1975
One pair of bullocks	900	2,000	4,000
Beef (Rp./maund)	54	80	200
Ghee (Rp./maund)	175	320	700
Milk (Rp./maund	18	33	75
Hides (not specified)	15	21	57
Indices			
Bullocks	100	220	440
Beef	100	150	370
Ghee	100	180	400
Milk	100	180	420
Hides	100	140	380
Farm prices (Rp/maund)			
Milk	16	30	70
Meat		60	150

Estimated annual cost of one pair of bullocks (Rupees)

	1960-65	1970	1975
Sales price	900	2,000	4,000
Useful life 8 years			
Residual value	250	600	1,200
Interest	8%	10%	12%
Shelter	100	150	200
Fodder 500 maunds of fodder crops at	1.-	2.50	5.-
80 maunds of straw at	3.50	4.20	8.-
concentrates 11.5 maunds at	15.50	30,-	65.-
Care medicine and salt	15	27	50
implements and blacksmith	60	70	100
labour (1 hr daily)	90	180	270
Annual cost			
Depreciation	81	175	350
Interest	46	130	312
Care	165	277	420
Shelter	100	150	200
Fodder	500 280 178	1,250 336 345	2,500 640 748
	958	1,931	3,888
Subtotal	1,350	2,663	5,170
Less farm yard manure	50	90	180
Total annual cost	1,300	2,573	4,990
index	100	198	384

Index numbers of wholesale prices for food and of farmgate prices

	1960	1965[1)]	1970[1)]	1975[2)]
Rice	100	105	134	390
Wheat	100	124	126	298
Maize	100	108	111	330
Gram	100	114	167	420
Potatoes	100	109	127	125
Fruits	100	90	73	
Milk	100	114	150	450
Ghee	100	107	143	400
Meat	100	116	185	370
Sugar	100	116	122	460
Gur	100	99	114	450
Eggs	100	169	137	200
Salt	100	121	172	320
Food	100	113	134	330
Farmgate price indices				
Wheat	100	100	115	273
Rice fine	100	100	132	412
coarse	100	100	120	350
Sugar-cane	100	100	144	296
Nitrogen	133	100	195	418
Phosphorus	133	100	126	293

1) Average 3-year period

2) Approximations

Estimated annual cost of tractor power (ca 45 hp) in Rupees

	1960-1965	1970	1975
Retail price	12,000	30,000	72,000 (68,000)[1]
Life 8 years or 10,000 hrs			
Salvage value 20%	2,400	6,000	14,400
Spares and repairs 100% of retail price of the tractor			
Interest	8%	10%	12%
Retail price of diesel oil	2.60	3.40	Rp 6/gallon
Housing	100	150	200
Insurance 1%	120	300	720
Operator	1.-	1.50/hr	Rp 4/hr
Fixed annual cost			
Depreciation	1,200	3,000	7,200
Interest	575	1,800	4,320
Spares and repairs	1,500	3,750	9,000
Housing	100	150	200
Insurance	120	300	720
total	3,495	9,000	21,440
per hour (1200 hrs/yr)	2.91	7.50	17.87
operator	1.-	1.50	4
fuel + lubrication	2.86	3.74	6.60
total cost per hour	6.77	12.74	28.47
Cost of implements (80% of fixed cost of tractor)	2.33	6.00	13.50[2]
Average cost per hour of operation	9.10	18.74	41.97
rounded	Rs 9.-	Rs 19.-	Rs 42.-
index	100	210	460

1) official price
2) adjusted by 6,800/7,200

J. Fodder Acreages and Livestock

36. Recent estimates of the grazing farm livestock population of Pakistan are given below:

Grazing Farm Livestock Population, 1972

	(million head)			
	Cattle	Buffalo	Sheep	Goats
Punjab	8.1	7.4	5.7	5.3
Sind	2.8	1.7	1.6	1.5
NWFP	1.2	0.46	0.6	0.7
Baluchistan	0.4	0.02	3.9	3.2
Total	12.5	9.6	11.8	10.7

Source: Derived from 1972 Livestock Census of Pakistan.

The above population is equivalent to about 23 million bullocks to which must be added about 1.5 million units consisting very largely of equines and some camels.

37. Comparison between the 1962 and 1972 livestock censuses indicates that in terms of grazing units the population did not alter significantly between the two censuses, however crop area data indicates that the resources of water and land provided to feed this population has increased between 1960/61 and 1973/74. Table 24 suggests that, in the Punjab at least the relative importance of fodder crops within the cropping patterns has declined even though the acreage devoted to fodder crops has increased at a rate of approximately 2 percent per year. At present, within the Punjab canal commands fodder crops occupy 16 percent of the total annual area under crops. They also require about 16 percent of the water supply. Data for Sind is not sufficiently complete to enable an estimation to be made for the southern zone canal commands but it is likely that the diversion of resources to provide fodder may be of a similar order, even though in some commands the sources of fodder such as the topping of paddy and production of gram on residual soil moisture, differ from the Punjab (Figure 8).

38. It is suggested that in the intensively cropped areas such as the Rechna and Bari doabs, a conflict will soon arise between providing land and water purely for the feeding of ruminants and that required to meet human requirements. This highlights the need for more research resources to be diverted to examine the livestock sector in detail not only as a direct source of human nutrition but also as an indirect source through the use of livestock as a source of power and the quantity of irrigation water that has to be utilized in order to provide that power.

K. Crop Area and Production Data

39. The data for each of the Canal Command Groups given in Tables 6 through 16 were compiled for the period 1960/61 to 1964/65 from West Pakistan Agricultural Statistics (Series No 1 - Crops) issued by the Department of Agriculture, Government of West Pakistan. Data for the period 1965/66 to 1967/68 was obtained from the Season and Crop Reports of West Pakistan. Subsequent to 1967/68, the data was largely obtained from information supplied by the Provincial Departments of Agriculture to the World Bank Resident Representative at Islamabd; from "Season and Crop Reports of the Punjab," Department of Agriculture Government of the Punjab; and from "Crop Acreage Statistics of the Sind" issued by the Bureau of Statistics, Planning and Development Department, Government of Sind.

40. The data were usually presented by these sources on the basis of administrative districts but sometimes data were also available on a tehsil or taluka basis, these being subdivisions of a District. It was necessary to amalgamate the data into the canal command groups, appropriate factors being developed for those districts which formed part of two or more canal command groups. This was a comparatively straight forward task for the northern zone canal commands but some difficulty was experienced in distributing crop areas and crop production of the district of Sukkur, and the talukas of Gharhi Khajro, and Usta Muhammad, between the Sukkur Right Bank and the Gudu commands. Data subsequent to 1969/70 appropriate to the former district of Jhat Pat, which largely reverted to Baluchistan when that State was formed, were not obtained in a form suitable for inclusion in the Tables and were therefore omitted.

41. In compiling the tables adjustments were made when the official figures appeared anomalous and an estimated figure entered when data for a short period were not available. Indications are given in the tables where this occurred.

42. In interpreting the data note should be made of the following events:

1964	Severe flooding in late summer in the southern parts of the Sukkur Left Bank Command and in the Kotri Barrage Command.
1965	Military operations interfered with the normal distribution of irrigation water supplies in late kharif and early rabi.
1967/68	42,000 tons of Mexican wheat seed imported and some 2,460,000 acres were planted with this seed.

1968/69 IRRI rice seed introduced on a large scale.

1969/70 Very favorable climatic conditions for wheat, cotton and sugarcane especially in the northern zone, although river flows were lower than normal.

1970/71 An exceptionally dry year adversely affecting the yields of wheat and sugarcane. Some 240,000 acres of wheat were lost because of military operations.

The price of cotton was increased with subsequent larger sowings in 1971/72.

1973/74 Severe summer flooding occurred in Punjab and Sind.

L. Canal Command Group 1 - Peshawar Vale. CCA 0.687 M acres

43. Of all the Canal Command Groups this is the most intensively cultivated with annual cropping intensities at 180 to 196 percent throughout the period. Maize is the most important kharif crop occupying slightly over one third of the CCA. In 1960 the reported acreage of maize was 339,000 acres, but in 1965-1966 the area dropped by about 100,000 acres and since then has recovered slowly to between 260,000 and 270,000 acres.

44. Fruit and sugarcane are also important crops together occupying some 250,000 to 280,000 acres annually. The area of sugarcane has shown a fairly consistent upward trend accompanied by a small reduction in the fruit area which appeared to have reached its maximum of about 120,000 acres from 1963 to 165 and subsequently declined to around 100,000 acres.

45. The Peshawar Vale has for a long time been an important source of tobacco with a peak of production of 97,000 tons in 1966/67. The production of this crop suffered a severe setback following the establishment of Bangladesh where much of the tobacco grown in the Vale had been sent for processing during the time of "One Unit".

46. During the period under review the area of wheat increased by 48 percent from 182,000 acres to 270,000 acres; during the same period production increased by 104 percent (74,000 tons to 128,000 tons). Average yields of 1,200 lbs per acre were obtained in 1971/72 and 1974/75. Prior to the introduction of high yielding varieties the average yield had been around 800 lbs per acre.

47. Details of crop areas, yields production and water supply are set out in Table 6. In the table the area of fodder crops has been included in the estimation of "other crops" because separate published data on fodders are incomplete. Similarily sugar beet has been included in this category. The assumptions made are given in the footnotes to the table. Figure 9 illustrates the sources of water supply.

M. Canal Command Group 2 - Thal Doab - Indus Right Bank. CCA 3.617 M acres

48. The cropping in this Canal Command Group is characterized by the cropping intensity in the rabi season being higher than in kharif. Annual cropping intensities are low, the highest, 107 percent was obtained in 1973/74. The kharif:rabi ratio has narrowed from 1:2.2 in 1960/61 to 1:1.6 in 1973/74. In fact each year the area of wheat has exceeded the total area of all kharif crops. The most important kharif crops are cotton, fodder, sugarcane, sorghum and millet. Since 1960 the most dramatic change in the kharif cropping pattern has been a 200 percent increase in the cotton area (132,000 acres to a maximum of 396,000 acres) and a 120 percent increase in sugarcane from 64,000 acres to a maximum of 140,500 acres. Productivity of cotton has changed little averaging 7.4 maunds of seed cotton per acre. The best year was 1963 when an average yield of 8.1 maunds per acre was obtained. Productivity of sugarcane however, has shown considerable improvement, with consistent increases in yield from around 270 maunds cane per acre to between 340 and 360 maunds per acre. Nearly 414 maunds per acre were obained in 1969.

49. Total rabi cropping has increased from 1,581,000 acres in 1960/61 to 2,386,000 acres in 1973/74, an increase of just over 50 percent. Throughout the period from 1960/61 the wheat acreage formed a fairly consistent 66 percent of the area cropped in rabi. Yields of wheat have increased from 8.2 maunds (674 lbs) per acre to 15.2 maunds (1,250 lbs) per acre. The combination of increased area and greater yields has raised wheat production from around 320,000 tons per annum to 860,000 tons, an increase of 169 percent.

50. Since 1960/61 fodder crops have become of increasing importance rising from eight percent of the CCA to over 16 percent, the relative importance of kharif fodders increasing over time. In 1960 they occupied 51 percent of the total fodder acreage rising to 62 percent in 1973/74.

51. Details of crop areas, yields, production and water supply for this Canal Command Group are given in Table 7. Figure 10 illustrates the sources of water supply.

N. Canal Command Group 3 - Chaj Doab. CCA 2.043 M acres

52. Annual cropping intensities remained fairly constant up to 1967/68 at around 115 to 120 percent. In 1968/69 the annual intensity rose abruptly to 128 percent accompanied by an increase of nine percentage points in the rabi cropping intensity, which rose a further 11 percentage points over the three years that followed. The increased intensity is almost wholly accounted for by an increase of the wheat acreage from 776,000 acres in 1967/68 to 956,000 acres in 1973/74. The effect of yield increases accompanied by this increase in area was to raise production from 278,000 tons (1966/67) to 503,000 tons (1973/74) an 81 percent increase.

53. Cotton is the most important of the kharif crops, but the acreage has declined from around 300,000 acres in the early '60s to 260,000 to 270,000 in recent years. 1973/74 saw an impressive drop in area to 190,000 acres with production dropping to 69 percent of the level achieved in 1960/61.

54. Sugarcane appears to have almost wholly occupied the area that came out of cotton production, the decline in the area of the one crop almost exactly matching the increased area of the other. Fodder acreages both in kharif and rabi have remained more or less static since 1960/61.

55. Details of crop areas, yields, production and water supplies are given in Table 8. Figure 11 illustrates the sources of water supply.

O. Canal Command Group 4 - Rechna Doab. CCA 4.705 M acres

56. Throughout the period under review, the kharif cropping intensity increased by about 1.5 percentage points each year from 46 percent in 1960 to 62 percent in 1973. A similar trend is observed in the rabi intensities up to 1967/68 when in the following year the intensity increased from 71 percent to 78 percent. This increase is almost wholly accounted for by the increase in that year of 360,000 acres in the wheat acreage which by 1973/74 had risen to 2.5 M acres from 1.7M acres in 1960/61.

57. The ratio between kharif and rabi crops narrowed slightly between 1960/61 and 1973/74. The respective kharif-rabi ratios were 0.70:1 and 0.75:1. Increased crop areas and yields combined to result in the following percentage increases in production since 1960/61.

Cotton	7
Rice	62
Maize	83
Wheat	121
Sugarcane	120

58. The Rechna Doab is the most intensively cropped area in the Punjab with a current annual cropping intensity of 144 percent. This high rate of land utilization is associated with an ample water supply of which a large proportion is derived from groundwater (see Annex 3, Figure 3) and with a comparatively high rate of fertilizer use (Table 21). Details of cropped areas, yields, production and water supply are given in Table 9. Figure 12 illustrates the sources of irrigation water.

P. Canal Command Group 5 - Bari Doab. CCA 5.826 M acres

59. During the period under review, annual cropping intensities have risen from 98 percent in 1960/61 to 132 percent in 1973/74. Proportionally, cropping intensities in kharif have risen more than in rabi. In 1960/61 the kharif to rabi ratio was 0.78:1; in 1973/74 it had narrowed to 0.94:1. The main increase in the kharif acreage has been due to cotton which

accounts for 72 percent of the increase, rising from 882,000 acres in 1960 to 1,777,000 acres in 1973. The area increase has been accompanied by a steady increase in cotton yields from 7.7 maunds of seed cotton per acre to 12.5 maunds. This results in an increase in productivity of 62 percent, a value not equaled in any of the other northern zone canal command groups. The doab is, of course, the major cotton producing area of Pakistan accounting for 40 percent of all irrigated cotton production and 62 percent of the cotton produced in the northern zone canal command groups.

60. Wheat has always been the dominant rabi crop in Bari Doab accounting for about 60 percent of the rabi acreage prior to 1967/68. Following the introduction of HYV's the proportion rose to 66 percent and at the same time average yields (1960/61 to 1966/67) rose from 12.3 maunds to 18.2 maunds per acre (196768 to 1973/74). Since 1960/61 wheat production has risen from 783,000 tons to 1,755,000 tons an increase of 124 percent. Details of crop area, yields, production and water supply are given in Table 10. Figure 13 illustrates the sources of irrigation water.

Q. Canal Command Group 6 - Sutlej Left Bank. CCA 2.051 M acres

61. From 1960/61 to 1973/74 annual cropping intensities rose from 87 percent to 110 percent. The kharif-rabi ratios showed little change, 0.89:1 in 1969/61 and 0.96:1 in 1973/74. The increase in the kharif acreage (893,000 acres to 1,108,000 acres) is almost wholly due to the expansion of the cotton area which in 1960 contributed 23.5 percent of the kharif acreage of the commands and in 1973, 41 percent.

62. Although wheat has been and still is the dominant rabi crop occupying some 56 percent of the rabi acreage, oilseeds have become of increasing importance during the period under review. In 1960/61 oilseeds occupied seven percent of the rabi cropped area: by 1973/74 this proportion had risen to 14 percent.

63. Apart from pulses and coarse grains crop yields have shown a steady increase throughout the period. The effect of the introduction of HYV's of wheat has not been as significant as in other areas in the Punjab. The most significant yield increases having occurred with rice (62 percent). The percentage increases in production since 1960/61 of the more important crops were:

Cotton	197
Rice	160
Wheat	84
Sugarcane	29
Oilseeds	254

Details of crop areas, yields, production and water supply are given in Table 11. Figure 14 illustrates the sources of irrigation water.

R. Canal Command Group 7 - Panjnad Left Bank. CCA 1.598 M acres

64. From 1960/61 to 1973/74 annual cropping intensities have risen from 82 percent to 100 percent. The kharif to rabi ratios have shown little change, being 1.02:1 in 1960/61 and 1.08:1 in 1973/74. The main changes in the cropping pattern have occurred with the rabi crops. Since 1960/61 the wheat acreage has increased by 30 percent, oilseeds by 108 percent and pulses have decreased by 64 percent. The pattern of cropping in kharif has shown little change.

65. As in other areas, yields have shown a consistant increase, those of major importance being in rice (90 percent) and maize (91 percent), wheat yields have increased by 41 percent. The percentage increase in production of the main crops since 1960/61 has been:

Cotton	10
Wheat	83
Rice	179
Oilseeds	190
Sugarcane	73

Details of crop area, yields, production and water supply are given in Table 12. Figure 15 illustrates the sources of irrigation water.

S. Canal Command Group 8 - Gudu Barrage CCA 1.598 M acres

66. Development in the command over time has been variable; the barrage was commissioned in 1962. In 1960/61, the annual cropping intensity was 104 percent; this rose to 124 percent in 19667/67 and 1967/68, declined to 94 percent in 1970/71 and then increased to around 117 percent at the present time.

67. The kharif cropping has, in most years shown a steady increase in area from 483,000 acres (41.2 percent of the CCA) in 1960 to 619,000 acres (64 percent of the CCA) in 1973. Rabi cropping has declined from 327,000 acres (62.3 percent of the CCA) to 234,000 acres (51.5 percent of the CCA). The declining acreage being shared by all the rabi crops. Kharif-rabi ratios have almost been reversed, being 0.66:1 in 1960/61 and 1.24:1 in 1973/74.

68. Prior to the construction of the Barrage, rice was the dominant crop. It occupied 73 percent of the kharif acreage in 1960, but has declined in importance since then, occupying 60 percent of the kharif acreage in 1973. With more assured water supplies following commissioning of the barrage, cotton has become an increasingly important crop, rising from 1.5 percent of the kharif acreage in 1960 to 20 percent in 1973. The proportional increase in sugarcane has been more dramatic, from 2,000 acres to 12,000 acres.

69. Pulses, particularly gram (Cicer arietinum) have continued to be the dominant rabi crop, much of it grown on residual water following the rice crop. The acreage of this crop is slowly declining as is that of wheat. Due to increased yields the overall production of wheat has increased, although both yields and area of wheat have increased in Sukkur District associated with the exploitation of the fresh groundwater along the left bank of the Indus. This has been accompanied by a declining acreage of wheat in Jacobabad District with only marginal increases in yields.

70. Percentage changes in crop production, of the major crops since 1960/61 are:

Rice	+128
Wheat	+18
Cotton	+5,440
Oilseeds	+7
Coarse grains	-118
Pulses	-20
Sugarcane	+694

Details of crop areas, yields, production and water supply are given in Table 13. Figure 16 illustrates the sources of irrigation water.

T. Canal Command Group 9 - Sukkur Barrage, Left Bank. CCA 4.705 M acres

71. Annual cropping intensities have increased from 67 percent (3.155 M acres) to 76 percent (3.557 M acres) between 1960/61 and 1973/74. The increase in cropped area of 402,000 acres has occurred almost entirely in rabi with the result that the kharif to rabi ratio has changed from 1.2:1 (1960/61) to 0.99:1 (1973/74). The increase in the rabi cropped area is due to increases in the areas of wheat (324,000 acres) and sugarcane (111,000). The acreages of cotton and rice have remained almost static.

72. Changes in the kharif cropping pattern since 1960 reflect the increasing importance of maize up 201 percent, and sugarcane up 236 percent, at the expense of bajra and jowar. The main increase in the sugarcane acreage has occurred in Nawabsha and Hyderabad Districts.

73. This canal command group is the major cotton producing area in the southern zone accounting for approximately three quarters of all cotton production in Sind and it ranks second to the Bari Doab in cotton production in Pakistan. Since 1960 cotton yields have nearly doubled, from 7.9 to 14.9 maunds per acre.

74. Percentage changes in crop production since 1960/61 for the main crops have been:

Cotton	+104
Rice	+129
Maize	+197
Wheat	+137
Oilseeds	-28
Pulses	-45
Coarse grains	-12
Sugarcane	+146

Details of crop areas, yields, production and water supply are given in Table 14. Figure 17 illustrates the sources of irrigation water.

U. Canal Command Group 10 - Sukkur Barrage Right Bank Command
CCA. 1.354 M acres

75. From 1960/61 to 1967/68 annual cropping intensities rose steadily from 93 percent to 97 percent. In 1969/70 the reported crop acreage had dropped by 236,000 acres bringing the cropping intensity down to 79 percent. From 1970/71 to 1973/74 the cropped acreage again increased, rising to 1.196 M acres giving an annual cropping intensity of 88 percent. The main drop in acreage occurred with the rabi crops of which wheat is predominant. At the same time the area of rice (kharif crop) has shown a rising trend. These changes have resulted in the kharif to rabi ratio altering from 0.67:1 in 1960/61 to 1.16:1 in 1973/74:

76. Historically the predominant crop has been rice and it is in this command that the introduction of HYV's has been most successful. Prior to 1968 the average yield of cleaned rice had been 11.3 maunds per acre; in 1968 and 1969 it averaged 15.5 maunds and in the following three years 18.4 maunds. The introduction of HYV's of wheat has been significant also. Average yields have risen from 7.3 maunds (1960/61 to 1966/67) to 14.1 maunds (1968/69 to 1973/74). Thus in spite of declining acreage, production has continued to increase. The percentage changes in production of the main crops since 1960/61 have been:

Rice	+120
Coarse grains	-22
Wheat	+27
Pulses	-25

Details of crop area, yields, production and water supply are given in Table 15. Figure 18 illustrates the sources of irrigation water.

V. Canal Command Group 11 - Kotri Barrage Command. CCA 1.323 M acres

77. Between 1960/61 and 1973/74 development, in terms of cropped area, has been static. The only crop to show significant increases in area has been sugarcane, up from 4,000 acres in 1960 to 62,000 acres in 1973. Production of sugarcane, rice and wheat have all increased. Production of other crops has either remained static or declined. Increased production of sugarcane has been due almost entirely to the increase in area. Yields, as good as in the better areas of the Punjab, have remained fairly static. Yields of rice and wheat have both shown encouraging increases associated with the adoption of HYVs. As in other areas in Sind cotton yields have increased steadily throughout the period under review.

78. Percentage changes in production of the main crops since 1960/61 have been:

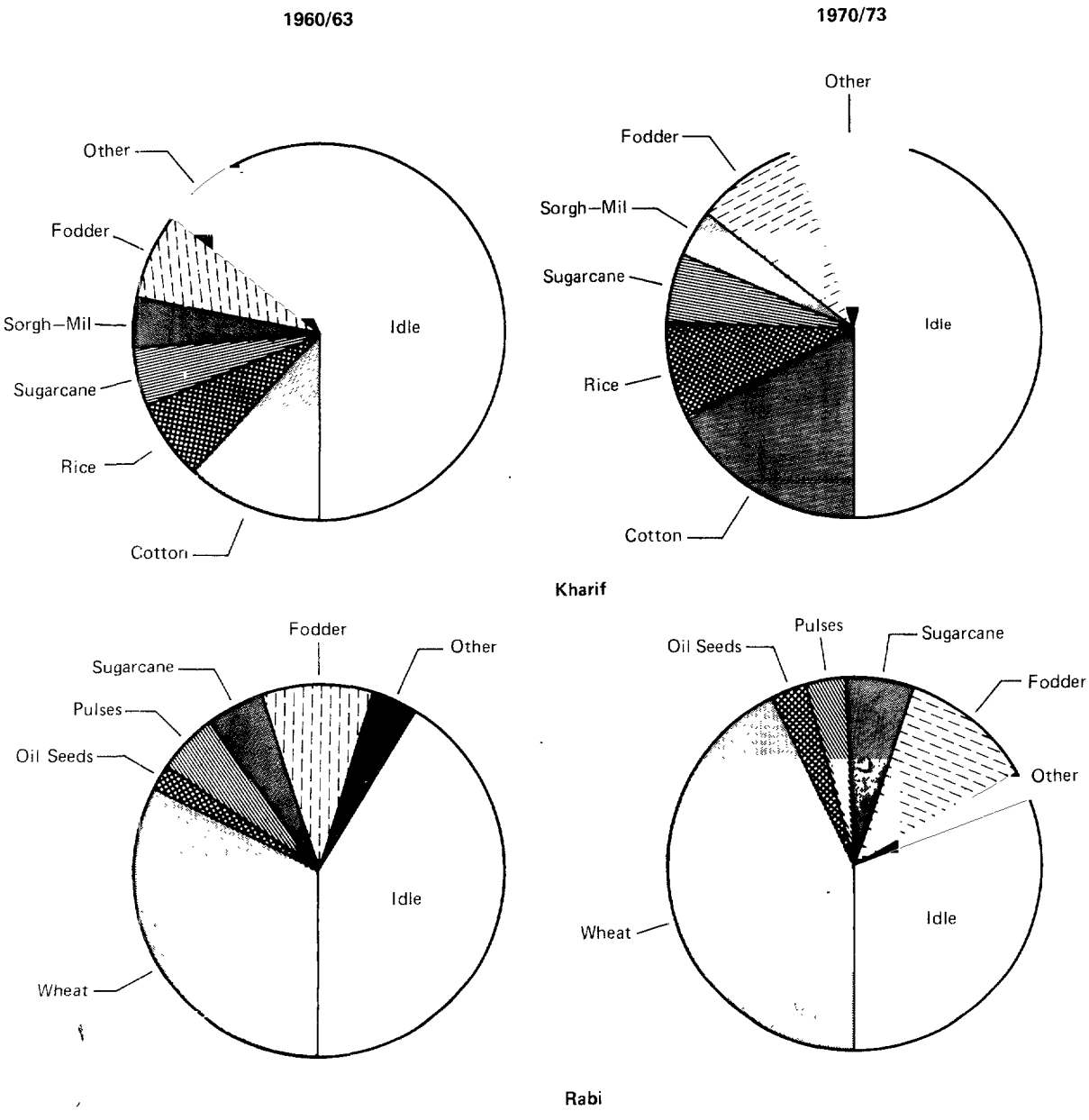
Cotton	+53
Rice	+214
Sugarcane	+1,336
Wheat	+62
Oilseeds	+11
Pulses	+13

Details of crop area, yields, production and water supply are given in Table 16. Figures 19 illustrates the sources of irrigation water.

ANNEX 4
Figure 1

A REVIEW OF THE INDUS BASIN PROJECT
1960 – 1975

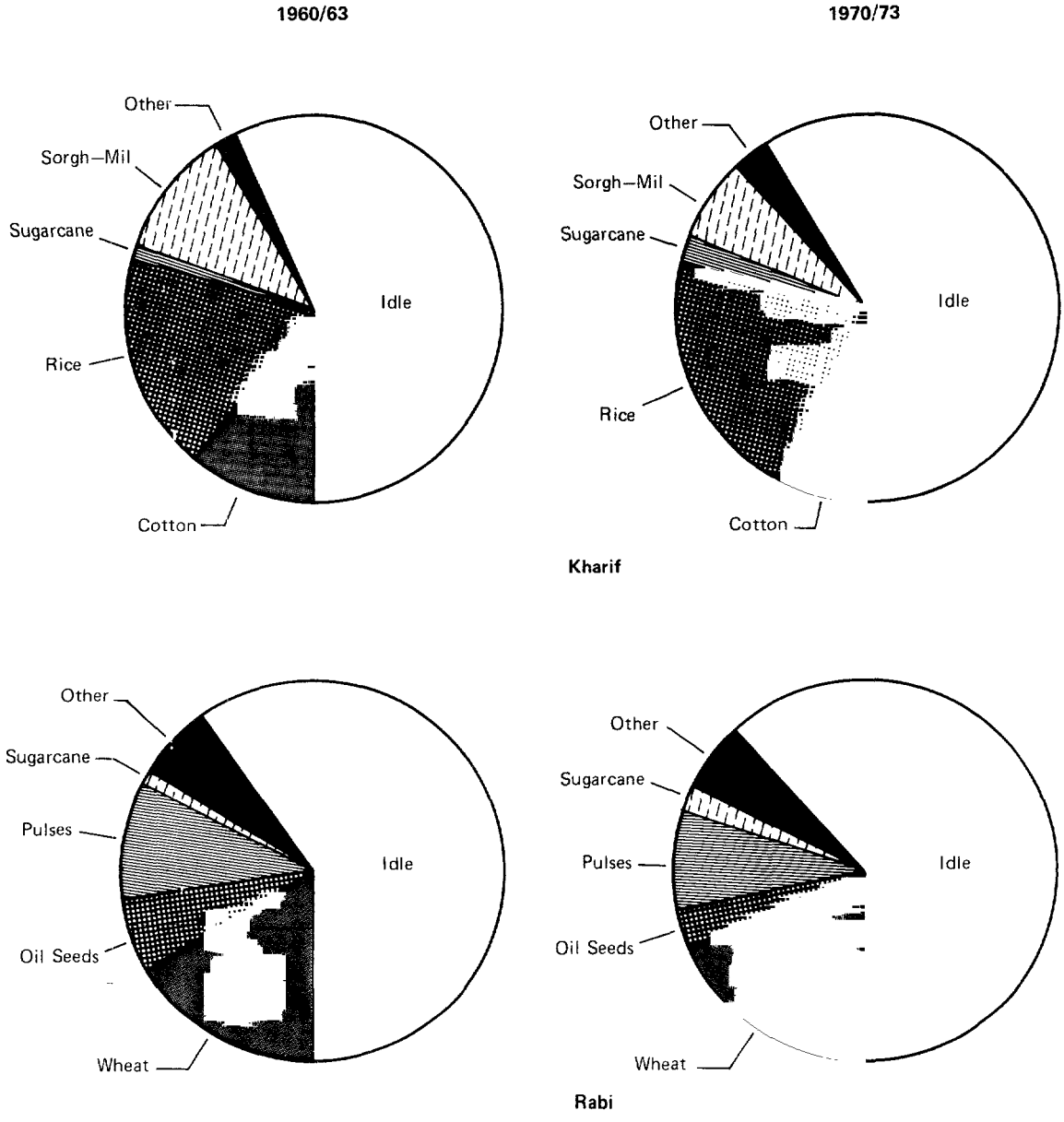
CROPPING INTENSITIES – NORTHERN ZONE



World Bank–15770

A REVIEW OF THE INDUS BASIN PROJECT
1960 – 1975

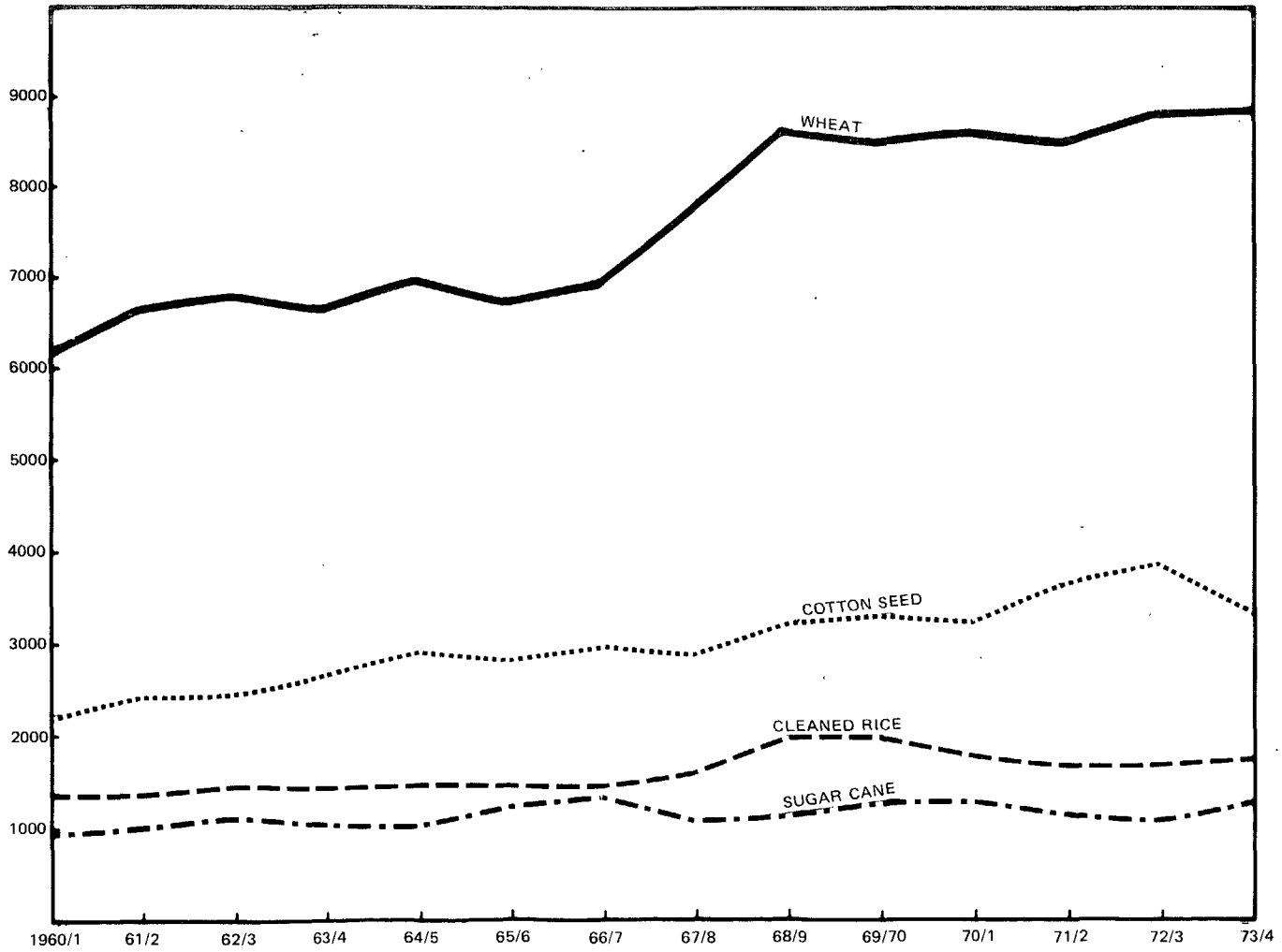
CROPPING INTENSITIES – SOUTHERN ZONE



World Bank–15771

A REVIEW OF THE INDUS BASIN PROJECT
1960–1975

AREAS OF COTTON, RICE, WHEAT AND SUGAR CANE
NORTHERN ZONE

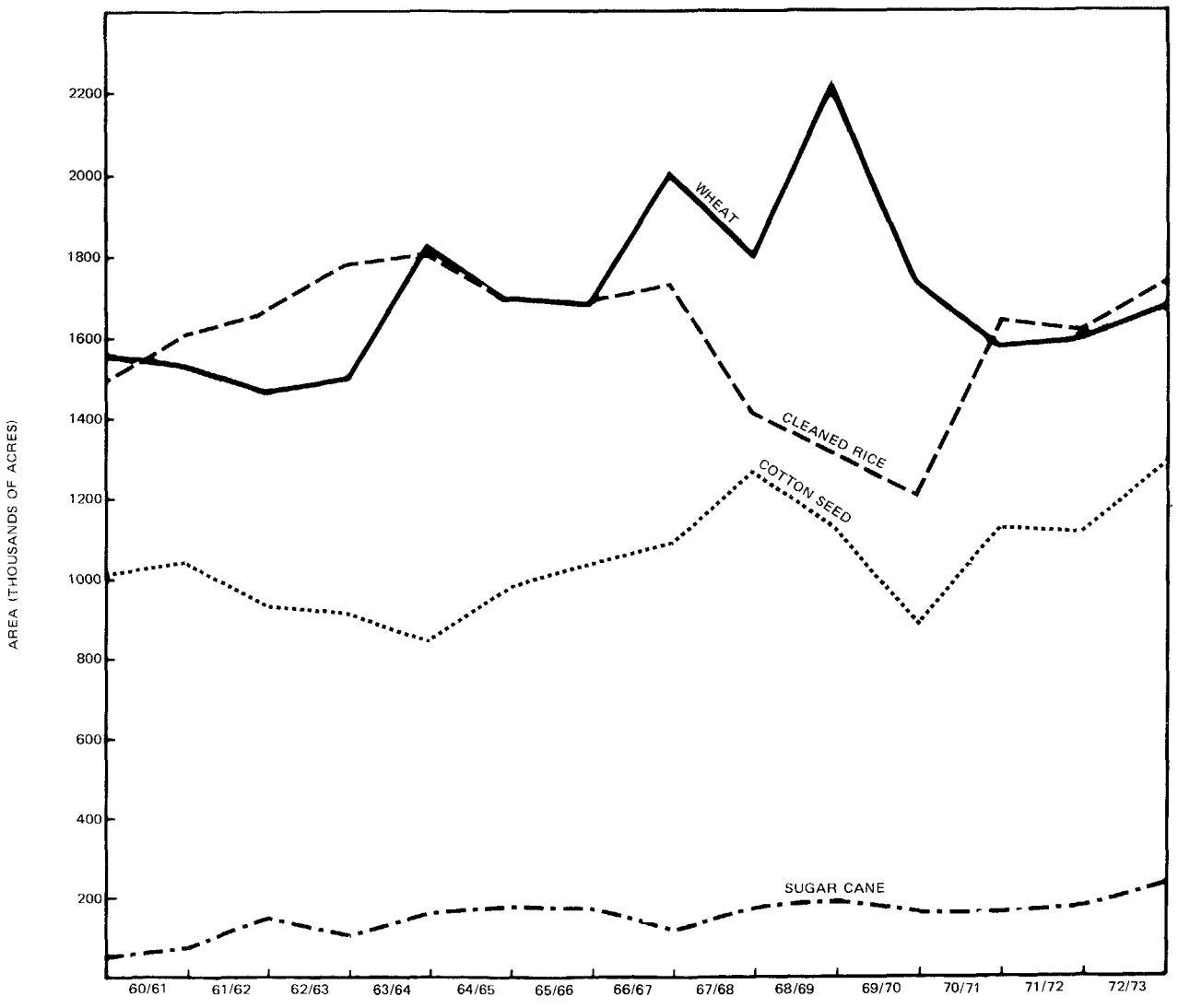


World Bank–15791

ANNEX 4
Figure 3

A REVIEW OF THE INDUS BASIN PROJECT
1960–1975

AREAS OF COTTON, RICE, WHEAT AND SUGAR CANE
SOUTHERN ZONE

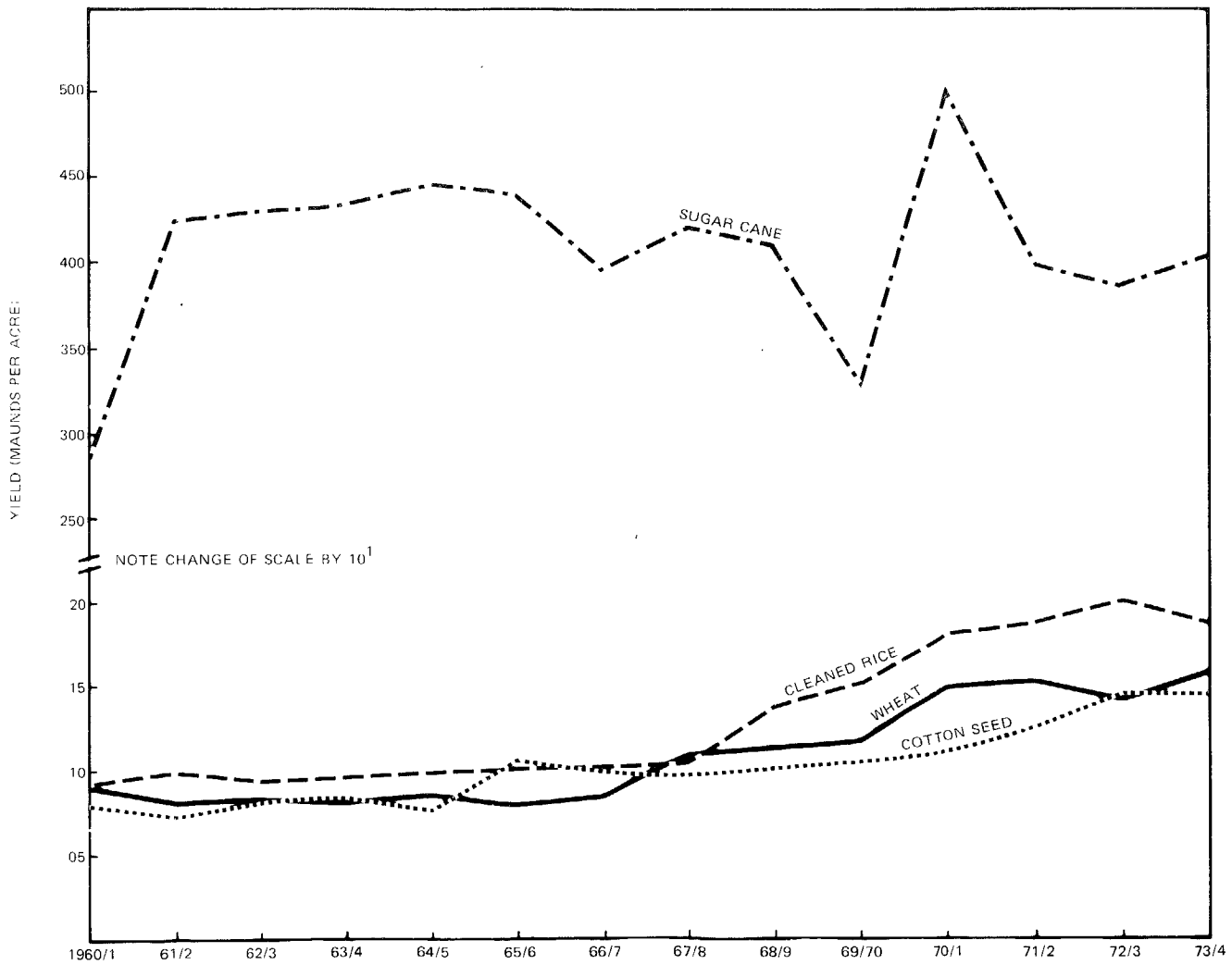


World Bank–15790

ANNEX 4
Figure 4

A REVIEW OF THE INDUS BASIN PROJECT
INDUS BASIN PROJECT
1960 – 1975

YIELD OF COTTON, RICE, WHEAT AND SUGAR CANE
NORTHERN ZONE



World Bank—15788

ANNEX 4
Figure 5

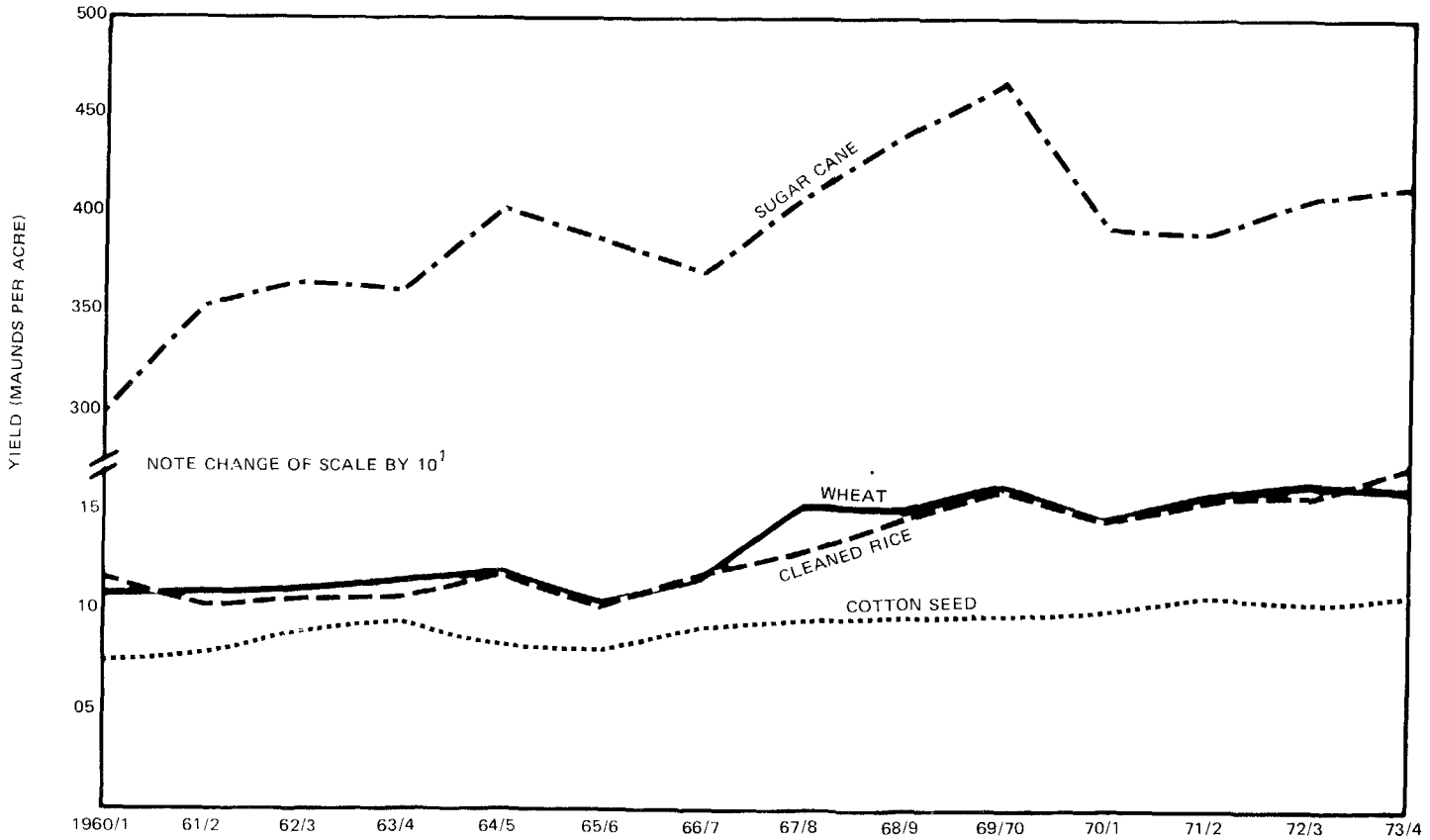
A REVIEW OF THE INDUS BASIN PROJECT

INDUS BASIN PROJECT

1960–1975

YIELD OF COTTON, RICE, WHEAT AND SUGAR CANE

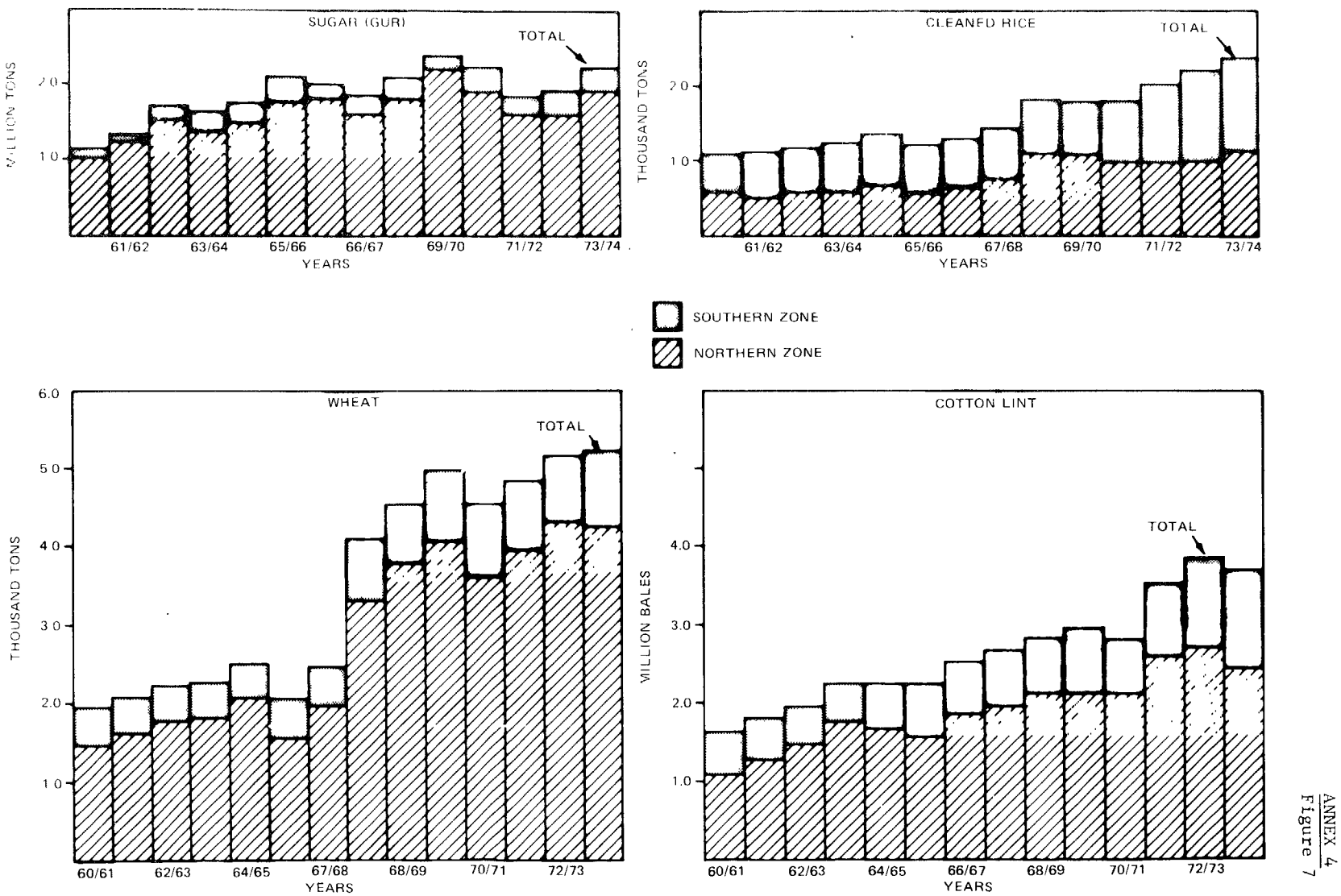
SOUTHERN ZONE



World Bank–15789

ANNEX 4
Figure 6

A REVIEW OF THE INDUS BASIN PROJECT
1960–1975
GROSS PRODUCTION MAIN CROPS

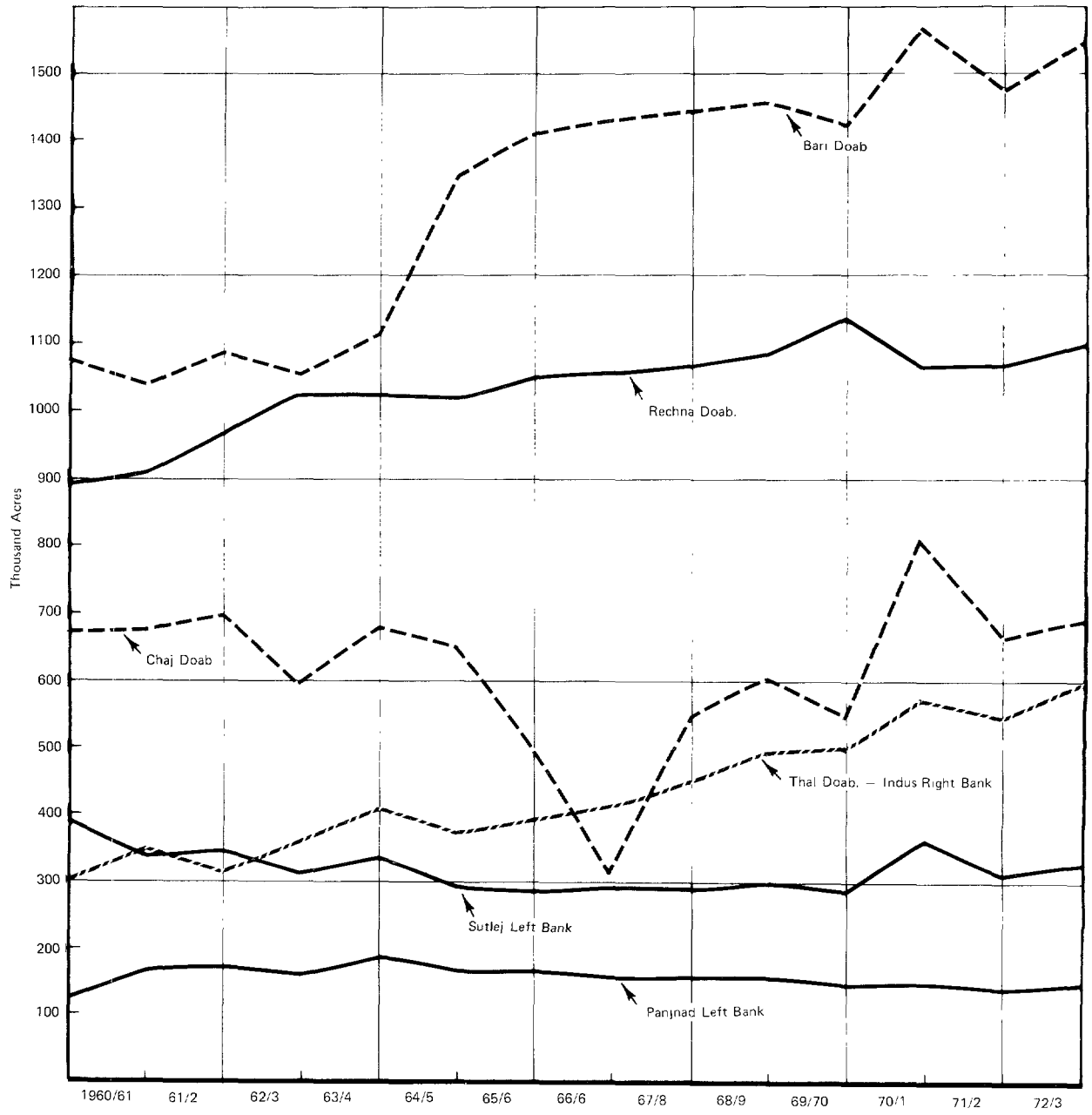


ANNEX 4
Figure 7

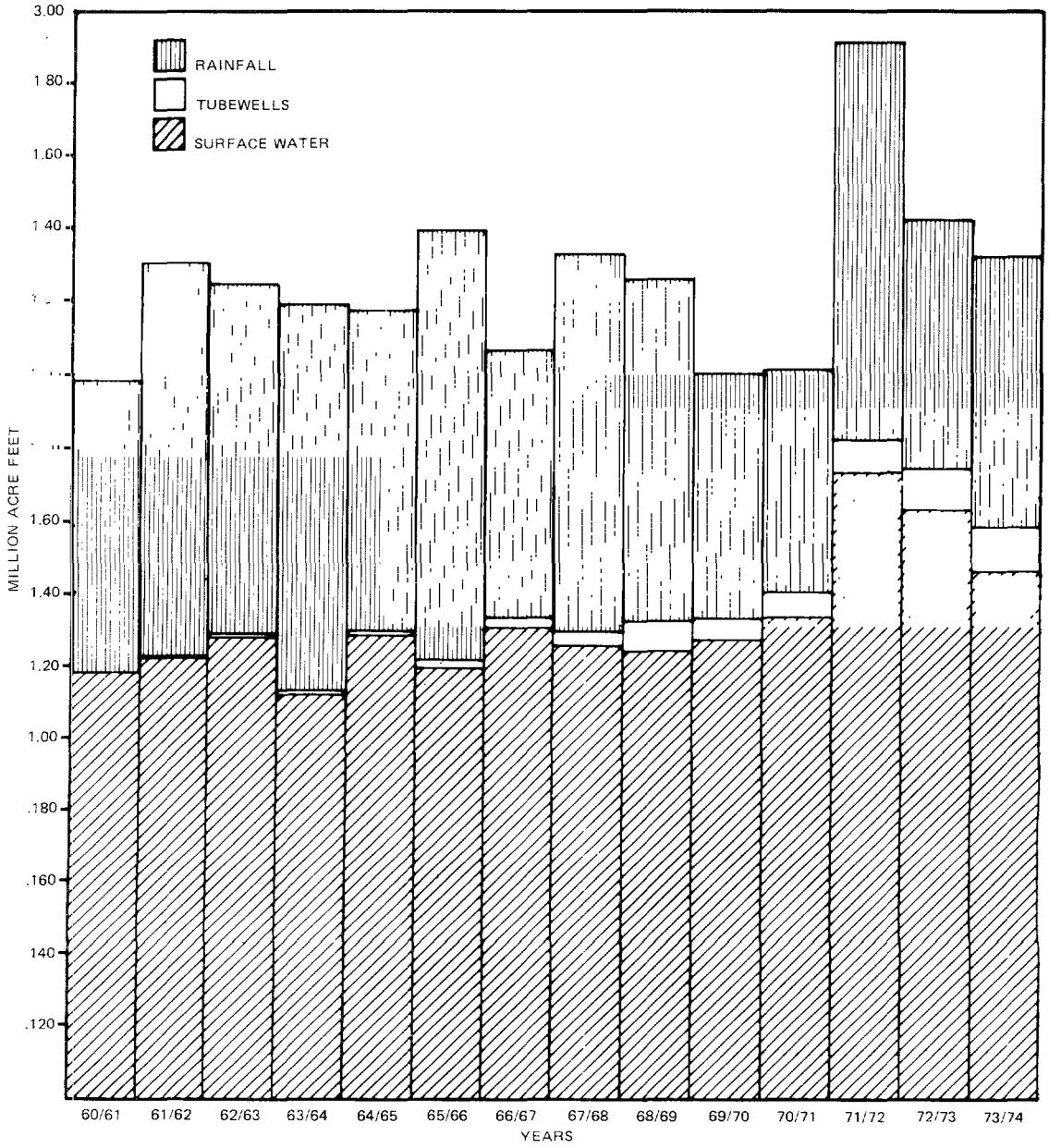
World Bank – 15802

A REVIEW OF THE INDUS BASIN PROJECT
1960 – 1975

ANNUAL FODDER AREAS – PUNJAB CANAL COMMAND GROUPS

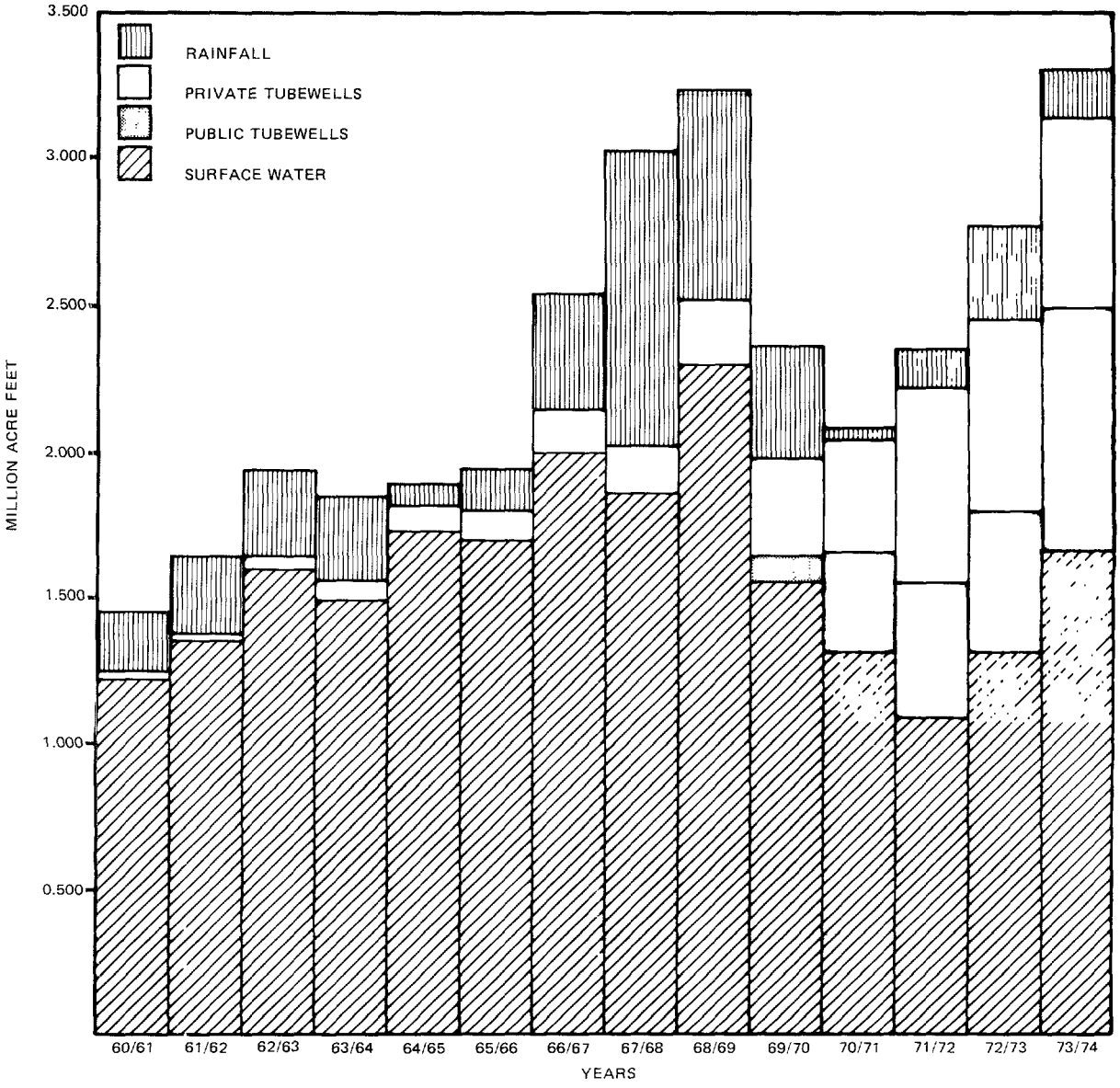


A REVIEW OF THE INDUS BASIN PROJECT
1960–1975
RABI SEASON WATER SUPPLY
CCG 1 PESHAWAR VALE
CCA .687 MILLION ACRES



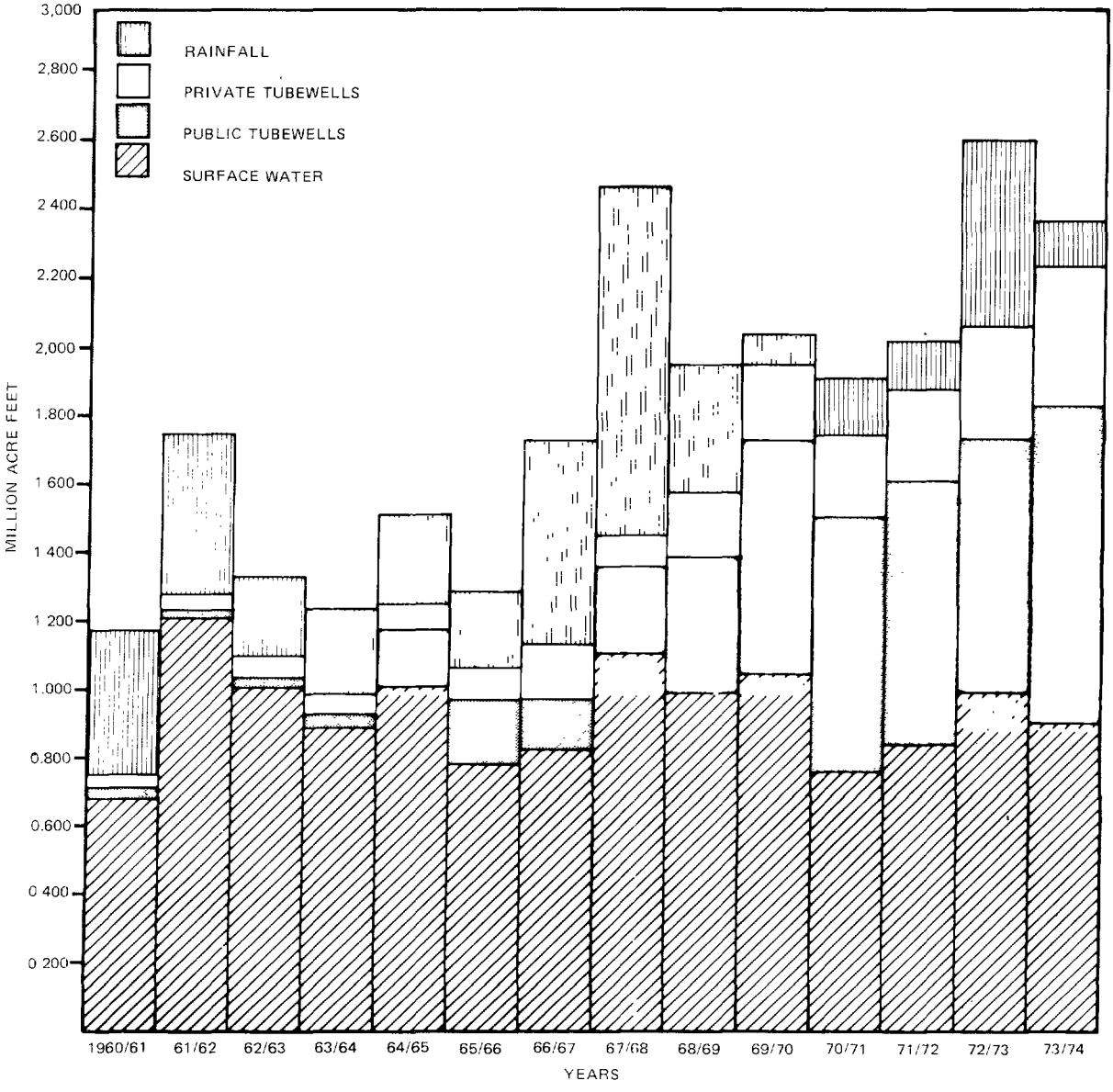
World Bank–15876

A REVIEW OF THE INDUS BASIN PROJECT
1960–1975
RABI SEASON WATER SUPPLY
CCG 2 THAL DOAB
(CCA 3.617 M ACRES)



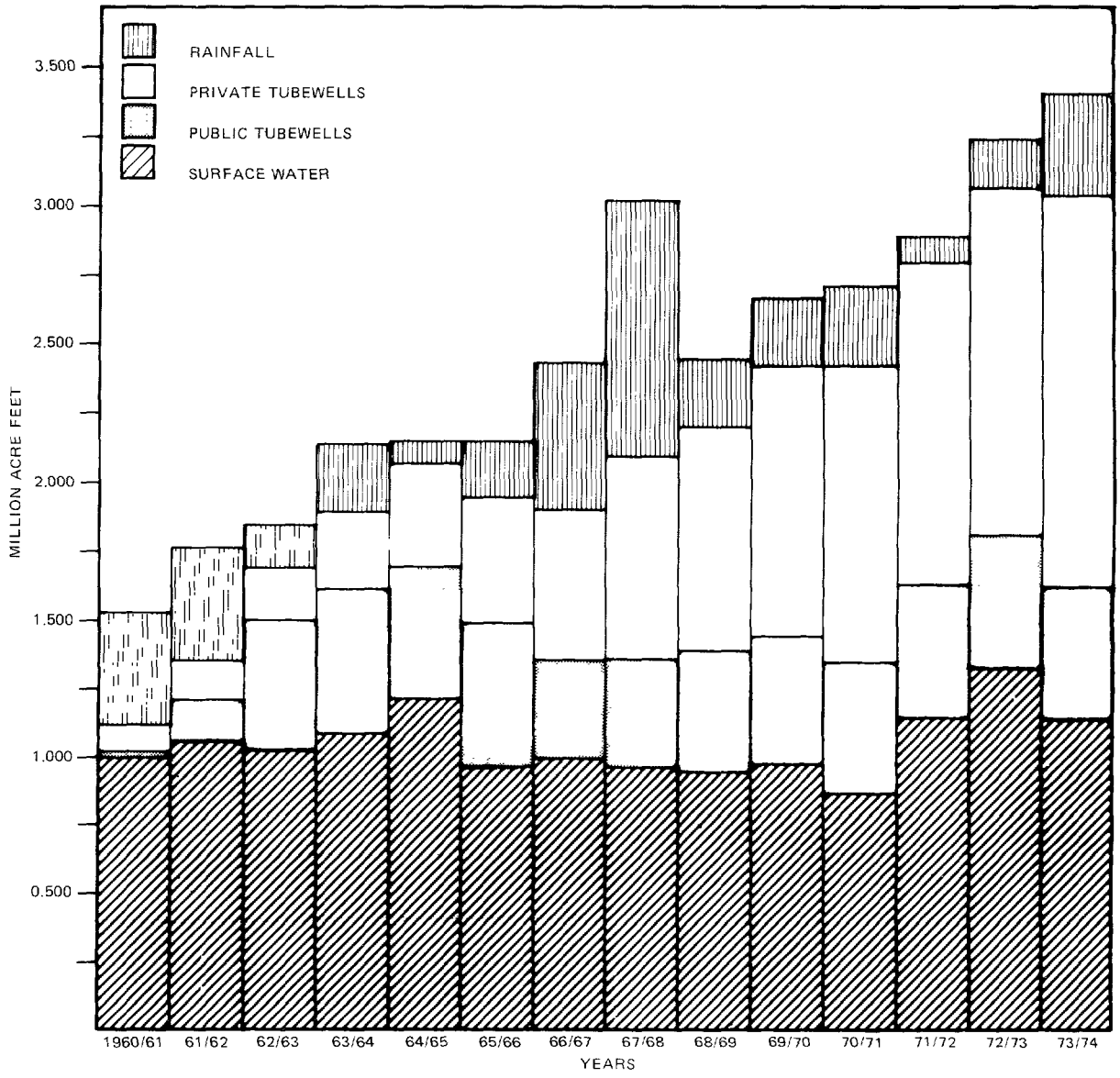
World Bank–15778

A REVIEW OF THE INDUS BASIN PROJECT
1960–1975
RABI SEASON WATER SUPPLY
CCG 3 CHAJ DOAB
(CCA 2.043 M ACRES)



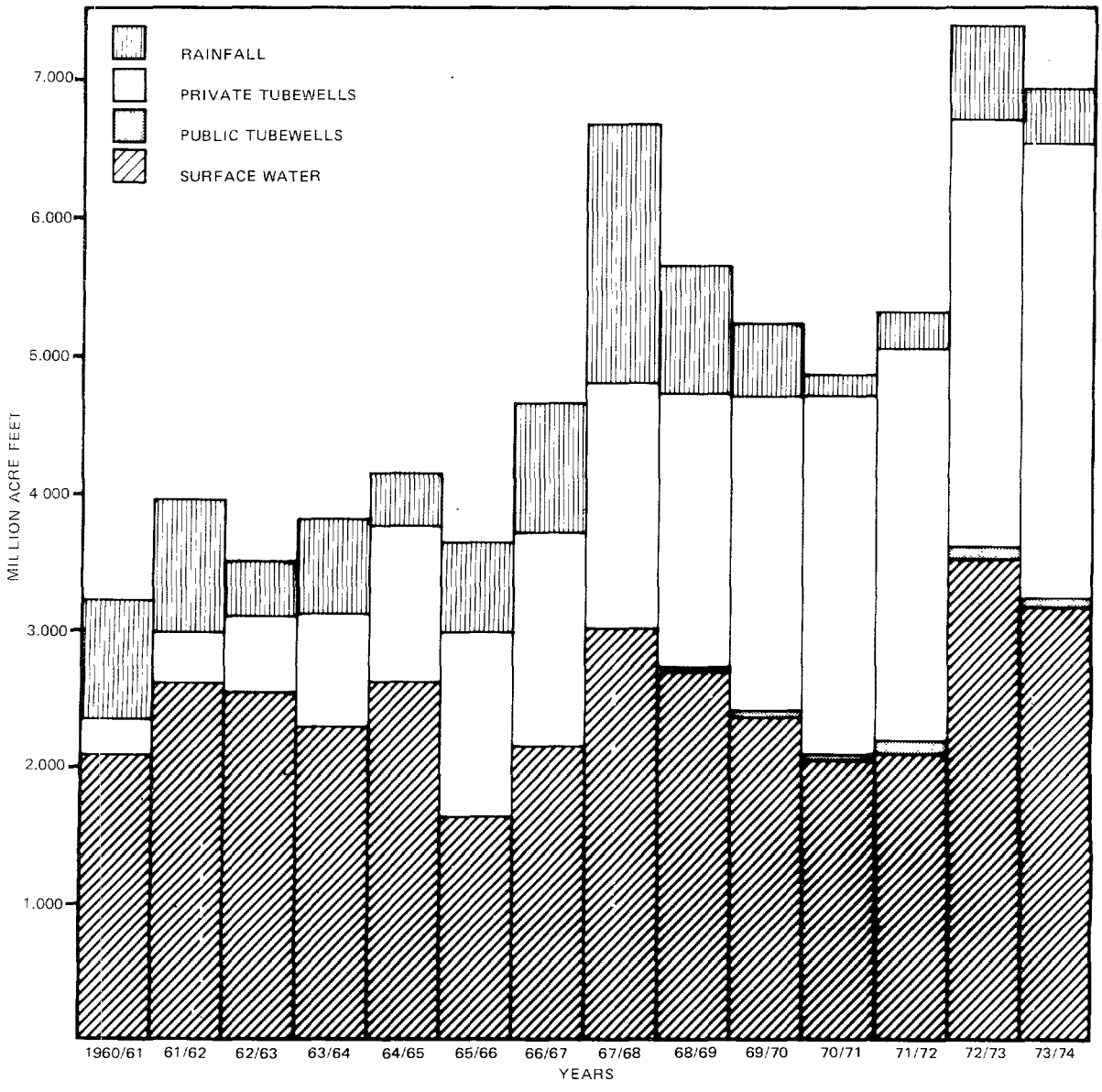
World Bank–15779

A REVIEW OF THE INDUS BASIN PROJECT
1960/1975
RABI SEASON WATER SUPPLY
CCG 4 RECHNA DOAB
(CCA 4.705 M ACRES)



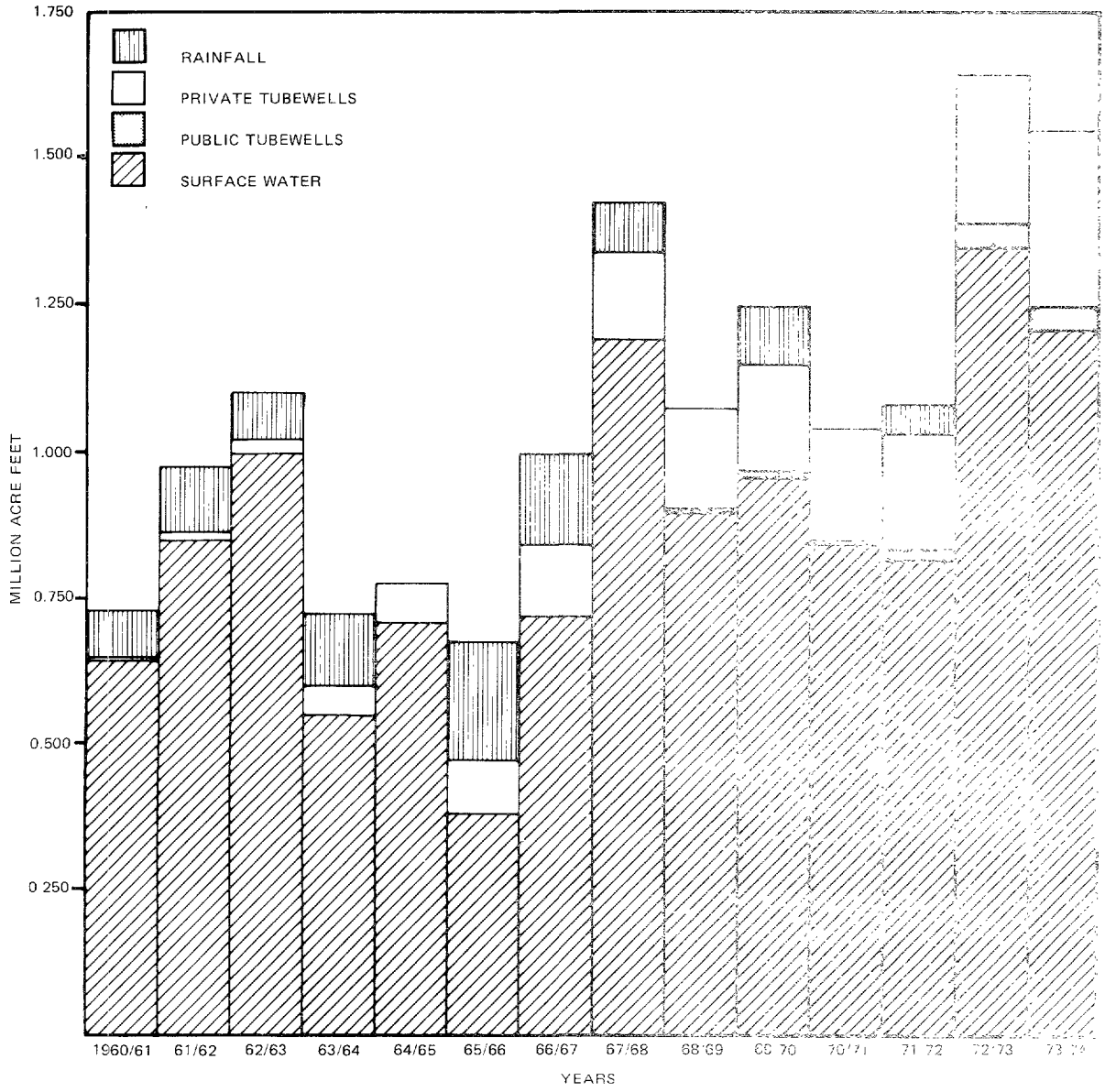
World Bank—15780

A REVIEW OF THE INDUS BASIN PROJECT
1960/1975
RABI SEASON WATER SUPPLY
CCG 5 BARI DOAB
(CCA 5.826 M ACRES)



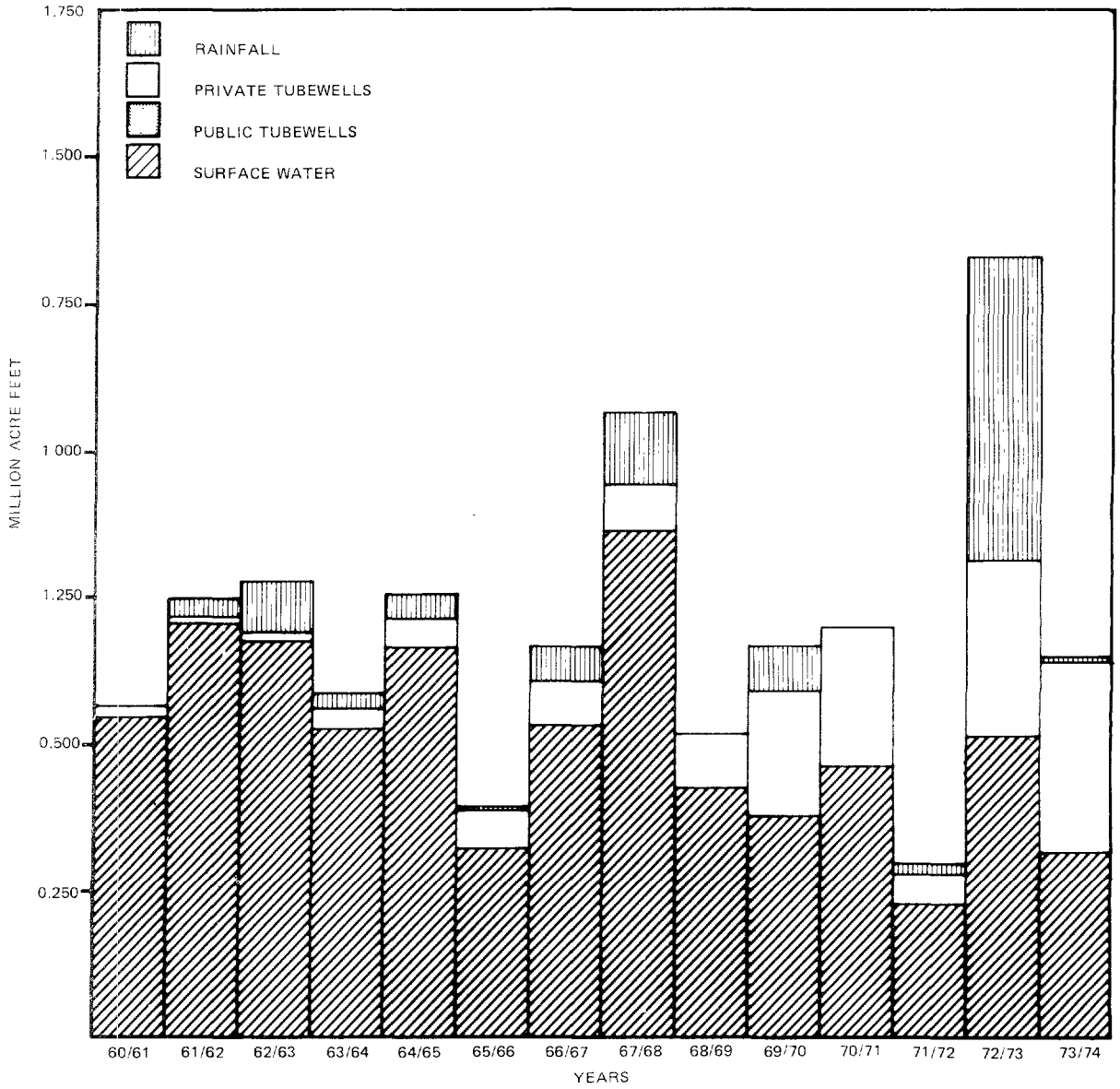
World Bank—15781

A REVIEW OF THE INDUS BASIN PROJECT
1960--1975
RABI SEASON WATER SUPPLY
CCG 6 SUTLEJ LEFT BANK
(CCA 2.051 M ACRES)



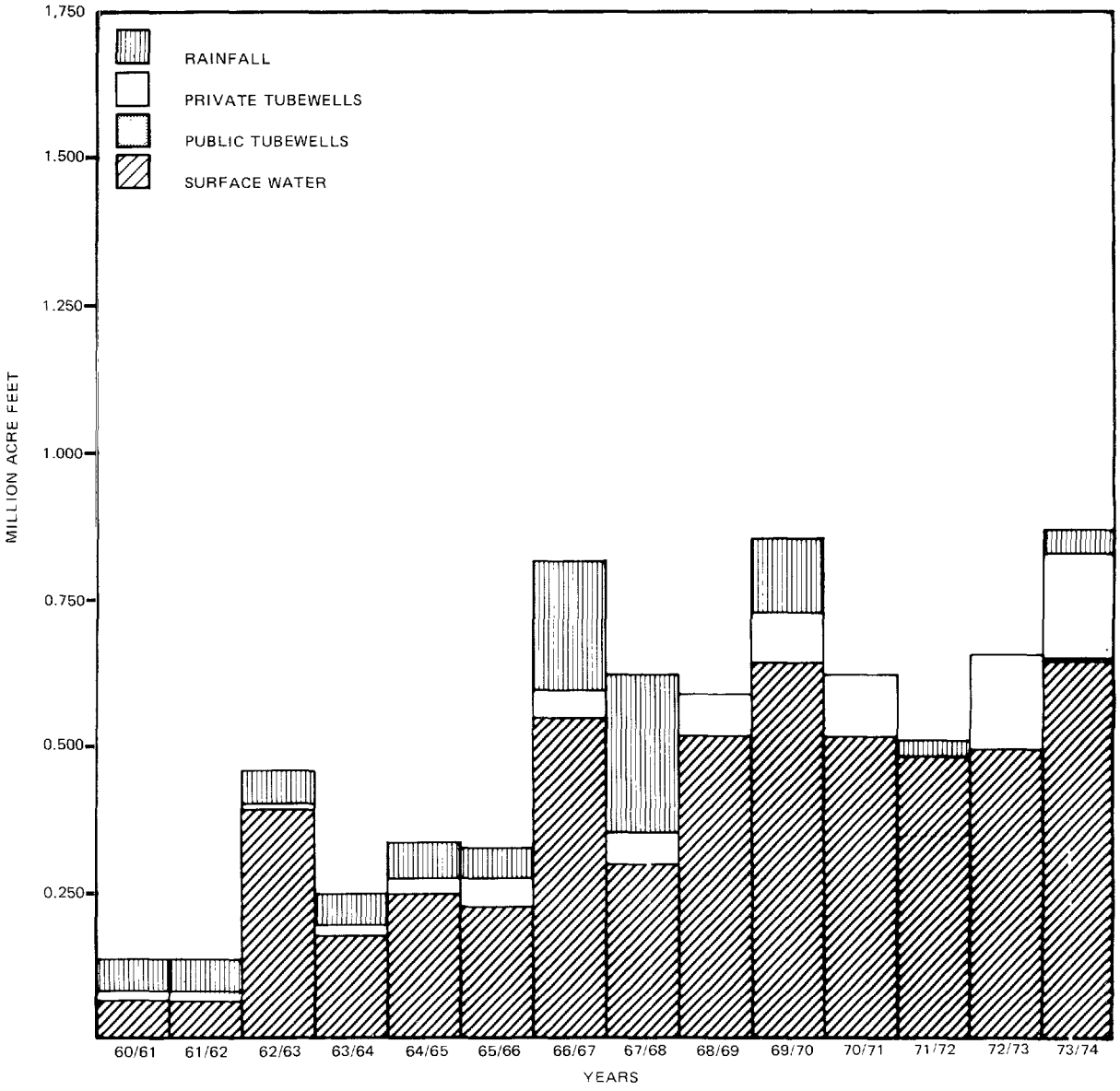
World Bank 18722

A REVIEW OF THE INDUS BASIN PROJECT
1960/1975
RABI SEASON WATER SUPPLY
CCG 7 PANJNAD–ABBASIA
(CCA 1.455 M ACRES)



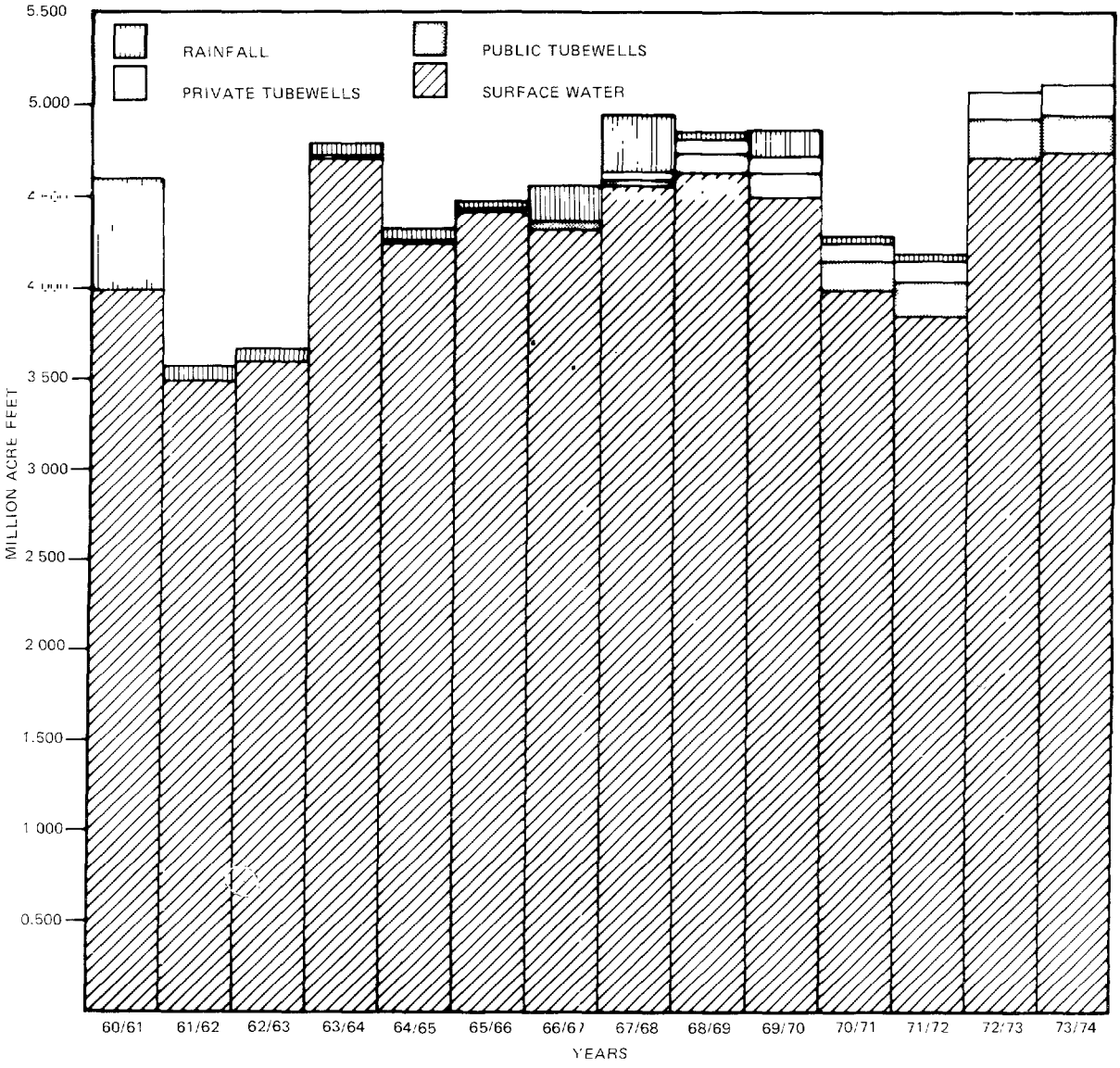
World Bank–15783

A REVIEW OF THE INDUS BASIN PROJECT
1960–1975
RABI SEASON WATER SUPPLY
CCG 8 GUDU BARRAGE COMMAND
(CCA 1.598 M ACRES)



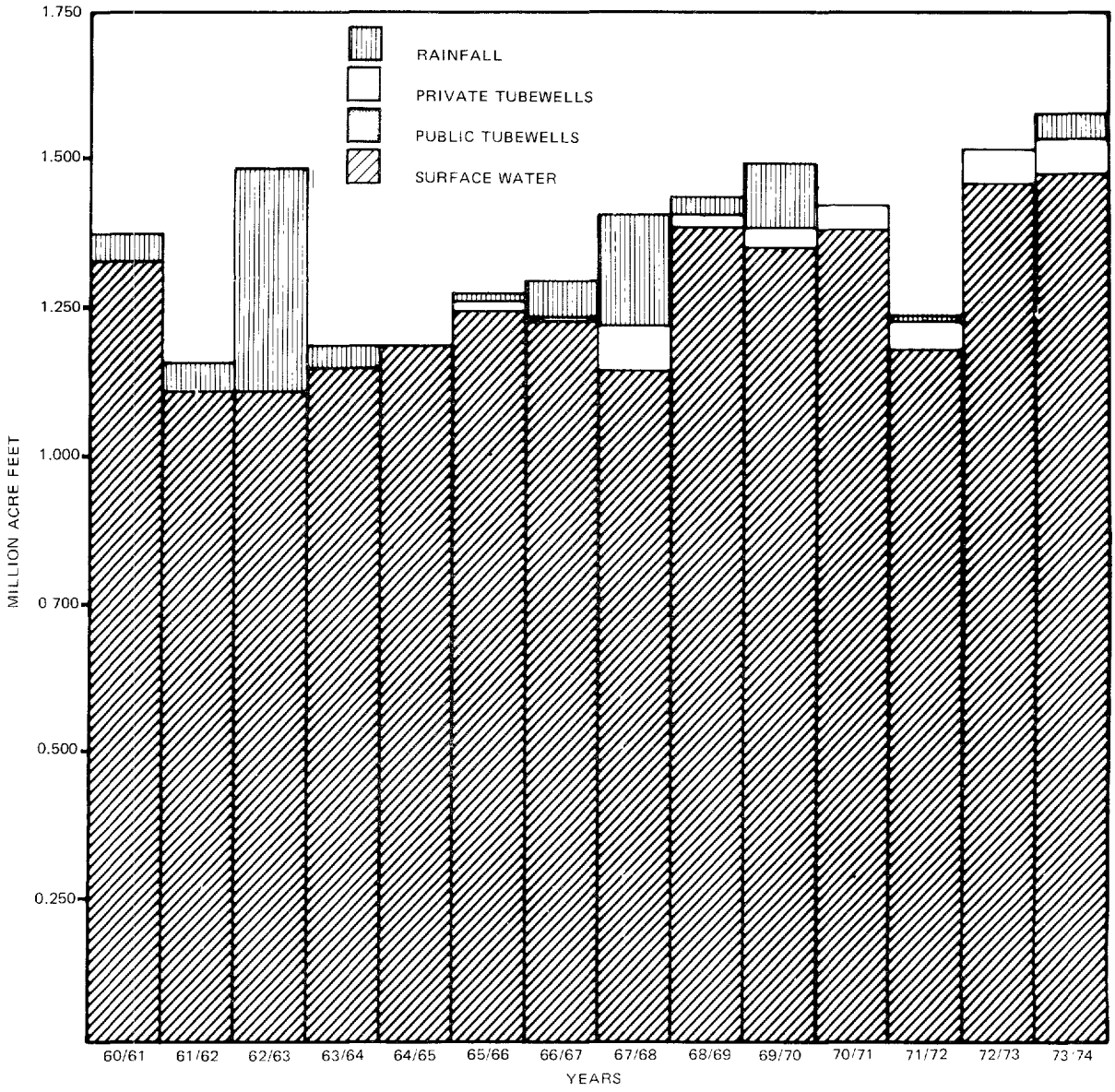
World Bank–15784

A REVIEW OF THE INDUS BASIN PROJECT
1960--1975
RABI SEASON WATER SUPPLY
CCG 9 SUKKUR BARRAGE LEFT BANK
(CCA 4.705 M ACRES)



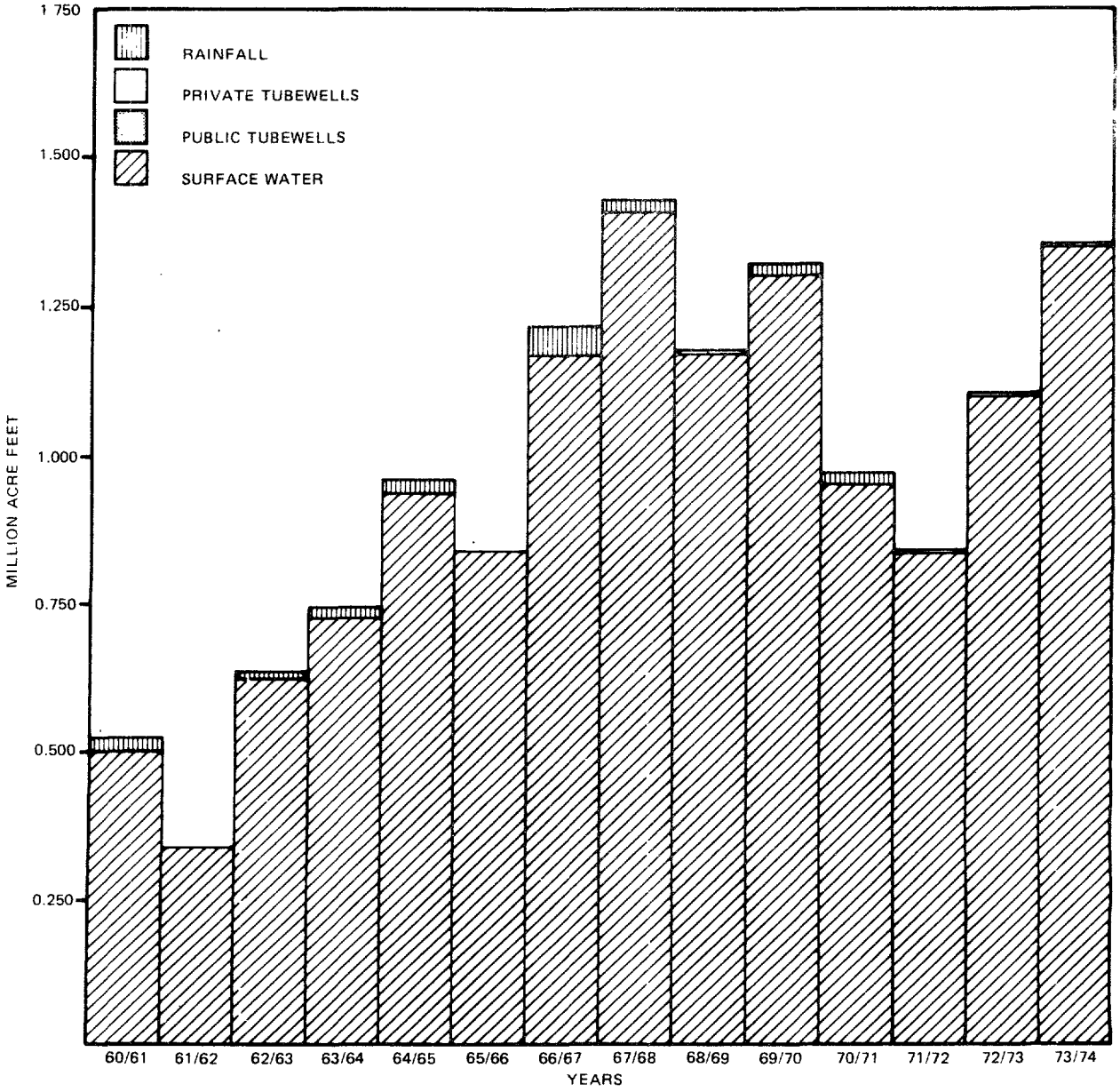
World Bank 15785

A REVIEW OF THE INDUS BASIN PROJECT
1960–1975
RABI SEASON WATER SUPPLY
CCG 10 SUKKUR RIGHT BANK
(CCA 1.354 M ACRES)



World Bank–15786

A REVIEW OF THE INDUS BASIN PROJECT
1960/1975
RABI SEASON WATER SUPPLY
CCG II GHULAM MOHAMMED BARRAGE
(CCA 1.323 M ACRES)



World Bank—15787

PAKISTAN

AREA, PRODUCTION AND PERCENT OF CCA OF MAIN CROPS
NORTHERN ZONE CANAL COMMAND GROUPS

KHARIF

CROP		1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
COTTON	Area	2188 1/	2409 1/	2428 1/	2675 1/	2915 1/	2828 1/	2957	2889	3206	3286	3216	3679	3886	3374
	Prod. 2/	1140	1314	1532	1803	1693	1579	1898	1933	2170	2239	2231	2771	2819	2524
	%	10.7	11.8	11.9	13.1	14.3	13.9	14.5	14.2	15.7	16.1	15.8	18.0	19.1	16.6
RICE	Area	1352	1327	1449	1451	1499	1481	1445	1589	1992	1976 1/	1787	1664	1695	1759
	Prod. 3/	576	500	570	559	663	602	633	754	1071	1167 1/	962	974	990	1103
	%	6.6	6.5	7.1	7.1	7.4	7.3	7.1	7.8	9.8	9.7	8.8	8.2	8.3	8.6
SUGAR CANE	Area	940	976	1126	1059	1018	1251	1341	1075	1119	1280	1294	1125	1070	1269
	Prod. 4/	10324	12654	15107	13987	15030	17722	18213	16132	18147	21906	18702	16148	16025	19297
	%	4.6	4.8	5.5	5.2	5.0	6.1	6.6	5.3	5.5	6.3	6.3	5.5	5.2	6.2
SORGHUM AND MILLET	Area	874	924	853 1/	817	1029	856 1/	1070	950	823	841	839	829	826	810
	Prod.	210	218	218 1/	208	261	203 1/	250	247	200	216	217 1/	215 1/	216 1/	205 1/
	%	4.3	4.5	4.2	4.0	5.0	4.2	5.2	4.7	4.0	4.1	4.1	4.0	4.0	4.0
FODDER 1/	Area	1479	1534	1550	1549	1683	1653	1678	1730	1779	1860	1765	2028	1841	1999
	%	7.3	7.5	7.6	7.6	8.3	8.1	8.2	8.5	8.7	9.1	8.7	9.9	9.0	9.8
OTHER CROPS	Area	1484	1557	1413	1374	1431	1330	1428	1957	1739	1417	1613	1479	1694	2560
	%	7.3	7.6	6.9	6.7	7.0	6.5	7.0	9.6	8.5	7.0	7.9	7.3	8.3	12.6
TOTAL KHARIF CROPS	Area	8317	8727	8819	8925	9575	9399	9919	10190	10658	10660	10514	10804	11012	11771
	%	40.8	42.8	43.3	43.8	47.0	46.1	48.7	50.0	52.3	52.3	51.6	53.0	54.0	57.7
ANNUAL TOTAL	Area	19651	20534	21424	20918	21982	21259	22439	22867	24484	24340	24377	24772	24965	26342
	%	96.4	100.7	105.1	102.6	107.8	104.3	110.1	112.2	120.1	119.4	119.6	121.5	122.5	129.2

RABI

CROP		1960/ 61	1961/ 62	1962/ 63	1963/ 64	1964/ 65	1965/ 66	1966/ 67	1967/ 68	1968/ 69	1969/ 70	1970/ 71	1971/ 72	1972/ 73	1973/ 74
WHEAT	Area	6169	6640	6829	6652	6993	6713	6975	7768	8657	8504	8630	8515	8840	8882
	Prod.	2434	2610	2802	2801	3079	2554	3009	4316	4808	5100	4614	4962	5341	5277
	%	30.3	32.6	33.5	32.6	34.3	32.9	34.2	38.1	42.5	41.7	42.3	41.8	43.4	43.6
OIL SEEDS 5/	Area	469	409	549	382	419	322	546	522	424	451	524	686	597	590
	Prod.	90	87	122	77	87	71	110	122	102	112	133	162	147	149
	%	2.3	2.0	2.7	1.9	2.1	1.6	2.7	2.6	2.1	2.2	2.6	3.4	2.9	2.9
GRAIN LEGUMES	Area 1/	1149	1094	1180	978	1048	815	957	742	728	677	640	667	591	899
	Prod. 1/	251	254	291	234	267	215	255	185	207	188	179	177	177	201
	%	5.6	5.4	5.8	4.8	5.1	4.0	4.7	3.6	3.5	3.3	3.1	3.3	2.9	4.4
SUGAR CANE	Area	940	976	1126	1059	1018	1251	1341	1075	1119	1280	1294	1125	1070	1269
	%	4.6	4.8	5.5	5.2	5.0	6.1	6.6	5.3	5.5	6.3	6.3	5.5	5.2	6.2
FODDER	Area 1/	1979	1764	2021	2045	2055	2194	2107	2132	2158	2223	2270	2497	2291	2407
	%	9.7	8.7	9.9	10.0	10.1	10.8	10.3	10.5	10.6	10.9	11.1	12.2	11.2	11.8
OTHER CROPS	Area	628	924	900	877	874	565	594	438	740	545	505	478	564	524
	%	3.1	4.5	4.4	4.3	4.3	2.8	2.9	2.1	3.6	2.7	2.5	2.3	2.8	2.6
TOTAL RABI CROPS	Area	11334	11807	12605	11993	12407	11860	12520	12677	13826	13680	13863	13968	13953	14571
	%	55.6	57.9	61.8	58.8	60.9	58.2	61.4	62.2	67.8	67.1	68.0	68.5	68.5	71.5

Source

1/ Not reported in Peshawar Vale.

2/ Thousand bales.

3/ Thousand tons cleaned rice.

4/ Thousand tons cane.

5/ Cotton not included.

NOTES:

Areas, Thousand acres.

Production thousand tons gross (but see Note 2/)

%=Area of crop(s) as a percentage of the CCA.

Minor discrepencies due to rounding.

ANNEX 4
Table 1

PAKISTA

AREA, PRODUCTION AND PERCENT OF CCA OF MAIN CROPS
SOUTHERN ZONE CANAL COMMAND GROUPS

KHARIF

CROP		1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
COTTON	Area 1/	1016	1043	935	918	844	985	1035	1087	1263	1135	887	1137	1177	1289
	Prod.	565	522	529	542	446	735	709	740	894	845	695	992	1203	1318
	%	11	12	10	10	9	11	12	12	14	13	10	13	13	14
RICE	Area 2/	1490	1607	1674	1781	1813	1701	1690	1730	1414	1311	1207	1644	1620	1731
	Prod.	504	589	581	635	661	632	634	664	718	730	805	1140	1200	1205
	%	17	18	19	20	20	19	19	19	16	15	13	18	18	19
SUGAR CANE	Area 3/	57	76	145	113	163	175	177	119	176	193	160	159	179	239
	Prod.	901	1187	2290	1801	2663	2824	2575	1839	2665	2336	2941	2337	2548	3557
	%	1	1	2	1	2	2	2	1	2	2	2	2	2	3
SORGHUM AND MILLET 4/	Area	794	962	1001	861	1074	883	670	793	527	534	568	577	586	565
	Prod.	162	193	221	197	256	202	150	181	125	143	134	150	141	140
	%	9	11	11	10	12	10	7	9	6	6	6	6	7	6
OTHER KHARIF CROPS	Area	191	267	298	238	211	194	194	254	211	199	227	258	283	280
	%	2	3	3	3	2	2	2	3	2	2	3	3	3	3
TOTAL KHARIF CROPS	Area	3548	3955	4052	3912	4104	3937	3765	3983	3618	3372	3048	3774	3845	4104
	%	40	44	45	44	46	44	42	44	40	38	34	42	43	46
ANNUAL TOTAL	Area	7076	7480	7823	7783	7623	7669	7488	7846	7271	7428	6584	7020	7196	7627
	%	79	83	87	87	85	85	83	87	81	83	73	78	80	85

RABI

CROP		1960 /61	1961 /62	1962 /63	1963 /64	1964 /65	1965 /66	1966 /67	1967 /68	1968 /69	1969 /70	1970 /71	1971 /72	1972 /73	1973
WHEAT	Area	1547	1527	1466	1493	1825	1702	1687	2004	1808	2198	1739	1583	1598	1677
	Prod.	507	461	442	451	563	506	516	812	760	948	949	889	844	965
	%	17	17	16	17	20	19	19	22	20	24	19	18	18	19
OIL 5/ SEEDS	Area	510	490	721	553	357	482	456	450	433	392	342	293	279	308
	Prod.	92	105	166	101	66	82	88	107	98	85	79	66	63	72
	%	6	5	8	6	4	5	5	5	5	4	4	3	3	3
GRAIN LEGUMES	Area	909	871	864	900	836	854	904	799	795	724	750	680	783	752
	Prod.	183	154	155	166	155	184	222	207	167	141	149	130	153	140
	%	10	10	10	10	9	10	10	9	9	8	8	8	9	8
SUGAR CANE	Area	57	76	145	113	163	175	177	119	176	193	160	159	179	239
	%	1	1	2	1	2	2	2	1	2	2	2	2	2	3
OTHER RABI CROPS	Area	504	561	575	652	541	519	500	532	440	548	545	532	512	547
	%	6	6	6	7	6	6	6	6	5	6	6	6	6	6
TOTAL RABI CROPS	Area	3528	3525	3771	3711	3722	3732	3723	3863	3653	4056	3536	3246	3351	3523
	%	39	39	42	41	41	42	41	43	41	45	39	36	37	39

Source

1/ Thousand bales.

2/ Thousand tons cleaned rice.

3/ Thousand tons cane.

4/ Includes area and production of maize grown in the Sukkur Barrage L.B. Command.

5/ Cotton not included.

NOTES:

Area: Thousand acres.

Production: Thousand tons gross (but see Note 1/).

%=Area of crop(s) as a percentage of the CCA.

Minor discrepancies due to rounding.

Crop area and production data for 1970/71 and subsequent years does not include the land in Baluchistan commanded by the Gudu and Sukkur Barrages; the data not being available at the time of going to press.

Crop area and production data for Kotri Barrage for the years 1968/69 and 1969/70 is estimated.

ANNEX 6
Table 2

PAKISTAN

CROPPING INTENSITIES
NORTHERN ZONE CANAL COMMAND GROUPS

Canal Command Group	1960/61			1961/62			1962/63			1963/64			1964/65			1965/66			1966/67			1967/68		
	K	R	A	K	R	A	K	R	A	K	R	A	K	R	A	K	R	A	K	R	A	K	R	A
1. Peshawar Vale	100	80	180	97	84	181	102	87	189	102	88	190	103	90	193	89	93	182	89	94	183	88	94	182
2. Thal Doab Indus RB	20	44	64	23	45	68	21	47	68	21	46	67	24	50	74	25	49	74	30	51	81	28	54	82
3. Chaj Doab	42	71	113	44	67	111	45	73	118	46	73	119	46	73	119	43	71	114	48	67	115	53	69	122
4. Rechna Doab	46	67	113	47	67	114	49	71	120	51	71	122	51	72	123	53	68	121	55	71	126	54	72	126
5. Bari Doab	43	55	98	46	59	105	46	62	108	47	57	104	50	61	111	50	58	108	52	62	114	55	61	116
6. Sutlej LB	41	46	87	40	54	94	40	60	100	41	48	89	47	52	99	45	41	86	45	54	99	49	53	102
7. Panjnad LB	41	40	81	44	42	86	44	45	89	40	41	81	47	42	89	47	40	87	48	43	91	50	45	95

	1968/69			1969/70			1970/71			1971/72			1972/73			1973/74			1974/75		
	K	R	A	K	R	A	K	R	A	K	R	A	K	R	A	K	R	A	K	R	A
1. Peshawar Vale	90	94	184	89	91	180	84	91	175	89	94	183	90	94	184	90	99	189	93	103	196
2. Thal Doab Indus RB	36	60	96	30	58	88	31	61	92	36	61	97	36	60	96	41	66	107	--	--	--
3. Chaj Doab	50	78	128	53	78	131	51	78	128	51	89	140	52	84	136	55	89	144	--	--	--
4. Rechna Doab	59	78	137	61	79	140	59	80	139	59	80	139	58	82	140	62	82	144			
5. Bari Doab	56	67	123	57	66	123	57	66	123	59	65	124	60	67	127	64	68	132			
6. Sutlej LB	47	57	104	47	56	103	47	58	105	49	53	102	50	53	103	54	56	110			
7. Panjnad LB	49	45	94	49	45	94	47	46	93	47	42	89	49	42	91	52	48	100			

K = Kharif R = Rabi A = Annual RB = Right Bank LB = Left Bank

ANNEX 4
Table 3

PAKISTAN

CROPPING INTENSITIES
SOUTHERN ZONE CANAL COMMAND GROUPS

Canal Command Group	1960/61			1961/62			1962/63			1963/64			1964/65			1965/66			1966/67			1967/68		
	K	R	A	K	R	A	K	R	A	K	R	A	K	R	A	K	R	A	K	R	A	K	R	A
7. Gudu Barrange	41.2	62.3	104	49.7	59.5	109	49.3	61.4	111	51.4	63.1	115	54.6	61.9	117	54.0	61.5	116	57.5	66.5	124	59.1	64.8	124
8. Sukkur Barrage RB	36.6	30.4	67.1	39.9	32.0	71.9	41.0	36.5	77.5	38.8	35.3	74.1	40.7	35.7	76.4	40.5	36.7	77.2	36.2	35.2	71.4	36.8	37.3	74.1
9. Sukkur Barrage LB	37.6	55.5	93.1	41.9	51.3	93.2	44.5	50.4	94.9	42.1	50.0	92	44.0	48.4	92	41.5	50.1	92	42.6	47.2	90	44.0	52.9	97
10. Kotri Barrage	50	26	76	54	28	82	55	29	84	52	28	80	54	30	84	46	26	72	43	28	71	54	27	81

	1968/69			1969/70			1970/71			1971/72			1972/73			1973/74		
	K	R	A	K	R	A	K	R	A	K	R	A	K	R	A	K	R	A
7. Gudu Barrage	52.4	61.5	114	46.7	57.1	104	41.4	52.5	94	60.9	45.9	107	62.0	57.1	119	64.0	51.5	115
8. Sukkur Barrage RB	34.5	30.2	64.7	33.7	47.9	81.6	31.0	36.1	67.0	34.9	34.0	68.9	35.8	32.9	68.7	37.6	38.0	75.6
9. Sukkur Barrage LB	39.0	67.4	99	37.0	42.3	79	35.5	45.3	81	43.2	42.8	86	43.1	41.2	84	47.6	40.7	88
10. Kotri Barrage	47	26	74	41	24	65	34	29	63	43	25	68	44	25	69	50	27	77

K = Kharif R = Rabi A = Annual RB = Right Bank LB = Left Bank

N.B. Minor discrepancies due to rounding.

ANNEX 4
Table 4

PAKISTAN

Average Crop Yields, Northern and Southern Zone Canal Commands

(Maunds per acre)

Crop	1960/61	1961/62	1962/63	1963/64	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72	1972/73	1973/74
Northern Zone:														
Cotton 1/	7.4	7.8	9.0	9.6	8.3	8.0	9.2	9.6	9.7	9.7	9.9	10.8	10.4	10.7
Rice 2/	11.6	10.3	10.7	10.5	12.0	10.1	11.9	12.9	14.6	16.1	14.7	15.9	15.9	17.1
Sugar cane 3/	299	353	365	360	402	386	370	408	441	466	393	391	407	414
Course grains	6.5	6.4	7.0	6.9	6.9	6.5	6.4	7.1	6.6	7.0	7.0	7.1	7.1	6.9
Wheat	10.7	10.7	11.1	11.5	12.0	10.4	11.7	15.1	15.1	16.3	14.6	15.9	16.4	16.2
Oil seeds	5.2	5.8	6.0	5.5	5.7	6.0	5.5	6.4	6.5	6.8	6.9	6.4	4.5	6.9
Grain legume	5.9	6.3	6.7	6.5	6.9	7.2	7.3	6.8	7.7	7.6	7.6	7.2	8.2	6.1
Southern Zone:														
Cotton 1/	7.9	7.2	8.1	8.4	7.6	10.7	9.8	9.7	10.1	10.6	11.2	12.5	14.6	14.6
Rice 2/	9.2	10.0	9.4	9.7	9.9	10.1	10.2	10.4	13.8	15.2	18.2	18.9	20.2	18.9
Sugar cane 3/	287	425	430	434	445	439	396	421	412	329	500	400	387	405
Course grains	5.6	5.5	6.0	6.2	6.5	6.2	6.1	6.2	6.5	7.3	6.4	7.1	6.5	6.7
Wheat	8.9	8.2	8.2	8.2	8.4	8.1	8.3	11.0	11.4	11.7	14.9	15.3	14.4	15.7
Oil seeds	4.9	5.8	6.3	5.0	5.0	4.6	5.3	6.5	6.2	5.9	6.3	6.1	6.1	6.4
Grain legume	5.5	4.8	4.9	5.0	5.0	5.9	6.7	7.1	5.7	5.3	5.4	5.2	5.3	5.1

Sources: Northern zone, Tables 6 to 12; Southern zone, Tables 13 to 16
(1) Seed cotton; (2) Cleaned rice; and (3) Cane

ANNEX 1
Table 5

PAKISTAN

CANAL GROUP 1 - PESHAWAR VALE - CROPS, PRODUCTION AND WATER

CCA 687,000 Acres

KHARIF

CROP		1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
COTTON	Area	-	-	-	-	-	-	3.0	3.0	3.7	3.0	2.3	1.8	2.0	1.8
	Yield							11.8	12.7	11.0	12.7	11.8	12.1	13.6	13.6
	Prod.							2.5	2.7	2.9	2.7	1.9	1.5	1.9	1.7
RICE	Area	5.0	4.0	7.0	4.0	5.0	11.7	4.0	5.0	7.0	7.0	6.1	5.5	5.5	4.8
	Yield	7.6	10.2	10.5	9.5	10.3	11.2	9.5	10.9	12.4	NR	12.0	13.4	14.4	14.2
	Prod.	1.4	1.5	7.7	1.4	1.9	1.8	1.4	2.0	3.2	NR	1.8	2.7	2.9	2.5
MAIZE	Area	339	339	346	336	335	NR	220	239	252	253	254	270	269	258
	Yield	9.7	9.9	9.1	10.0	10.7	NR	15.9	18.3	16.0	17.0	14.8	13.6	14.0	17.3
	Prod.	121	123	116	123	132	NR	129	161	148	158	158	135	138	164
BAJRA & JOWAR	Area	18	2	-	3	6	NR	13	17	18	16	2	0.5	(2)	2
	Yield	12.3				18		10.5	11.3	10.6	13.6				
	Prod.	5	1.3	2	2.4	4		5.0	7.0	7.0	8.0				
SUGARCANE	Area	140	134	151	159	162	172	181	155	156	164	158	170	166	173
	Yield	344	375	421	352	482	486	431	460	462	465	439	457	441	454
	Prod.	1769	1844	2335	2058	2869	3070	2868	2618	2647	2799	2550	2857	2688	2888
FRUIT	Area	(117)	(118)	(119)	(121)	(122)	(123)	117	115	(106)	(95)	86	87	101	(101)
OTHER CROPS	Area	(72)	(72)	(75)	(76)	(77)	(74)	(75)	(73)	(74)	(74)	(73)	(76)	(75)	(78)
TOTAL AREA		684	669	700	699	707	611	613	607	617	612	579	611	621	619
INTENSITY IN %		100	97	102	102	103	89	89	88	90	89	84	89	90	90
WATER IN MAF		1.19	1.54	1.38	1.18	1.40	1.52	1.12	1.24	1.43	1.21	1.29	1.86	1.39	1.46
TOTAL ANNUAL AREA		1240	1242	1296	1305	1329	1250	1257	1256	1265	1240	1204	1259	1266	1300
TOTAL ANNUAL INTENSITY IN %		180	181	189	190	193	182	183	183	184	180	175	183	184	189
TOTAL WATER IN MAF		1.98	2.32	2.25	2.00	2.18	2.40	2.07	2.33	2.27	2.01	2.02	2.92	2.43	2.33

RABI

CROP		1960/ 61	1961/ 62	1962/ 63	1963/ 64	1964/ 65	1965/ 66	1966/ 67	1967/ 68	1968/ 69	1969/ 70	1970/ 71	1971/ 72	1972/ 73	1973/ 74
WHEAT	Area	182	200	203	199	207	194	174	220	237	223	251	246	254	400
	Yield	11	11	10	10	11	9	8	12	13	13	9	15	14	13
	Prod.	74	81	77	74	80	62	54	93	113	109	79	134	126	128
OILSEEDS	Area	3.6	3.6	2.7	2.4	2.5	2.2	2.0	3.0	1.7	1.5	1.3	1.8	1.1	1.2
	Yield	3.0	2.3	5.0	2.3	3.3	6.1	5.4	7.3	6.4	5.4	6.3	6.1	7.4	6.8
	Prod.	0.5	0.3	0.5	0.2	0.3	0.5	0.4	0.8	0.4	0.3	0.3	0.4	0.3	0.3
SUGARCANE	Area	140	134	151	159	162	172	181	155	156	164	158	170	166	173
FRUIT	Area	(117)	(118)	(119)	(121)	(122)	(123)	119	115	(106)	(95)	86	87	101	(101)
TOBACCO	Area	35.5	39.4	39.4	43.5	44.7	71.3	94	78	68	67	73	62	44	56
	Yield	26.3	27.1	26.9	77.8	28		28	27	29	28	26	24	17	17
	Prod.	34.3	39.2	38.9	44.5	45.9		97	76	73	70	71	54	28	35
OTHER CROPS	Area	(78)	(78)	(84)	(81)	(82)	(76)	(76)	(78)	(79)	(78)	(76)	(79)	(79)	(82)
TOTAL AREA		556	573	596	606	620	639	644	649	648	628	625	648	645	681
INTENSITY IN %		81	83	87	88	90	93	94	94	94	91	91	94	94	99
WATER IN MAF		0.79	0.77	0.87	0.82	0.78	0.88	0.95	1.09	0.84	0.80	0.73	1.06	1.04	0.87

Notes:

1. Figures in parenthesis indicate either an estimated quantity because of the lack of official data or the official data appears anomolous, or usually, in the case of 'total cropped area' that the official figure is less than the sum of the crop acreages recorded in the Table for that particular year.

2. Areas - Thousand acres
   Yield - Maunds per acre
   Production - Thousand tons

3. Cotton: Yield data in maunds of seed cotton; production data in thousands of bales of raw cotton (lint) 1 bale = 392 lbs. net.

4. Rice: Yield and production as cleaned rice is taken at 62 percent in the case of the northern canal command groups.

5. Estimate of 'other crops' based on the following assumptions:

   (a) Fodder = 13 percent of total (cropped area minus other crops), perennial crops counted once only in the ratio K:R 36:52, then kharif fodder = 5.3 percent, Rabi fodder = 7.7 percent
   (See ISS Report, Vol. 7, Page 106, Table 2.41A)

   (b) Sugar beet equals 12 percent of sugarcane area
   (source: Govt. of NWFP 1974/75 data)

   (c) Unspecified = 2 percent of the CCA, i.e. 13.7 thousand acres.

ANNEX 4
Table 6

PAKISTAN

CANAL GROUP 2 - THAL DOAB - INDUS R.B., CROPS, PRODUCTION AND WATER

CCA 3.617 M. Acres

KHARIF

CROP		1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
COTTON	Area	132	135	146	185	225	220	226	254	245	260	287	375	396	346.1
	Yield	6.0	6.6	8.0	8.1	6.6	6.4	7.0	7.1	7.6	6.9	7.4	7.8	7.6	7.9
	Prod.	56	62.0	81.9	105.1	103.6	99.2	111.3	126.0	129.6	126.3	148.9	204.0	210.0	190.7
RICE	Area	100	95	80	87	83	87	90	95	139	117	102	86.6	104.2	95.7
	Yield	7.4	7.4	7.6	7.7	8.0	7.3	7.6	8.0	10.6	11.9	13.4	12.4	14.4	16.0
	Prod.	27.3	25.9	22.4	24.7	24.4	23.3	25.2	28.2	54.3	51.1	50.1	39.4	55.3	56.4
MAIZE	Area	25	21	21	23	23	23.6	27	30	35.6	36	66	90	92	90
	Yield	7.9	9.9	8.8	10.0	8.8	11.4	10.5	14.2	10.8	11.6	12.1	13.8	12.5	14.4
	Prod.	7.3	7.7	6.8	8.5	7.4	9.9	10.4	15.7	14.1	15.4	29.4	45.7	42.3	47.6
BAJRA & JOWAR	Area	179	208	187	171	215	178	338	193	171	195	204	212	210	203
	Yield	5.4	5.9	6.6	6.7	6.3	6.4	5.4	6.5	6.0	6.6	6.8	6.5	5.6	5.5
	Prod.	35.5	45	45	42	50	42	67	46	37.5	47	51	51	43	41
SUGARCANE	Area	64	69	85	77	65	90	110	95	99	125	140.5	126.3	121.8	139.0
	Yield	277.3	273.4	290.8	292.3	291.5	303.7	286.0	329.5	372.8	413.5	341.6	329.3	346.8	363.7
	Prod.	652	693	908	827	696	1004	1156	1150	1356	1899	1757	1528	1552	1857
FRUIT	Area	14.2	14.4	14.7	15.1	10.5	17.0	17.9	21.2	22.5	23.3	24.0	24.9	25.2	26.3
FODDER	Area	153.5	174	152	180	230	213	225	(244)	(263)	302	284	329	(329)	(370)
OTHER CROPS	Area	60.3	101.6	54.3	8.9	19.5	61.4	47.1	280.8	28.3	9.0	19.5	40.2	39.8	210.9
TOTAL AREA		728	818	740	747	871	888	1081	1002	1301	1067	1127	1284	1318	1481
INTENSITY IN %		20.1	22.6	20.5	20.7	24.1	24.6	29.9	27.7	36.0	29.5	31.2	35.5	36.4	40.9
WATER IN MAF		4.32	4.38	4.31	5.20	4.95	5.10	5.84	5.15	5.43	5.88	5.51	5.21	6.16	5.71
TOTAL ANNUAL AREA		2309	2435	2445	2407	2670	2670	2906	2950	3455	3172	3323	3485	3481	3867
TOTAL ANNUAL INTENSITY IN %		63.8	67.3	67.6	66.5	73.8	73.8	80.3	81.6	95.5	87.7	91.9	98.4	96.2	106.9
TOTAL WATER IN MAF		5.77	6.09	6.28	7.07	6.85	7.08	8.40	8.21	8.72	8.30	7.66	7.44	9.02	9.11

RABI

CROP		1960/ 61	1961/ 62	1962/ 63	1963/ 64	1964/ 65	1965/ 66	1966/ 67	1967/ 68	1968/ 69	1969/ 70	1970/ 71	1971/ 72	1972/ 73	1973/ 74
WHEAT	Area	1031.5	1046.2	1077.1	1066.6	1153.7	1141.6	1157	1371	1441	1449	1511	1464.8	1517.6	1541
	Yield	8.5	8.2	8.2	9.0	10.2	9.3	9.5	12.5	13.3	14.3	12.3	14.6	14.9	15.2
	Prod.	322.0	313.4	323.7	355.6	431.8	389.6	404.2	627.1	702.1	758.7	685.5	787.9	830.1	860.1
OILSEEDS	Area	89.1	49.5	64.0	59.5	60.9	50.2	64.0	64.0	45.3	75.3	76.8	74.0	77.6	86.5
	Yield	4.0	3.7	4.3	3.6	3.7	4.0	4.8	5.2	5.9	5.4	5.0	5.0	6.3	5.3
	Prod.	13.1	6.8	10.1	7.8	8.3	7.5	9.4	11.3	8.6	16.5	15.3	13.5	18.0	17.0
PULSES	Area	265	236	264	238	292	294	292	223	203	207	196	261	204	368
	Yield	5.5	5.5	5.8	6.2	6.7	6.6	6.8	6.8	8.8	8.5	8.3	7.0	8.6	5.8
	Prod.	53.7	47.5	55.8	54.4	72.2	70.8	72.7	56.0	65.3	64.4	59.6	66.9	64.4	79
FODDER	Area	147	173	158	180	172	158	168	41	(180)	192	212	250	(216)	(225)
SUGARCANE	Area	64	69	85	77	65	90	110	95	99	125	140.5	126.3	121.8	139.0
FRUIT	Area	- Included in other crops													
OTHER CROPS	Area	-	43.3	56.9	38.9	55.4	48.2	34.0	154.0	185.7	56.7	59.7	24.9	26	26.3
TOTAL AREA		1581	1617	1705	1660	1799	1782	1825	1948	2154	2105	2196	(2201)	2163	(2386)
INTENSITY IN %		43.7	44.7	47.1	45.9	49.7	49.3	50.5	53.9	59.6	58.2	60.7	60.9	59.8	66.0
WATER IN MAF		1.45	1.71	1.97	1.87	1.90	1.98	2.56	3.06	3.29	2.42	2.15	2.73	2.86	3.40

Notes:

1. Figures in parenthesis indicate either an estimated quantity because of the lack of official data or the official data appears anomolous, or usually, in the case of 'total cropped area' that the official figure is less than the sum of the crop acreages recorded in the Table for that particular year.

2. Areas - Thousand acres
   Yield - Maunds per acre
   Production - Thousand tons

3. Cotton: Yield data in maunds of seed cotton; production data in thousands of bales of raw cotton (lint) 1 bale = 392 lbs. net.

4. Rice: Yield and production as cleaned rice is taken at 62 percent in the case of the northern canal command groups.

ANNEX 4
Table 7

PAKISTAN

CANAL GROUP 3 - CHAJ DOAB, CROPS, PRODUCTION AND WATER

CCA 2.043 M. Acres

KHARIF

CROP		1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
COTTON	Area	294	304	288	328	347	290	279	293	272	260	238	258	267	190
	Yield	7.5	8.4	9.4	9.6	7.5	6.8	7.8	8.3	6.8	7.2	8.0	9.1	7.9	8.0
	Prod.	154	179	189	221	183	139	152	170	129	132	133	165	148	107
RICE	Area	100	106	122	111	125	119	123	142	182	195	160	146	146	145
	Yield	9.8	11.5	12.7	13.0	12.8	12.6	12.8	12.8	14.0	16.3	15.8	16.0	17.0	17.6
	Prod.	36	45	57	53	59	55	58	67	94	117	93	86	91	94
MAIZE	Area	74	68	70	70	64	70	77	81	86	90	88	88	88	84
	Yield	7.3	9.2	8.9	8.5	9.2	10.5	11.3	15.8	12.3	11.5	12.4	13.0	13.0	13.9
	Prod.	20	23	23	27	22	27	32	47	39	38	40	42	42	43
BAJRA & JOWAR	Area	171	171	159	162	160	150	149	157	151	153	161	167	173	179
	Yield	7.2	7.5	8.4	8.1	8.3	7.2	6.9	7.6	6.5	6.9	6.8	7.0	7.1	7.1
	Prod.	45	47	49	48	49	40	38	44	36	39	40	43	45	47
SUGARCANE	Area	73	75	97	95	93	108	128	115	127	162	169	145	137	163
	Yield	321.0	339.0	349.1	362.7	340.9	385.2	342.4	380.1	474.9	516.5	421.5	411.3	407.9	416.5
	Prod.	861	934	1244	1266	1165	1500	1610	1606	2216	3074	2617	2191	2053	2494
FRUIT	Area	24	26	29	29	30	34	36	38	38	37	37	37	37	39
FODDER	Area	141	142	161	152	155	(147)	138	(147)	(155)	172	143	163	(147)	(158)
OTHER CROPS	Area	-	-	-	-	-	-	40	237	16	6	42	40	60	173
TOTAL AREA		(877)	(892)	(926)	(947)	944	(869)	972	1082	1027	1075	1038	1045	1055	1131
INTENSITY IN %		43	44	45	46	46	43	48	53	50	53	51	51	52	55
WATER IN MAF		1.96	2.71	2.56	2.25	2.52	2.62	2.58	2.75	3.05	3.63	2.81	3.11	3.69	3.65
TOTAL ANNUAL AREA		(2336)	(2257)	(2424)	(2442)	(2431)	(2325)	2344	2493	2612	2675	2622	(2868)	(2778)	(2957)
TOTAL ANNUAL INTENSITY IN %		114	111	119	120	119	114	115	122	128	131	128	140	136	146
TOTAL WATER IN MAF		3.14	4.45	3.87	3.48	4.03	3.90	4.30	5.21	4.99	5.90	4.71	5.18	6.28	6.00

RABI

CROP		1960/ 61	1961/ 62	1962/ 63	1963/ 64	1964/ 65	1965/ 66	1966/ 67	1967/ 68	1968/ 69	1969/ 70	1970/ 71	1971/ 72	1972/ 73	1973/ 74
WHEAT	Area	674	640	732	722	736	722	727	776	888	892	899	915	942	956
	Yield	11.5	11.7	11.6	11.1	11.2	10.3	10.4	14.3	14.5	16.6	13.3	13.6	14.8	14.3
	Prod.	286	275	311	294	305	274	278	408	472	544	441	458	514	503
OILSEEDS	Area	53	22	31	33	27	21	22	22	19	25	25	30	36	32
	Yield	5.1	6.2	7.0	5.8	6.0	5.2	4.9	7.4	7.2	7.6	7.6	7.2	6.8	7.6
	Prod.	10	5	8	7	6	4	4	6	5	7	7	8	9	9
PULSES	Area	104	67	73	75	72	69	55	48	59	56	49	52	57	99
	Yield	7.1	6.7	7.4	6.9	7.9	6.7	5.9	5.7	7.8	8.3	7.2	7.8	8.1	6.6
	Prod.	27	16	20	19	21	17	12	10	17	17	13	15	17	24
FODDER	Area	531	535	536	541	529	502	356	(374)	(392)	428	405	644	(514)	(537)
SUGARCANE	Area	73	75	97	95	93	108	128	115	127	162	169	145	137	163
	Yield	321.0	339.0	349.1	362.7	340.9	385.2	342.4	380.1	474.9	516.5	421.3	411.3	407.9	416.5
	Prod.	861	934	1244	1266	1165	1500	1610	1606	2216	3074	2617	2191	2053	2494
FRUIT	Area	- Included in other crops													
OTHER CROPS	Area	24	26	29	29	30	34	84	76	100	37	37	37	37	39
TOTAL AREA		1315	1323	1381	1420	1399	1399	1372	1411	1585	1600	1384	1823	1723	1826
INTENSITY IN %		71	67	73	73	73	71	67	69	78	78	78	89	84	89
WATER IN MAF		1.18	1.74	1.31	1.23	1.51	1.28	1.72	2.46	1.94	2.27	1.90	2.07	2.59	2.35

Notes:

1. Figures in parenthesis indicate either an estimated quantity because of the lack of official data or the official data appears anomolous, or usually, in the case of 'total cropped area' that the official figure is less than the sum of the crop acreages recorded in the Table for that particular year.

2. Areas - Thousand acres
   Yield - Maunds per acre
   Production - Thousand tons

3. Cotton: Yield data in maunds of seed cotton; production data in thousands of bales of raw cotton (lint) 1 bale = 392 lbs. net.

4. Rice: Yield and production as cleaned rice is taken at 62 percent in the case of the northern canal command groups.

ANNEX 4
Table 8

PAKISTAN

CANAL GROUP 4 - RECHNA DOAB, CROPS, PRODUCTION AND WATER

CCA 4.731 M. Acres

KHARIF

CROP		1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
COTTON	Area	368	369	378	441	455	417	427	482	448	449	416	476	493	349
	Yield	7.7	8.0	8.6	9.7	7.5	7.1	7.7	8.3	6.7	7.4	7.9	9.5	8.5	8.6
	Prod.	198	208	228	300	240	207	239	279	211	232	231	316	293	211
RICE	Area	874	835	890	913	990	952	954	1000	1210	1234	1144	1083	1073	1118
	Yield	13.4	10.8	11.0	10.8	12.5	11.6	12.4	13.8	15.0	16.3	14.7	16.2	15.6	16.9
	Prod.	429	332	359	362	454	404	435	508	662	738	616	644	616	693
MAIZE	Area	188	194	197	202	204	205	217	244	233	244	240	238	238	226
	Yield	10.1	12.4	12.4	12.1	12.4	12.4	13.1	18.3	13.6	13.0	14.0	14.2	14.1	15.4
	Prod.	70	89	90	90	93	93	105	164	117	117	123	124	123	128
BAJRA & JOWAR	Area	119	124	120	123	121	116	116	124	117	123	126	123	126	119
	Yield	5.6	5.4	6.2	6.0	6.0	6.3	6.6	7.0	6.6	6.8	6.9	7.2	7.2	7.2
	Prod.	25	25	28	27	27	27	28	32	28	31	32	33	33	32
SUGARCANE	Area	313	321	362	356	355	419	442	350	353	391	408	354	339	390
	Yield	260	357	359	368	427	428	383	426	433	456	427	429	448	460
	Prod.	2990	4209	4776	4811	5564	6584	6212	5479	5618	6553	6401	5581	5580	6588
FRUIT	Area	19	19	20	21	23	25	29	33	27	26	24	21	21	22
FODDER	Area	260	266	274	303	308	358	347	(376)	(404)	460	428	429	(414)	(440)
OTHER CROPS	Area	23	96	66	46	51	22	58	254	-	-	-	22	59	269
TOTAL AREA		2164	2224	2307	2405	2507	2514	2590	2562	(2792)	(2927)	(2786)	2746	2763	2933
INTENSITY IN %		46	47	49	51	51	53	55	54	59	61	59	59	58	62
WATER IN MAF		5.0	5.62	6.09	7.30	8.04	7.97	7.66	8.11	7.71	8.76	7.73	8.30	9.67	10.77
TOTAL ANNUAL AREA		5298	5377	5640	5728	5896	5721	5949	5931	6452	6595	6540	6530	6608	6801
TOTAL ANNUAL INTENSITY IN %		112	114	120	121	123	121	126	125	137	140	139	139	139	144
TOTAL WATER IN MAF		8.05	9.14	9.80	11.58	12.36	12.29	12.54	14.17	12.62	14.12	13.19	14.10	16.17	17.60

RABI

CROP		1960/ 61	1961/ 62	1962/ 63	1963/ 64	1964/ 65	1965/ 66	1966/ 67	1967/ 68	1968/ 69	1969/ 70	1970/ 71	1971/ 72	1972/ 73	1973/ 74
WHEAT	Area	1744	1852	1833	1820	1869	1806	1879	2006	2364	2395	2420	2452	2548	2499
	Yield	10.6	10.5	11.2	11.6	12.4	11.0	12.3	15.4	15.4	16.9	14.5	15.9	16.6	16.4
	Prod.	681	714	755	772	853	728	846	1136	1338	1489	1287	1431	1555	1502
OILSEEDS	Area	96	86	91	73	67	72	99	101	112	77	89	154	107	95
	Yield	6.2	5.7	6.7	6.3	6.2	5.7	6.2	7.0	6.7	7.1	8.9	6.6	6.7	6.7
	Prod.	22	18	22	17	15	15	23	26	28	20	29	37	27	24
PULSES	Area	248	207	201	180	190	143	183	119	83	106	92	99	87	98
	Yield	7.1	7.5	7.5	8.1	7.7	7.7	7.9	7.0	7.8	7.6	8.1	7.3	8.5	6.9
	Prod.	65	57	56	53	54	41	53	31	24	30	27	26	27	25
FODDER	Area	637	643	695	723	718	666	700	(680)	(661)	623	708	631	(653)	(658)
SUGARCANE	Area	313	321	362	356	355	419	442	350	353	391	408	354	339	390
FRUIT	Area	- Included in other crops.													
OTHER CROPS	Area	96	44	[illegible]	171	190	101	56	613	103	124	51	94	111	128
TOTAL AREA		3134	3153	3333	3323	3389	3207	3359	3369	3675	3716	3768	3784	3845	3868
INTENSITY IN %		66	67	71	70	72	68	71	71	78	79	80	80	81	82
WATER IN MAF		3.05	3.52	3.71	4.28	4.32	4.32	4.88	6.04	4.91	5.36	5.44	5.80	6.50	6.83

Notes:

1. Figures in parenthesis indicate either an estimated quantity because of the lack of official data or the official data appears anomalous, or usually, in the case of 'total acropped area' that the official figure is less than the sum of the crop acreages recorded in the Table for that particular year.

2. Areas - Thousand acres
   Yield - Maunds per acre
   Production - Thousand tons

3. Cotton: Yield data in maunds of seed cotton; production data in thousands of bales of raw cotton (lint) 1 bale = 392 lbs. net.

4. Rice: Yield and production as cleaned rice is taken at 62 percent in the case of the northern canal command groups.

ANNEX 4
Table 9

PAKISTAN

CANAL GROUP 5 - BARI DOAB, CROPS, PRODUCTION AND WATER

CCA 5,826,00 Acres

KHARIF

CROP		1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
COTTON	Area	882	1090	1091	1243	1322	1325	1412	1512	1516	1597	1620	1752	1841	1777
	Yield	7.7	7.9	9.9	10.9	9.6	9.4	11.1	11.1	12.1	11.5	11.6	12.6	12.3	12.5
	Prod.	475	605	759	944	891	874	1097	1172	1274	1286	1312	1540	1579	1556
RICE	Area	213	233	282	251	151	243	221	272	347	332	306	280	289	317
	Yield	8.4	9.3	10.4	10.5	11.9	11.0	11.8	12.4	16.5	17.5	14.9	16.9	17.5	18.4
	Prod.	66	80	108	97	110	98	96	124	210	213	168	174	186	214
MAIZE	Area	116	111	100	99	108	105	119	138	148	150	149	142	144	143
	Yield	10.3	11.2	12.8	11.0	13.1	12.8	14.0	14.3	15.0	15.0	15.6	16.9	15.3	15.6
	Prod.	44	46	47	40	52	49	61	73	81	83	86	83	81	82
BAJRA & JOWAR	Area	198	183	171	155	214	167	165	172	134	127	116	119	109	115
	Yield	6.3	6.6	6.9	7.1	6.0	7.2	7.5	7.7	7.3	7.5	7.6	7.8	10.0	7.8
	Prod.	46	44	43	40	47	44	45	48	36	35	33	34	40	33
SUGARCANE	Area	217	209	242	204	204	260	269	224	216	235	246	201	187	234
	Yield	335	354	362	363	391	396	378	405	425	448	333	336	384	403
	Prod.	2674	2716	3217	2723	2930	2781	3732	3333	3371	3864	3013	2480	2641	3461
FRUIT	Area	58	58	59	59	59	64	62	65	56	57	58	59	61	63
FODDER	Area	587	631	636	631	670	669	708	(714)	(720)	712	694	801	(702)	(764)
OTHER CROPS	Area	205	154	104	97	82	88	74	656	819	90	143	69	178	307
TOTAL AREA		2477	2669	2685	2739	2910	2921	3030	3214	3216	3300	3332	3423	3509	3720
INTENSITY IN %		43	46	46	47	50	50	52	55	56	57	57	59	60	64
WATER IN MAF		6.66	7.22	7.63	8.26	8.71	9.15	9.57	9.34	10.21	11.55	10.02	10.81	11.38	12.70
TOTAL ANNUAL AREA		5702	6090	6287	6066	6439	6281	6613	6772	7188	7123	7175	7233	7389	7683
TOTAL ANNUAL INTENSITY IN %		98	105	108	104	111	108	114	116	123	122	123	124	127	132
TOTAL WATER IN MAF		9.87	11.15	11.12	12.05	12.84	12.79	14.22	16.00	15.87	16.79	14.89	16.14	18.75	19.61

RABI

CROP		1960/ 61	1961/ 62	1962/ 63	1963/ 64	1964/ 65	1965/ 66	1966/ 67	1967/ 68	1968/ 69	1969/ 70	1970/ 71	1971/ 72	1972/ 73	1973/ 74
WHEAT	Area	1749	1972	2064	2000	2111	2060	2143	2376	2608	2509	2524	2470	2550	2565
	Yield	12.2	12.0	13.0	13.2	13.4	11.9	13.9	17.6	17.7	18.7	17.3	19.0	19.2	18.6
	Prod.	783	872	979	973	1032	898	1093	1536	1652	1722	1601	1724	1802	1755
OILSEEDS	Area	120	122	153	96	116	92	155	147	104	119	144	186	185	128
	Yield	5.9	6.2	6.4	6.0	6.1	6.2	6.0	6.9	7.0	7.1	6.6	(6.8)	(7.0)	8.5
	Prod.	26	28	36	21	26	21	34	37	27	31	35	(46)	(48)	40
PULSES	Area	289	313	317	239	254	191	222	200	215	160	146	125	124	193
	Yield	5.9	6.3	7.0	7.1	7.0	8.9	8.4	6.5	7.3	6.5	7.7	8.5	7.2	6.0
	Prod.	63	72	82	62	65	62	69	48	58	38	41	39	33	42
FODDER	Area	485	405	445	419	440	673	694	(706)	(718)	743	725	769	(773)	(780)
SUGARCANE	Area	217	209	242	204	204	260	269	224	216	235	246	210	187	234
FRUIT	Area	- Included in other crops													
OTHER CROPS	Area	365	408	381	369	404	84	100	412	71	57	58	59	61	63
TOTAL AREA		3225	3429	3602	3327	3529	3360	3583	3558	3932	3823	3843	3810	3880	3963
INTENSITY IN %		55	59	62	57	61	58	62	61	67	66	66	65	67	68
WATER IN MAF		3.21	3.93	3.49	3.79	4.13	3.64	4.65	6.66	5.66	5.24	4.87	5.33	7.37	6.91

Notes:

1. Figures in parenthesis indicate either an estimated quantity because of the lack of official data or the official data appears anomolous, or usually, in the case of 'total cropped area' that the official figure is less than the sum of the crop acreages recorded in the Table for that particular year.

2. Areas - Thousand acres
   Yield - Maunds per acre
   Production - Thousand tons

3. Cotton: Yield data in maunds of seed cotton; production data in thousands of bales of raw cotton (lint) 1 bale = 392 lbs. net.

4. Rice: Yield and production as cleaned rice is taken at 62 percent in the case of the northern canal command groups.

ANNEX 4
Table 10

PAKISTAN

CANAL GROUP 6 - SUTLEJ L.B., CROPS, PRODUCTION AND WATER

CCA 2.051 M. Acres

KHARIF

CROP		1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
COTTON	Area	198	216	208	275	227	257	277	345	378	367	318	423	476	462
	Yield	6.8	6.7	5.2	5.5	5.0	4.6	5.7	7.6	5.8	7.7	8.1	9.3	8.5	8.6
	Prod.	94	102	75	105	80	82	110	183	153	198	181	276	282	279
RICE	Area	39	30	44	45	45	46	30	47	69	61	50	46	48	47
	Yield	6.6	7.6	8.2	8.2	8.5	6.9	8.2	8.9	11.2	12.3	12.2	10.1	13.6	14.7
	Prod.	10	8	13	13	14	12	9	15	29	28	22	19	24	26
MAIZE	Area	20	16	16	16	17	16	18	20	21	20	16	15	16	17
	Yield	9.0	10.7	10.4	11.0	11.0	9.9	10.0	14.2	10.5	12.1	13.3	13.3	13.3	14.6
	Prod.	7	6	6	7	7	6	7	11	8	9	8	8	8	9
BAJRA & JOWAR	Area	140	135	126	126	206	163	192	185	140	137	135	118	121	117
	Yield	6.2	6.6	6.7	6.6	7.9	5.3	6.4	6.6	6.4	6.7	7.0	6.9	7.2	7.2
	Prod.	32	33	31	30	60	32	45	45	33	34	35	30	32	31
SUGARCANE	Area	77	94	102	93	64	87	105	64	81	108	111	68	61	89
	Yield	304.0	341.7	368.3	360.0	331.7	369.2	319.9	396.8	450.6	475.0	300.1	299.8	351.2	340.1
	Prod.	860	1180	1380	1230	780	1180	1234	933	1341	1885	1224	749	787	1112
PULSES	Area	44	33	34	32	42	30	36	42	30	13	42	42	34	37
	Yield	4.3	3.2	3.2	4.2	4.5	5.4	6.0	5.8	4.5	4.2	5.8	5.8	4.8	4.1
	Prod.	7	4	4	5	7	6	8	9	5	2	9	9	6	7
FRUIT	Area	14	14	14	15	15	16	17	18	14	14	13	13	13	13
FODDER	Area	286	238	248	216	232	189	183	(176)	(168)	153	150	241	(185)	(199)
OTHER CROPS	Area	24	39	25	42	109	111	73	195	73	101	138	39	77	127
TOTAL AREA		842	815	817	860	957	915	931	995	974	974	973	1005	1031	1108
INTENSITY IN %		41	40	40	41	47	45	45	49	47	47	47	49	50	54
WATER IN MAF		1.79	2.45	2.27	2.27	2.31	2.23	2.33	2.79	2.90	3.04	2.68	2.47	2.52	3.26
TOTAL ANNUAL AREA		1778	1921	2041	1845	2019	1765	2039	2083	2150	2123	2154	2099	2111	2254
TOTAL ANNUAL INTENSITY IN %		87	94	100	90	98	86	99	102	105	104	105	102	103	110
TOTAL WATER IN MAF		2.51	3.41	3.40	3.00	3.08	2.90	3.34	4.21	3.97	4.30	3.72	3.56	4.20	4.81

RABI

CROP		1960/ 61	1961/ 62	1962/ 63	1963/ 64	1964/ 65	1965/ 66	1966/ 67	1967/ 68	1968/ 69	1969/ 70	1970/ 71	1971/ 72	1972/ 73	1973/ 74
WHEAT	Area	473	594	575	521	574	487	549	621	710	649	652	597	646	645
	Yield	9.9	10.3	10.4	9.6	10.1	8.0	9.0	12.7	11.5	13.7	13.0	12.9	13.4	13.4
	Prod.	173	225	219	184	214	143	181	290	299	327	311	282	317	318
OILSEEDS	Area	69	87	153	80	106	57	161	147	104	109	138	181	138	168
	Yield	4.3	5.9	5.9	5.4	5.6	5.2	5.1	5.9	6.3	6.3	6.5	6.3	6.3	6.3
	Prod.	11	19	33	16	22	11	30	32	24	26	33	42	32	39
PULSES	Area	145	219	273	184	202	94	173	123	142	122	129	111	100	105
	Yield	6.6	6.3	6.6	5.8	6.2	4.9	6.0	6.8	6.7	6.9	6.5	6.1	6.8	5.9
	Prod.	35	51	66	39	46	17	38	31	35	31	31	25	25	23
FODDER	Area	107	98	97	92	101	109	103	(114)	(125)	147	138	124	(122)	(126)
SUGARCANE	Area	77	94	102	93	64	87	105	64	81	108	111	68	61	89
	Yield	304.0	341.7	368.3	360.0	331.7	369.2	319.9	396.8	450.6	475.0	300.1	299.8	351.2	340.1
	Prod.	860	1180	1380	1230	780	1180	1234	933	1341	1885	1224	749	787	1112
FRUIT	Area - Included in other crops.														
OTHER CROPS	Area	65	14	24	15	15	16	17	19	14	14	13	13	13	13
TOTAL AREA		936	1106	1224	985	1062	850	(1108)	(1088)	(1176)	(1149)	(1181)	(1094)	(1080)	(1146)
INTENSITY IN %		46	54	60	48	52	41	54	53	57	56	58	53	53	56
WATER IN MAF		0.72	0.96	1.13	0.73	0.77	0.67	1.01	1.42	1.07	1.26	1.04	1.09	1.68	1.55

Notes:

1. Figures in parenthesis indicate either an estimated quantity because of the lack of official data or the official data appears anomolous, or usually, in the case of 'total cropped area' that the official figure is less than the sum of the crop acreages recorded in the Table for the particular year.

2. Areas - Thousand acres
   Yield - Maunds per acre
   Production - Thousand tons

3. Cotton: Yield data in maunds of seed cotton; production data in thousand of bales of raw cotton (lint) 1 bale = 392 lbs. net.

4. Rice: Yield and production as cleaned rice is taken at 62 percent in the case of the northern canal command groups.

ANNEX 4
Table 11

PAKISTAN

CANAL GROUP 7 - PANJNAD L.B., CROPS, PRODUCTION AND WATER

CCA 1.455 M. Acres

KHARIF

CROP		1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
COTTON	Area	314	295	317	203	339	319	333	361	343	350	335	393	411	248
	Yield	7.4	7.7	9.0	9.0	8.2	8.0	8.0	9.0	11.2	10.7	9.5	11.4	10.6	10.3
	Prod.	163.2	158.2	199.4	127.9	195.2	178.2	186.1	226.9	270.0	261.7	223.0	313.5	305.0	179.2
RICE	Area	21	24	24	22	20	22	23	28	39	37	21	17	29	31
	Yield	8.0	8.4	8.5	9.5	9.9	10.0	9.9	9.9	13.2	14.5	13.9	13.1	13.9	15.2
	Prod.	6.2	7.4	7.5	7.7	7.3	8.1	8.4	10.7	18.9	19.7	10.7	8.2	14.8	17.3
MAIZE	Area	17	17	18	18	21	21	27	31	33	29	29	24	24	19
	Yield	7.8	9.9	8.9	8.3	9.9	9.5	9.7	17.0	15.7	13.0	14.0	14.5	14.0	14.9
	Prod.	4.9	6.2	5.9	5.5	7.6	7.3	9.6	19.4	19.0	13.9	14.9	12.8	12.3	10.4
BAJRA & JOWAR	Area	90	101	90	77	107	82	97	102	92	90	95	88	85	75
	Yield	6.4	6.2	6.7	6.7	6.1	6.0	6.2	6.7	6.5	6.7	7.4	7.4	7.4	7.6
	Prod.	21	23	22	19	24	18	22	25	22	22	26	24	23	21
SUGARCANE	Area	56	82	87	75	75	115	106	72	87	95	94	61	58	74
	Yield	251.7	357.8	390.1	389.0	372.4	379.4	359.8	383.0	499.9	524.9	330.1	340.0	339.8	330.0
	Prod.	518	1078	1247	1072	1026	1603	1401	1013	1598	1832	1140	762	724	897
FRUIT	Area	7.3	8.1	8.9	9.7	10.5	11.6	12.7	11.0	14.4	16.6	18.8	21.7	22.2	23.2
FODDER	Area	51	83	79	67	88	77	77	(73)	(69)	61	66	65	(64)	(68)
OTHER CROPS	Area	43.7	24.9	20.1	105.3	18.5	32.4	26.3	93	28.6	26.4	20.2	20.3	21.8	21.8
TOTAL AREA		600	635	644	577	679	680	702	728	706	705	679	690	715	760
INTENSITY IN %		41.2	43.6	44.3	39.7	46.7	46.7	48.2	50.0	48.5	48.5	46.7	47.4	49.1	52.2
WATER IN MAF		2.00	2.70	2.59	2.22	2.45	2.25	2.42	2.62	2.41	2.41	2.33	1.91	2.41	2.47
TOTAL ANNUAL AREA		1154	1241	1291	1173	1288	1245	1331	1382	1350	1364	1339	1294	1332	1443
TOTAL ANNUAL INTENSITY IN %		82	85	89	81	89	88	91	95	94	94	92	89	91.5	100.0
TOTAL WATER IN MAF		2.55	3.44	3.36	2.82	3.21	2.65	3.08	3.67	2.94	3.08	3.04	2.42	3.23	3.51

RABI

CROP		1960/ 61	1961/ 62	1962/ 63	1963/ 64	1964/ 65	1965/ 66	1966/ 67	1967/ 68	1968/ 69	1969/ 70	1970/ 71	1971/ 72	1972/ 73	1973/ 74
WHEAT	Area	315	336	345	323	342	302	346	398	409	387	393	368	382	408
	Yield	10.0	10.5	12.1	12.5	13.0	10.0	12.0	15.8	15.5	15.5	14.5	10.7	14.0	14.1
	Prod.	115.2	129.8	153.8	148.5	163.4	111.2	152.5	226.3	232.3	220.4	209.4	145.1	197.3	211.3
OILSEEDS	Area	38	39	54	38	40	28	43	38	38	44	30	59	52	79
	Yield	4.9	6.7	6.1	5.8	6.4	5.4	5.5	6.5	6.4	6.8	7.0	6.9	6.8	6.9
	Prod.	6.9	9.6	12.2	8.1	9.4	5.6	8.7	9.1	9.0	11.0	13.0	15.0	13.0	20.0
PULSES	Area	98.2	52.4	52.3	61.7	38.2	24.3	32.0	29.0	25.8	26.3	27.8	18.8	18.7	35.6
	Yield	2.2	5.6	5.9	2.7	5.9	7.6	9.1	7.8	8.0	7.8	7.1	7.1	14.8	6.4
	Prod.	7.8	10.8	11.3	6.1	8.4	6.8	10.7	8.3	7.6	7.5	7.3	4.9	10.2	8.4
FODDER	Area	72	83	90	90	95	86	86	(84)	(82)	90	82	79	(74)	(81)
	Yield														
	Prod.														
SUGARCANE	Area	56	82	87	75	75	115	106	72	87	95	94	61	58	74
	Yield	251.7	357.8	390.1	389.0	372.4	379.4	359.8	383.0	499.9	524.9	330.1	340.0	339.8	330.0
FRUIT	Area	- Included in other crops.													
OTHER CROPS	Area	7.3	13.6	18.7	8.9	18.8	10.5	16.0	11.2	14.4	16.6	18.8	21.7	32.3	23.2
TOTAL AREA		547	606	647	596.6	609	565.8	629	654	656	659	666	608	617	701
INTENSITY IN %		40.3	41.6	44.5	41.0	41.9	48.9	43.2	44.9	45.3	45.3	45.8	41.8	42.4	48.2
WATER IN MAF		0.55	0.74	0.77	0.60	0.76	0.40	0.66	1.05	0.53	0.67	0.71	0.51	0.82	1.04

Note:

1. Figures in parenthesis indicate either an estimated quantity because of the lack of official data or the official data appears anomolous, or usually, in the case of 'total cropped area' that the official figure is less than the sum of the crop acreages recorded in the Table for that particular year.

2. Areas - Thousand acres
   Yield - Maunds per acre
   Production - Thousand tons

3. Cotton: Yield data in maunds of seed cotton; production data in thousands of bales of raw cotton (lint) 1 bale = 392 lbs. net.

4. Rice: Yield and production as cleaned rice is taken at 62 percent in the case of the northern canal command groups.

ANNEX 4
Table 12

PAKISTAN

CANAL GROUP 8 - CHAK BARRAGE, CROPS, PRODUCTION AND WATER

CCA 1,598 M. Acres

KHARIF

CROP		1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
COTTON	Area	9.4	9	8	10	16	28	53	84	(80)	(77)	72	154	167	207
	Yield	5.3	5.8	6.6	5.7	4.1	6.6	6.5	6.8	(7.0)	(7.9)	9.1	12.9	14.3	14.2
	Prod.	3.7	3.7	3.7	4.0	4.6	13	24	36	(39)	(43)	46.3	139	167.1	205
RICE	Area	483	550	593	622	672	661	686	626	552	486	428	692	599	619
	Yield	10.7	10.7	10.2	10.8	11.3	11.4	11.3	11.9	(10.3)	(10.3)	18.5	18.6	23.3	19.0
	Prod.	190	217	222	248	280	276	286	274	(285)	(291)	392	426	514	433
MAIZE	Area	1	-	-	-	-	-	0.9	-	-	-	6	2	6	5
	Yield	10.9	-	-	-	-	-	5.4	-	-	-	4.5	6.4	6.0	6.0
	Prod.	0.4	-	0.2	1.1	1.1	-	0.2	-	-	-	1	0.5	1.3	1.1
BAJRA & JOWAR	Area	163	234	183	187	183	173	174	230	(199)	(176)	108	141	148	131
	Yield	7.5	5.5	5.3	6.1	6.1	6.3	6.2	5.8	(6.3)	(6.8)	7.4	7.5	6.6	7.5
	Prod.	66.7	47.7	35.9	42.2	47.3	39.6	39.8	48.7	(46)	(44)	29.5	39	36	36
SUGARCANE	Area	2	2	3.7	2.8	1.8	2.7	4.4	3.7	(5.8)	(7.9)	10	5	11	12
	Yield	231.4	244.9	286.9	311.1	302.4	272.2	284.6	331.1	(330)	(330)	332.1	310.1	299.4	306
	Prod.	17	18	39	32	20	27	46	45	(70)	(96)	122	57	121	135
FRUIT	Area	---------- Not Available ----------										39	49	60	48
FODDER	Area	---------- Not Available ----------													
TOTAL AREA		658.9	795	787.7	821.8	872.8	863.7	918.3	943.7	(837)	(747)	661	973	991	102.2
INTENSITY IN %		41.2	49.7	49.3	51.4	54.6	54.0	57.5	59.1	(52.4)	(46.7)	41.4	60.9	62.0	64.0
WATER IN MAF		2.74	3.02	3.15	3.49	4.11	4.38	4.54	4.33	4.13	4.88	4.70	4.81	5.32	4.63
TOTAL ANNUAL AREA		1655	1746	1749	1830	1863	1846	1981	1979	(1819)	(1659)	1500	1706	1903	1845
TOTAL ANNUAL INTENSITY IN %		104	109	111	115	117	116	124	124	(114)	(104)	94	107	119	115
TOTAL WATER IN MAF		2.88	3.16	3.61	3.75	4.45	4.71	5.36	4.96	4.79	5.74	5.32	5.93	6.19	5.50

RABI

CROP		1960/ 61	1961/ 62	1962/ 63	1963/ 64	1964/ 65	1965/ 66	1966/ 67	1967/ 68	1968/ 69	1969/ 70	1970/ 71	1971/ 72	1972/ 73	1973/ 74
WHEAT	Area	327	324	328	319	370	321	315	354	(320)	(283)	245	231	295	234
	Yield	7.6	7.9	7.5	7.8	8.2	7.8	7.8	9.9	(10.4)	(10.9)	11.3	11.1	12.9	12.7
	Prod.	92	94	90	91	111	92	90	129	(122)	(113)	102	94	137	109
OILSEEDS	Area	95	85	129	131	106	139	156	162	(147)	131	111	66	72	82
	Yield	4.0	4.5	4.8	4.1	4.4	4.3	4.8	6.0	(5.2)	4.4	5.5	5.1	4.9	5.0
	Prod.	16	16	22.8	19.8	17	21.8	27.8	33.8	(28.1)	21	22.6	12.5	13	15
PULSES	Area	572	540	521	555	513	494	582	516	(509)	421	449	402	507	467
	Yield	5.9	5.5	5.5	5.5	5.4	5.9	7.1	7.1	(6.6)	6.0	6.0	5.8	5.9	5.8
	Prod.	124.5	110	105	112.7	101.5	108	147.6	134.7	(123.5)	93	98.6	86.4	110	99
FODDER	Area	N.A.	N.A.	19.8	23.8	N.A.	25.8	24.8	-	-	44	24	23	25	26
	Yield														
	Prod.														
SUGARCANE	Area	2	2	3.7	2.8	1.8	2.7	4.4	3.7	(5.8)	(7.9)	10	5	11	12
	Yield	331.4	244.9	286.9	311.1	302.4	272.2	284.6	331.1	(330)	(330)	332.1	310.1	299.4	306
	Prod.	17	18	39	32	20	27	46	45	(70)	(96)	122	57	121	135
FRUIT	Area	---------- Not Available ----------										3.8	7	8	1.8	1.8
OTHER CROPS	Area	---------- Not Available ----------														
TOTAL AREA		996	951	981.7	1007.8	989.8	982.5	1062.2	1035.7	(982)	(912)	839	733	911.8	822.3
INTENSITY IN %		62.3	59.5	61.4	63.0	61.9	61.5	66.5	64.8	(61.5)	(57.1)	(52.5)	45.9	57.1	51.5
WATER IN MAF		0.14	0.14	0.46	0.26	0.34	0.33	0.82	0.63	0.59	0.86	0.65	0.52	0.66	0.87

Notes:

1. Figures in parenthesis indicate either an estimated quantity because of the lack of official data or the official data appears anomalous, or usually, in the case of 'total cropped area' that the official figure is less than the sum of the crop acreages recorded in the Table for that particular year.

2. Areas - Thousand acres
   Yield - Maunds per acre
   Production - Thousand tons

3. Cotton: Yield data in maunds of seed cotton; production data in thousands of bales of raw cotton (lint) 1 bale = 392 lbs. net.

4. Rice: Yield and production as cleaned rice is taken at 72 percent in the case of the southern canal command groups.

ANNEX 4
Table 13

PAKISTAN

CANAL GROUP 9 - SUKKER BARRAGE L.B., CROPS, PRODUCTION AND WATER (1960-1973)

CCA 4.705 M. Acres

KHARIF

CROP		1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
COTTON	Area	855.3	882.3	800.3	795.4	715.6	827.0	851.0	880.7	1051.3	942.8	716.5	875.4	887.9	927.1
	Yield	7.9	7.2	8.1	8.4	7.5	10.7	9.6	9.7	(10.3)	(10.8)	(11.4)	12.3	14.7	14.9
	Prod.	474.1	443.1	454.1	469.1	377.1	620.5	589.9	599.2	(758)	(713)	(571)	759	918	969
RICE	Area	180	187	195	211	211	184	170	206	65.3	67.5	94	143	162	174
	Yield	7.7	8.7	8.0	8.0	8.4	8.5	8.6	9.1	8.5	12.0	16.5	17.8	18.5	18.3
	Prod.	51	60	57	62	65	58	54	69	20.4	30.0	57	94	110	117
MAIZE	Area	12.9	13.9	16.3	15.7	22.7	36.7	26.7	31.7	12.7	24.7	43.2	47.6	37.7	38.9
	Yield	6.3	6.7	7.3	7.6	5.3	5.5	5.9	7.2	5.4	5.9	5.6	5.7	5.3	6.2
	Prod.	3.0	3.4	4.4	4.4	4.4	7.4	4.9	8.4	2.5	5.4	8.9	9.9	7.4	8.9
BAJRA & JOWAR	Area	493.7	593.9	656	570.7	702.5	573.6	380.4	403.8	202.5	251.1	345.1	307.9	320.3	308.8
	Yield	4.8	5.2	6.0	6.2	6.4	6.1	6.0	6.8	6.9	7.1	6.4	7.3	6.7	6.8
	Prod.	87.1	113.1	144	129.1	166	129	84	96.1	51.4	65.1	80.8	83.0	79.0	76.9
SUGARCANE	Area	47.2	58.7	112.9	88.3	113.8	132.9	128.4	63.2	148	156	119.1	115.6	121.7	158.4
	Yield	439.7	435.8	434.3	436.4	441.6	447.3	400.6	429.2	416.6	307.1	524.0	401.5	394.7	407.1
	Prod.	962.4	939.7	1801.3	1415.8	1846.4	2184.1	1889.7	996.6	2265	1767	2292.7	1705.0	1764.6	2369.3
FRUIT	Area	(47)	(47)	(49)	(52)	(54)	(56)	(59)	(61)	(64)	(66)	(68)	(71)	(73)	(75)
FODDER	Area	(87)	(95)	(98)	(92)	(77)	(96)	(86)	(87)	(81)	(79)	(72)	(82)	(84)	(88)
TOTAL AREA		1723.1	1877.8	1927.5	1825.1	1916.6	1906.2	1701.5	1733.4	1624.8	1587.1	1457.9	1642.5	1686.6	1770.2
INTENSITY IN %		36.6	39.9	41.0	38.8	40.7	40.5	36.2	36.8	34.5	33.7	31.0	34.9	35.8	37.6
WATER IN MAF		4.77	4.99	5.27	5.61	6.01	6.52	6.67	6.46	6.50	6.93	7.25	7.50	7.83	7.73
TOTAL ANNUAL AREA		3154.8	3382.6	3646.6	3485.1	3595.2	3632.4	3359.9	3487.5	3045.3	3839.9	3154.7	3241.6	3233.3	3556.9
TOTAL ANNUAL INTENSITY IN %		67.1	71.9	77.5	74.1	76.4	77.2	71.4	74.1	64.7	81.6	67.0	68.9	68.7	75.6
TOTAL WATER IN MAF		9.38	8.54	8.94	10.41	10.34	11.00	11.24	11.43	11.37	11.80	11.54	11.70	12.90	12.83

RIBI

CROP		1960/61	1961/62	1962/63	1963/64	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72	1972/73	1973/74
WHEAT	Area	755.2	825.1	788.2	804.2	1012.1	936.1	919.2	1114.8	755.3	1463.3	1055.2	976.8	937.0	1078.8
	Yield	9.7	8.6	8.7	8.7	8.8	9.0	8.5	11.0	12.3	11.9	16.3	16.8	15.0	16.1
	Prod.	269.8	261.4	251.3	256.5	325.8	309.9	285.5	486.9	342.3	638.7	633	601.4	519.4	638.7
OILSEEDS	Area	295.3	288	421	312.5	174.7	243.2	205.8	201.1	204	183.4	156.5	162.7	146	162.5
	Yield	5.5	6.6	6.9	5.6	5.8	5.2	6.0	6.7	6.9	7.1	7.1	7.0	7.0	7.1
	Prod.	59.2	70.2	106.3	64.3	37.3	46.4	45.5	50.7	52.4	48.1	40.8	42.3	37.4	42.5
FULSES	Area	104	90	99	94	110	115	109	90	70.2	64.1	53	44	43	56
	Yield	5.5	2.8	4.3	4.8	5.1	6.9	6.5	6.1	4.3	-	6.3	5.6	5.6	(5.6)
	Prod.	21	9	15.5	16.5	20.5	29.5	26.2	20.3	11.2	-	12.3	9.5	9.4	11.5
FODDER	Area	(183)	(192)	(249)	(309)	(214)	(243)	(237)	(224)	(179)	(320)	(245)	(229)	(226)	(256)
	Yield														
	Prod.														
SUGARCANE	Area	47.2	58.7	112.9	88.3	113.8	132.9	128.4	63.2	148	156	119.1	115.6	121.7	158.4
	Yield														
	Prod.														
FRUIT	Area	(47)	(47)	(49)	(52)	(54)	(56)	(59)	(61)	(64)	(65)	(58)	(71)	(73)	(75)
TOTAL AREA		1431.7	1504.8	1719.1	1660.0	1678.6	1726.2	1658.4	1754.1	1420.5	2252.8	1696.8	1599.1	1546.7	1786.7
INTENSITY IN %		30.4	32.0	36.5	35.3	35.7	36.7	35.2	37.3	30.2	47.9	36.1	34.0	32.9	38.0
WATER IN MAF		4.60	3.56	3.67	4.80	4.33	4.48	4.57	4.96	4.87	4.87	4.29	4.19	5.07	5.10

Notes:

1. Figures in parenthesis indicate either an estimated quantity because of the lack of official data or the official data appears anomolous, or usually, in the case of 'total cropped area' that the official figure is less than the sum of the crop acreages recorded in the Table for that particular year.

2. Areas - Thousand acres
   Yield - Maunds per acre
   Production - Thousand tons

3. Cotton: Yield data in maunds of seed cotton; production data in thousands of bales of raw cotton (lint) 1 bale = 392 lbs. net.

4. Rice: Yield and production as cleaned rice is taken at 72 percent in the case of the southern canal command groups.

ANNEX 4
Table 14

PAKISTAN

CANAL GROUP 10 - SUKKUR BARRAGE R. B., CROPS, PRODUCTION AND WATER

CCA 1.354 M. Acres

KHARIF

CROP		1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
COTTON	Area	4.5	4.8	14.5	1.8	2.4	3.2	6.3	5.9	2.6	2.3	2.0	8.0	9.8	17.0
	Yield	3.8	3.6	5.1	2.4	2.4	4.9	5.2	7.9	(7.5)	(7.1)	(6.6)	(5.9)	9.2	9.9
	Prod.	1.2	1.2	5.2	0.3	0.4	1.1	2.3	3.3	(1.4)	(1.1)	(0.9)	(3.3)	6.3	11.8
RICE	Area	456	504	515	519	518	498	523	493	(473)	453	432	525	519	569
	Yield	10.7	11.7	11.3	11.3	11.2	11.3	11.1	11.6	(15.7)	15.2	18.5	19.3	17.7	18.8
	Prod.	179	216	213	216	213	206	213	211	(273)	(253)	294	373	338	394
MAIZE	Area	0.1	0.3	1.3	1.3	1.0	-	-	1.3	0.6	0.3	1.0	1.0	2.0	1.0
	Yield	NR	NR	NR	NR	NR	-	-	NR	4.5	5.4	NR	NR	NR	NR
	Prod.	NR	NR	NR	NR	NR	-	-	NR	0.1	0.6	NR	NR	NR	NR
BAJRA & JOWAR	Area	44.7	50.9	62.2	40.6	67.4	52.2	39.7	49.9	49	32.0	36.4	41	44	45
	Yield	7.1	7.2	8.2	7.2	6.7	7.1	7.7	6.5	6.1	6.4	5.8	5.8	5.4	5.5
	Prod.	(11.7)	13.6	18.7	10.7	16.6	13.7	11.2	12.0	11	7.5	7.7	7.7	8.1	9.1
SUGARCANE	Area	4.1	8	10	7	7	9	8	45	8	8	4	4	4	7
	Yield	342	342	340	383	378	361	382	411	327	391	395	354	354	354
	Prod.	55	107	140	101	100	122	118	684	96	115	58	52	52	91
FRUIT	Area	----------Not Available----------									5.9	4.6	4.9	4.3	4.2
FODDER	Area	----------Not Available----------										1.0	1.7	1.0	1.3
TOTAL AREA		509.4	568.0	603.0	569.7	595.8	562.4	577.0	595.1	(533.2)	(501.5)	481.0	585.6	584.1	644.5
INTENSITY IN %		37.6	41.9	44.5	42.1	44.0	41.5	42.6	44.0	39.0	37.0	35.5	43.2	43.1	47.6
WATER IN MAF		2.79	2.82	3.12	3.14	3.67	3.58	3.50	3.48	3.69	3.96	3.77	3.78	4.03	3.68
TOTAL ANNUAL AREA		1260	1262	1285	1249	1252	1240	1216	1311	1210	1075	1094	1166	1142	1196
TOTAL ANNUAL INTENSITY IN %		93.1	93.2	94.9	92	92	92	90	97	89	79	81	86	84	88
TOTAL WATER IN MAF		4.16	3.97	4.61	4.33	4.84	4.85	4.80	4.88	5.13	5.45	5.19	5.02	5.55	5.27

RABI

CROP		1960/ 61	1961/ 62	1962/ 63	1963/ 64	1964/ 65	1965/ 66	1966/ 67	1967/ 68	1968/ 69	1969/ 70	1970/ 71	1971/ 72	1972/ 73	1973/ 74
WHEAT	Area	316	257	233	240	272	266	262	305	(287)	261	244	219	218	229
	Yield	8.2	7.3	7.5	7.3	7.5	4.8	8.2	9.6	10.6	11.2	12.5	13.1	13.3	14.4
	Prod.	95	69	64	64	75	48	79	108	112	107	112	106	106	121
OILSEEDS	Area	78	66	78	62	51	64	64	61	(56)	(51)	45	43	41	30
	Yield	4.0	4.8	5.5	4.3	4.1	3.9	4.4	6.2	5.5	5.2	5.2	4.5	5.1	6.0
	Prod.	12	12	16	10	7.8	9	10	14	(11)	9.7	9	7	8	7
PULSES	Area	213	223	225	235	196	222	212	175	(196)	217	195	198	188	177
	Yield	4.1	3.9	3.8	3.9	4.1	5.1	5.7	7.5	4.0	4.1	4.5	4.1	4.2	3.7
	Prod.	32	32	32	34	30	42	44	48	(29)	33	32	30	29	24
FODDER	Area	(140)	(140)	136	(135)	(130)	117	93	(130)	(130)	130	120	111	103	104
	Yield														
	Prod.														
SUGARCANE	Area	4	8	10	7	7	9	8	45	8	8	4	4	4	7
	Yield														
	Prod.														
FRUIT	Area	----------Not Available----------									5.9	4.6	4.9	4.3	4.2
TOTAL AREA		751	694	682	679	656	678	639	716	(677)	(573)	613	580	558	551
INTENSITY IN %		55.5	51.3	50.4	50.0	48.4	50.1	47.2	52.9	50.0	42.3	45.3	42.8	41.2	40.7
WATER IN MAF		1.37	1.15	1.48	1.19	1.18	1.27	1.29	1.40	1.44	1.49	1.42	1.24	1.51	1.58

Notes:

1. Figures in parenthesis indicate either an estimated quantity because of the lack of official data or the official data appears anomolous, or usually, in the case of 'total cropped area' that the official figure is less than the sum of the crop acreages recorded in the Table for that particular year.

2. Areas - Thousand acres
   Yield - Maunds per acre
   Production - Thousand tons

3. Cotton: Yield data in maunds of seed cotton; production data in thousands of bales of raw cotton (lint) 1 bale = 392 lbs. net.

4. Rice: Yield and production as cleaned rice is taken at 72 percent in the case of the southern canal command groups.

PAKISTAN

CANAL GROUP 11 - GHULAM MOHAMMED BARRAGE (KOTRI): CROPS, PRODUCTION AND WATER 1960-61 to 1973-74

CCA 1.323 M. Acres

KHARIF

CROP		1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
COTTON	Area	146	147	112	111	110	127	124	146	(129)	(113)	96	100	112	138
	Yield	8.4	7.2	8.4	8.9	8.3	11.3	10.7	9.9	(10.6)	11.1	11.5	13.0	14.3	13.7
	Prod.	86	74	66	69	64	100	93	101	(96)	(88)	77	91	112	132
RICE	Area	371	366	371	429	412	358	311	405	(354)	(304)	253	354	340	369
	Yield	6.2	7.1	6.5	7.0	6.8	7.0	7.1	7.4	(10.7)	(1.4)	17.4	19.0	19.1	19.3
	Prod.	84	96	89	109	103	92	81	110	(139)	(156)	162	247	238	261
MAIZE	Area	3	3	3	3	3	3	3	3	(3)	(3)	4	4	3	7
	Yield	-	5.3	6.1	5.0	5.0	5.0	5.0	5.0	(5.2)	(5.3)	5.4	4.9	4.3	4.3
	Prod.	-	0.6	0.6	0.6	0.6	0.6	0.6	0.6	(0.6)	(0.6)	1.5	1.5	1.0	2.0
BAJRA & JOWAR	Area	80	69	83	47	98	48	49	78	(64)	(50)	35	39	36	41
	Yield	5.2	5.9	5.9	6.4	6.1	6.8	6.7	5.7	(5.6)	(5.5)	5.4	7.0	7.6	6.0
	Prod.	15.4	15	18	11	22	12	12	16	(13)	(10)	7	10	10	9
SUGARCANE	Area	4	7	18	15	40	30	36	7	(14)	(21)	27	34	42	62
	Yield	468	455	469	467	472	444	398	446	(455)	(464)	474	414	393	925
	Prod.	67	122	310	252	697	491	521	113	(234)	(358)	463	523	610	962
FRUIT	Area	----------Not Available----------										11	18	21	19
FODDER	Area	-	-	14	13	NA	9	11	1	(2)	(3)	4	5	9	9
OTHER CROPS	Area	53	122	133	76	56	30	34	71	(57)	(42)	22	19	20	22
TOTAL AREA		657	714	734	694	719	605	568	711	(623)	(536)	448	573	585	667
INTENSITY IN %		50	54	55	52	54	46	43	54	(47)	(41)	34	43	44	50
WATER IN MAF		3.95	3.08	3.67	4.57	3.44	4.81	4.87	3.45	4.28	3.80	3.90	4.50	5.40	5.33
TOTAL ANNUAL AREA		1006	1089	1122	1058	1116	950	932	1068	(981)	(854)	835	907	917	1029
TOTAL ANNUAL INTENSITY IN %		76	82	84	80	84	72	71	81	(74)	(65)	63	68	69	77
TOTAL WATER IN MAF		4.47	3.42	4.30	5.31	4.40	5.65	6.09	4.88	5.45	5.11	4.86	5.34	6.50	6.68

RABI

CROP		1960/61	1961/62	1962/63	1963/64	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72	1972/73	1973/74
WHEAT	Area	149	117	117	130	171	179	191	230	(211)	191	195	156	148	135
	Yield	9.1	8.6	8.6	8.2	8.5	8.7	11.1	(12.1)	(13.1)	14.2	15.4	15.6	15.1	16.3
	Prod.	50	37	37	39	51	56	61	94	(94)	(92)	102	88	82	81
OILSEEDS	Area	42	51	93	47	25	36	30	26	(26)	27	29	21	20	33
	Yield	4.2	4.6	6.1	4.1	4.1	3.8	3.9	6.3	(6.3)	(6.3)	6.3	5.8	6.0	5.9
	Prod.	6.5	8.7	20.8	7.1	3.7	5.0	4.3	6.0	(6)	(6)	6.6	4.4	4.4	7.2
PULSES	Area	20	18	19	16	18	23	21	18	(20)	22	53	36	45	52
	Yield	7.1	4.8	3.9	4.6	5.0	5.2	5.1	5.9	(4.9)	(3.9)	2.9	2.8	3.0	3.1
	Prod.	5.2	3.2	2.7	2.7	3.3	4.4	3.9	3.9	(3.6)	(3.2)	5.7	3.7	4.9	5.9
FODDER	Area	-	-	34	(30)	(30)	23	26	4	(26)	30	28	30	30	32
	Yield														
	Prod.														
SUGARCANE	Area	4	7	18	15	40	30	36	7	(14)	(21)	27	34	42	62
	Yield	468	455	469	467	472	444	398	446	-	-	474	414	393	425
	Prod.	67	122	310	252	697	491	521	113	-	-	468	523	610	962
FRUIT	Area	----------Not Available----------									(27)	18	21	19	21
OTHER CROPS	Area	134	182	107	(126)	(113)	54	60	72	(41)	-	37	36	30	27
TOTAL AREA		349	375	388	364	397	345	364	357	(338)	(318)	387	334	334	362
INTENSITY IN %		26	28	29	28	30	26	28	27	(26)	(24)	29	25	25	27
WATER IN MAF		0.52	0.34	0.63	0.74	0.96	0.83	1.21	1.42	1.18	1.32	0.97	0.84	1.10	1.35

Notes:

1. Figures in parenthesis indicate either an estimated quantity because of the lack of official data or the official data appears anomolous, or usually, in the case of 'total cropped area' that the official figure is less than the sum of the crop acreages recorded in the Table for that particular year.

2. Areas - Thousand acres
   Yield - Maunds per acre
   Production - Thousand tons

3. Cotton: Yield data in maunds of seed cotton; production data in thousands of bales of raw cotton (lint) 1 bale = 392 lbs. net.

4. Rice: Yield and production as cleaned rice is taken at 72 percent in the case of the southern canal command groups.

ANNEX 4
Table 16

PAKISTAN

PERCENTAGE CHANGES IN CROP PRODUCTION

Crop	Northern Zone						Southern Zone						Total: Northern and Southern Zones					
	1960/61-64/65		1965/66-69/70		1970/71-73/74		1960/61-64/65		1965/66-69/70		1970/71-73/74		1960/61-64/65		1965/66-69/70		1970/71-73/74	
	% increase 1/	Growth rate %/Year 1/	% increase 2/	Growth rate %/Year 2/	% increase 3/	Growth rate %/Year 3/	% increase 1/	Growth rate %/Year 1/	% increase 2/	Growth rate %/Year 2/	% increase 3/	Growth rate %/Year 3/	% increase 1/	Growth rate %/Year 1/	% increase 2/	Growth rate %/Year 2/	% increase 3/	Growth rate %/Year 3/
Rice 4/	15.1	3.6	93.9	18.0	14.6	4.7	31.2	6.9	15.6	3.7	65.1	18.2	22.6	5.4	53.8	11.4	30.6	9.3
Cotton 5/	48.5	10.4	41.8	9.1	13.1	4.2	-21.1	-4.9	15.0	3.6	89.6	24.0	25.5	5.8	33.3	7.4	31.3	7.1
Sugarcane	45.6	9.8	23.6	5.5	3.2	1.1	195.6	31.0	-17.2	-4.0	20.9	6.5	57.6	12.0	18.0	4.2	5.6	1.4
Coarse grains 6/	17.1	4.0	-1.8	-0.4	-3.5	-1.2	58.0	12.1	-29.2	-6.6	4.5	1.5	39.0	8.6	-11.0	-2.6	-1.7	-0.4
Wheat	26.9	6.1	99.7	18.9	14.4	4.6	11.0	2.6	87.4	17.0	1.7	0.6	23.8	5.5	97.6	18.6	12.2	3.9
Oilseeds 7/	-3.3	-0.8	57.7	12.1	33.0	10.0	-28.3	-6.4	3.6	0.9	-15.3	-4.9	-19.0	-4.4	28.8	6.6	4.2	1.0
Pulses	6.4	1.6	-12.6	-3.0	12.3	4.0	-15.3	-3.6	-23.4	-5.4	-6.0	-2.0	2.8	0.3	-17.5	-4.1	4.0	1.0

1/ Base 1960/61.

2/ Base 1965/66.

3/ Base 1970/71

4/ Cleaned rice.

5/ Cotton lint.

6/ Bajra, Jowar and Maize

7/ Excludes cotton seed.

ANNEX 4
Table 17

ANNEX 4
Table 18

PAKISTAN

Economic Value of Production, 1960/61 - 1973/74

	1960/61	1961/62	1962/63	1963/64	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72	1972/73	1973/74	Increase 1960-73 Value	%
Southern Zone																
Gross Economic Value	6,722	6,890	6,973	7,148	7,836	8,033	7,776	9,455	8,976	8,732	7,837	9,476	11,170	11,579	4,857	72
Fertilizer Costs	30	32	35	36	32	57	69	144	177	284	319	364	410	483		
Seed Costs 1/	270	276	279	286	313	321	311	567	538	524	470	569	670	695		
Labor Costs	137	160	170	200	220	220	231	270	310	350	400	480	560	626		
Animal Power Costs	297	350	400	450	500	550	598	600	600	600	600	700	820	960		
Net Economic Value	6,988	6,073	6,089	6,176	6,771	6,885	6,567	7,874	7,351	6,974	6,048	7,363	8,710	8,815	1,827	26
Northern Zone																
Gross Economic Value	13,973	15,286	17,247	17,441	17,841	17,336	19,687	23,412	25,560	27,686	25,252	27,024	27,855	27,260	13,287	95
Fertilizer Costs	130	130	132	240	316	225	376	606	750	907	778	1,124	1,280	800		
Seed Costs	559	611	690	698	714	693	787	1,405	154	1,661	1,515	1,621	1,673	1,636		
Labor Costs	435	500	550	600	650	700	770	900	1,090	1,200	1,354	1,500	1,720	1,858		
Animal Power Costs	863	1,040	1,220	1,400	1,680	1,760	1,845	1,980	2,100	2,250	2,340	2,640	3,040	3,346		
Net Economic Value	11,986	13,005	14,655	14,503	14,481	13,958	15,909	18,521	21,466	21,668	19,265	20,139	20,172	19,620	7,634	63
Total Gross Value	20,695	22,176	24,220	24,589	25,677	25,369	27,463	32,867	34,537	36,419	33,089	36,501	39,025	38,839	18,144	88
Total Net Value	18,974	19,078	20,744	20,679	21,252	20,843	22,476	26,395	28,817	28,642	25,313	27,502	28,882	28,435	9,461	50

1/ 4% of gross value up to 1966/67, 6% thereafter.

PAKISTAN

FERTILIZER SALES BY CANAL COMMAND GROUPS, 1965/66-1974/75, NORTHERN ZONE

(Nutrient tons x 10^3)

Canal Command Group	1965/66				1966/67				1967/68				1968/69			
	N	P	K	T	N	P	K	T	N	P	K	T	N	P	K	T
1. Peshawar Vale	3.2	0.3	-	3.5	6.6	0.2	-	8.8	16.0	1.1	-	17.1	13.3	3.1	0.4	16.7
2. Thal Doab - Indus R.B.	5.8	-	-	5.8	7.4	tr	-	7.4	13.0	1.0	0.9	14.9	17.4	2.6	tr	20.0
3. Chaj Doab	5.7	0.2	-	5.9	7.3	0.2	-	7.5	11.9	0.9	tr	13.0	10.8	3.2	tr	14.0
4. Rechna Doab	17.9	0.4	-	18.3	25.4	1.0	tr	26.4	31.1	2.7	tr	33.0	44.4	8.9	tr	52.6
5. Bari Doab	16.1	0.3	-	16.4	30.7	1.2	tr	31.9	48.6	3.3	tr	51.0	47.7	10.4	tr	59.0
6. Sutlej L.B.	2.9	-	-	2.9	4.0	-	-	4.0	8.1	0.4	-	9.0	12.2	2.2	tr	14.0
7. Panjnad L.B.	2.2	-	-	2.2	4.8	0.2	tr	5.0	6.3	0.3	tr	7.0	10.2	1.3	-	12.0
Total Northern Zone Command	53.8	1.2	-	55.0	86.2	2.8	tr	91.0	135.0	9.7	0.9	145.0	156.0	31.7	0.4	188.3

Canal Command Group	1969/70				1970/71				1971/72				1972/73				1973/74				1974/75			
	N	P	K	T	N	P	K	T	N	P	K	T	N	P	K	T	N	P	K	T	N	P	K	T
1. Peshawar Vale	19.3	3.4	0.1	22.7	12.1	2.2	tr	14.5	24.0	2.2	tr	27.1	24.4	3.2	tr	27.6	19.7	2.6	tr	22.3	18.4	2.3	0.2	20.7
2. Thal Doab - Indus R.B.	15.9	1.6	tr	17.2				12.6				16.2	13.2	2.2	tr	13.7	23.2	3.7	tr	27.8	25.3	3.7	0.1	29.0
3. Chaj Doab	14.4	1.3	tr	15.4				13.8				18.2	21.1	1.9	0.1	23.2	16.5	3.9	1.5	21.9	19.1	3.6	0.1	22.8
4. Rechna Doab	59.7	6.4	tr	67.6				58.6				66.6	79.2	9.6	1.0	89.8	61.7	10.9	0.5	73.1	74.5	11.6	0.6	86.7
5. Bari Doab	69.7	9.7	0.2	80.0				76.0				112.0	106.5	14.6	0.4	121.0	84.7	13.2	0.7	98.6	93.9	14.9	0.5	109.3
6. Sutlej L.B.	10.6	1.7	tr	12.0				9.0				14.0	15.2	1.6	tr	17.0	14.4	1.0	tr	15.0	16.1	1.7	tr	17.8
7. Panjnad L.B.	12.1	1.6	-	14.0				13.0				21.0	18.3	1.7	tr	20.0	11.9	1.7	0.1	14.0	16.4	2.0	0.1	16.0
Total Northern Zone Command	201.7	25.7	0.2	228.9				183.0				248.0	277.9	34.8	1.6	313.3	232.1	37.0	2.8	272.7	263.9	38.7	1.6	302.3

Sources and Compilation notes.

1. tr = less than 100 tons
2. Canal Group 6b. Panjnad L.B. Rahimyar Khan District only
3. Canal Group 2 to 6 b (except for D - I Khan District in Canal Group 2.
4. All Canal Groups 1965/66 - 1969-70, 1972/73 - Federal Directorate of Agricultural Supplies
5. Peshawar Vale 1970/71, 71/72, 73/74, 74/75 and D.I. Khan District in Canal Group 2.
6. Canal Group 2 to 6b for years 1972/73 - 74/75 Punjab Agricultural Supplies and Development Corporation. Retail Sails

Source 1967/68 to 1974/75 Development statistics of the Punjab Oct 1975 Govt. of Punjab Lahore
1965/66 to 1966/67 " " " " " Nov 1972 " "
Government of NWFP

ANNEX 4
Table 19

PAKISTAN

FERTILISER SALES BY CANAL COMMAND GROUPS 1965/66 - 1974/75, SOUTHERN ZONE

(Nutrient - tons x 10^3)

Canal Command Group	1965/66				1966/67				1967/68				1968/69				1969/70				1970/71				1971/72				1972/73				1973/74			
	N	P	K	T	N	P	K	T	N	P	K	T	N	P	K	T	N	P	K	T	N	P	K	T	N	P	K	T	N	P	K	T	N	P	K	T
8. Gudu Barrage	0.7	-	-	0.7	0.8	tr	tr	0.9	2.4	0.2	tr	2.6	2.5	0.7	tr	3.2	6.5	0.5	-	5.0	4.6	0.4	tr	5.0	7.8	0.9	-	8.7	15.0	1.3	tr	16.3	7.3	0.4	tr	7.7
9. Sukkur Left Bank	9.5	-	-	9.5	10.6	0.5	tr	11.1	22.4	1.6	tr	24.1	27.3	3.5	0.7	31.6	45.9	4.8	tr	50.9	47.0	5.9	0.4	53.4	55.1	4.7	0.1	59.9	63.0	7.8	tr	71.1	70.3	16.6	0.2	87.3
10. Sukkur Right Bank	1.0	-	-	1.0	1.4	0.1	tr	1.5	3.8	0.2	tr	4.0	4.9	0.5	tr	5.5	5.7	0.4	-	6.1	13.5	0.7	tr	14.4	9.9	1.1	-	11.1	10.6	1.5	tr	12.4	8.0	1.3	tr	9.3
11. G.M. (Kotri) Barrage	2.8	-	-	2.8	3.0	0.4	tr	3.4	5.9	0.4	tr	6.3	6.2	1.1	0.2	7.5	9.5	0.9	tr	10.6	13.8	1.5	0.2	15.5	14.2	1.3	tr	15.7	15.5	1.4	tr	17.0	16.1	4.2	0.3	20.6
Total Southern Zone Command	14.0	-	-	14.0	15.8	1.0	tr	16.9	34.5	2.4	tr	37.0	40.9	5.8	0.9	47.8	67.6	6.6	tr	72.6	78.9	8.5	0.6	88.3	87.0	8.0	0.1	95.4	104.1	12.0	tr	116.8	101.7	22.5	0.5	124.9

Sources and Compilation Notes

Sources. Federal Directorate of Agricultural Supplies, Lahore.
1974/75 data. Ministry of Food, Agriculture and Under Developed Areas

West Pakistan Agricultural Supplies organisation

Sind Agricultural Supply organisation.

Minor discrepencies due to rounding.

tr - less than 100 tons

ANNEX 4
Table 20

PAKISTAN

AVERAGE FERTILIZER APPLICATION RATES
NORTHERN ZONE CANAL COMMAND GROUPS

YEAR	Peshawar Vale			Thal Doab-Indus R.B.			Chaj Doab			Rechna Doab			Bari Doab			Sutlej L.B.			Panjnad L.B.		
	Area Main Crops Acres x 10^3 1/	Fertiliser Supplied Nutrient Tons x 10^3	Average Application rate (lbs/acre)	Area Crops Acres x 10^3 2/	Fertiliser Supplied Nutrient Tons x 10^3	Average Application rate (lbs/acre)	Area Main Crops Acres x 10^3 2/	Fertiliser Supplied Nutrient Tons x 10^3	Average Application rate (lbs/acre)	Area Main Crops Acres x 10^3 2/	Fertiliser Supplied Nutrient Tons x 10^3	Average Application rate (lbs/acre)	Area Main Crops Acres x 10^3 2/	Fertiliser Supplied Nutrient Tons x 10^3	Average Application rate (lbs/acre)	Area Main Crops Acres x 10^3 2/	Fertiliser Supplied Nutrient Tons x 10^3	Average Application rate (lbs/acre)	Area Main Crops Acres x 10^3 2/	Fertiliser Supplied Nutrient Tons x 10^3	Average Application rate (lbs/acre)
1965/66	854	3.5	9	1791	5.8	7	1480	5.9	9	3487	18.3	12	4252	16.4	9	1113	2.9	6	889	2.2	6
1966/67	872	8.8	23	2012	7.4	8	1505	7.5	11	4134	26.4	14	4484	31.9	16	1347	4.0	6	975	5.0	11
1967/68	875	17.1	44	2102	14.9	16	1586	13.0	18	4307	33.0	17	4841	51.0	24	1429	9.0	14	1030	7.0	15
1968/69	900	16.7	42	2175	20.0	21	1725	14.0	18	4837	52.6	24	5073	59.0	26	1503	14.0	21	1041	12.0	26
1969/70	898	22.7	57	2257	17.2	17	1777	15.4	19	4913	67.6	31	5069	80.0	35	1451	12.0	19	1032	14.0	30
1970/71	883	14.5	37	2388	12.6	12	1789	13.8	17	4843	58.6	27	5105	76.0	33	1420	9.0	14	1017	13.0	29
1971/72	930	27.1	65	2429	16.2	15	1749	18.2	23	4880	66.6	31	5150	112.0	49	1408	14.0	22	1010	21.0	47
1972/73	910	27.6	68	2470	13.7	12	1739	23.2	30	4924	89.8	41	5305	121.0	51	1506	17.0	25	1041	20.0	43
1973/74	938	22.3	53	2502	27.8	25	1749	21.9	28	4796	73.1	34	5279	98.6	42	1545	15.0	22	934	14.0	34
1974/75	978	20.7	47	NA	29.0	--	NA	22.8	--	NA	86.1	---	NA	109.3	--	NA	17.8	--	NA	16.0	--

1/ Excludes fruit and 'other' crops.

2/ Includes cotton, rice, sugar cane, coarse grains, wheat and oilseeds only.

ANNEX 4
Table 21

PAKISTAN

Average Fertilizer Application Rates, Southern Zone Canal Command Groups

Year	Gudu Barrage			Sukkur Right Bank			Sukkur Left Bank			Kotri Barrage		
	Area Main Crops Acres x 10^3 1/	Fertiliser Supplied Nutrient Tons x 10^3	Average Application Rate lbs./Acre	Area Main Crops Acres x 10^3 1/	Fertiliser Supplied Nutrient Tons x 10^3	Average Application Rate lbs./Acre	Area Main Crops Acres x 10^3 2/	Fertiliser Supplied Nutrient Tons x 10^3	Average Application Rate lbs./Acre	Area Main Crops Acres x 10^3 1/	Fertiliser Supplied Nutrient Tons x 10^3	Average Application Rate lbs./Acre
1965/66	1013	0.7	1.5	776	1.0	2.9	2323	9.5	9.2	694	2.8	9.0
1966/67	1058	0.9	1.9	799	1.5	4.2	2274	11.1	10.9	662	3.4	11.5
1967/68	1068	2.6	5.4	849	4.0	10.6	2465	24.1	21.9	788	6.3	17.9
1968/69	958	3.2	7.5	1006	5.5	12.2	2223	31.6	31.8	708	7.5	23.7
1969/70	854	5.0	13.1	724	6.1	18.9	2813	50.9	40.5	629	10.6	37.7
1970/71	755	5.0	14.8	682	14.4	47.3	2141	53.4	55.9	572	15.5	60.7
1971/72	1012	8.7	19.2	756	11.1	32.9	2274	59.9	59.0	644	15.7	54.6
1972/73	1072	16.3	34.1	750	12.4	37.0	2254	71.1	70.6	642	17.0	59.3
1973/74	1072	7.7	16.1	822	9.3	25.3	2501	87.3	78.2	704	20.6	65.5

1/ Includes rice, cotton, sugar cane and wheat only.

2/ Includes rice, cotton, sugar cane, wheat and oilseeds only.

ANNEX 4
Table 22

PAKISTAN

Probable average applications of fertilizer to wheat.

Punjab Canal Commands 1967/68 - 1974/75.

	1967/68	1968/69	1969/70	1970/71	1971/72	1972/73	1973/74	1974/75
Sales, Nitrogen. Nutrient tons	49397	61654	93462	71848	81966	108759	123600	144423
Sales, Phosphate. Nutrient tons	4392	15164	16453	10775	12670	13040	21692	25809
Sales, Potash. Nutrient tons	70	48	433	128	118	418	126	754
Irrig.Wheat. acres x 10^3	7,524	8,379	8,255	8,353	8,222	8,538	8,536	8,294
Average application rate,	N.14.7	N.16.5	N.25.4	N.19.3	N.22.3	N.28.3	N.32.4	N.39
Lbs. nutrient per acre	P. 1.3	P. 4.1	P. 4.5	P. 2.9	P. 3.5	P. 3.4	P. 5.7	P. 7
N : P_2O_5	11:1	4:1	6:1	7:1	6:1	8:1	6:1	5.6:1

Note: Totals for the Punjab; it being assumed that insignificant quantities are applied to purely rainfed wheat.

ANNEX 4
Table 23

PAKISTAN

Relative Importance of Fodder Crops in Punjab
Per cent of Cropped Area

Canal Command Group	1960/61	61/62	62/63	63/64	64/65	65/66	66/67	67/68	68/69	69/70	70/71	71/72	72/73	73/74	Average Kharif: Rabi Ratio
No. 2 Thal Doab-Indus R.B.															
Kharif	21	21	21	24	26	24	21	24	20	28	25	26	25	25	
Rabi	9	11	9	11	10	9	9	9	8	9	10	12	10	10	1:0.4
Annual	13	14	13	15	15	14	14	14	13	16	15	17	16	16	
No. 3 Chaf Doab															
Kharif	17	16	17	17	16	18	14	14	15	16	14	16	14	14	
Rabi	37	40	37	37	36	35	26	11	25	27	26	36	31	31	1:1.8
Annual	29	30	29	25	29	28	21	12	20	23	21	29	24	24	
No. 4 Rechna Doab															
Kharif	12	12	12	13	12	14	13	15	15	16	15	16	15	15	
Rabi	20	20	21	22	21	21	21	20	18	17	19	17	17	17	1:1.4
Annual	17	17	17	18	17	18	18	18	17	16	17	16	16	14	
No. 5 Bari Doab															
Kharif	24	24	24	23	23	23	23	22	22	22	21	23	20	21	
Rabi	15	12	12	13	12	20	19	19	18	20	19	20	20	20	1:0.8
Annual	19	17	17	17	17	21	21	21	20	20	20	22	20	20	
No. 6 Sutlej Left Bank															
Kharif	34	29	30	25	24	21	20	18	17	16	15	24	18	18	
Rabi	11	9	8	9	10	15	11	11	12	15	13	12	12	12	1:0.5
Annual	22	17	17	17	16	18	15	14	15	15	14	18	15	15	
No. 7 Panjnab Left Bank															
Kharif	9	13	12	12	13	11	11	10	10	9	10	9	9	9	
Rabi	13	14	14	15	16	15	14	13	13	14	12	13	12	12	1:1.3
Annual	11	13	13	13	14	13	12	11	11	11	11	11	10	10	

ANNEX 4
Table 24

PAKISTAN

A REVIEW OF THE INDUS BASIN PROJECT, 1960-1975

Population and Employment in Pakistan

1. The population in Pakistan increased from 42 million in 1960 to 72.5 million in 1975, which implies an annual growth rate of 3.7% (Table 1). The increase has resulted partly from immigration but mainly from a high natural growth rate. The present natural growth rate is estimated at about 3.5% per annum.

2. The urban population increased by 5% annually from 23% to 27% of the total population, leaving an annual growth rate of 3.5% for the rural population (see Table 1). The rural population can be further divided into farming and non-farming; the farming population increased by 2.7%, leaving an annual growth rate of 5.2% for the non-farming population in rural areas. The farming population can be further divided into farm operators and landless laborers. The provisional data of the latest agricultural census show that the number of farm holdings has decreased and so has the number of operators. It may therefore be concluded that the number of landless laborers has increased considerably.

3. The limited cultivable area is not likely to provide adequate employment opportunities for the growing numbers of landless laborers and non-farming population in rural areas, and a further concentration of job seekers is to be expected in the urban centers.

4. The income per capita rose from Rs. 400 in 1965 to Rs. 1,445 in 1974/75. The consumer price index rose during the same period from 100 to 270. Expressed in constant 1974/75 US dollars, the income per capita rose from US$106 to US$147. A closer look at the development of incomes reveals, however, that the income per capita had been increasing up to the early seventies but levelled off thereafter as shown below:

	1965	1971/72	1973/74	1974/75
GNP/capita (current Rs.)	400	794	1,185	1,445
Consumer price index	100	152	217	270
GNP/capita (constant 74/75 dollars)	106	142	149	147

5. The agricultural sector contributes about 36% to the Gross National Product, while the farming population makes up between 50 to 60% of the total. The income disparity factor is about 0.60.

Table 1--Total and Farming Population in Pakistan, 1960-1975

	1960	Annual Growth Rates	1975
Population (million)			
Pakistan	42.0	3.7% /a	72.5
Punjab	25.0	3.4%	40.9
Population Growth rate	2%		3.0-3.5%
Urban Population, Pakistan	23%	5.0%	27%
Rural Population, Pakistan	77%	3.5%	73%
Farming Population	60%	2.7%	52%
Number of Farms (million):			
Pakistan	4.86		3.76 /b
Punjab	3.33		2.38 /b

/a Including migration.

/b Provisional data from 1972 Pakistan Census of Agriculture.

Note: The discrepancy between the increase in farming population and the decrease in number of farms at the same time may be attributed to the fact that about one million small tenant-farmers or landless laborers cultivating less than 2.5 acres have not been accounted for in the 1972 Census.

PAKISTAN

A REVIEW OF THE INDUS BASIN PROJECT, 1960-1975

Economic Analysis

1. The analysis of agriculture, water supply and power over the period 1960-75 provided much of the data needed to assess the role and value of IBP in economic terms.

2. The questions addressed were:

- what incremental water supply for agriculture can be attributed to IBP, and what was its value;
- what was the magnitude of the benefits resulting from development at Mangla; and
- what was the cost of the water supplied by the IBP works, and how did the cost compare with its value.

The Incremental Volume of Water Attributable to IBP

3. Rabi Season: The analysis of surface water supplies showed that on average an increase in deliveries (over and above replacement) had occurred in the month of November. The increase amounted to 0.3 MAF, and could be attributed to the success of Mangla in regulating flows on the Jhelum River.

4. Kharif Season: River flows in the kharif are very variable. In the period since Mangla became operational, they have been more than usually variable. The seven years have included the single highest flow ever, and two of the lowest. It was, therefore, difficult to make judgments on the effects of IBP works. It appears that kharif supplies have been maintained, and may have increased slightly in some CCGs. Owing to the shortness and untypical nature of the review period, no precise estimate of IBP effects in excess of replacement has been attempted.

5. The Value of Incremental Water Supply in Rabi: The agricultural and water delivery data were sufficiently detailed to allow regression analysis. The variable which has been affected by IBP--water deliveries in November--was found to correlate well with cropped acreage in rabi. This was expected, since water deliveries in November allow land preparation. The regression equation indicated that one extra acre foot of water resulted

in 0.4 1/ extra acres being planted. Thus, the effect of the increased average water deliveries of 0.3 MAF was to increase cropped area by 0.12 million acres. The average per acre net value of production in rabi was Rs. 870 (Annex 4). Thus, the unit value of extra water in November is Rs. 350 per acre foot, and the total value of the extra water supplied is approximately Rs. 105 million.

The Magnitude of the Benefits from Power

6. The power benefits were measured in terms of the savings in investment O&M and fuel costs resulting from the use of hydro-power compared to thermal alternatives. Based on the known cost of the thermal station at Llyalpur (adjusted to 1975 prices), and the actual energy sent out from Mangla, it was possible to estimate the investments in thermal stations which would have provided the power available from Mangla. The alternative cost streams are shown in Table 13 of Annex 2. The savings are substantial, and, at an opportunity cost of capital of 10%, they justify 70% of the cost of Mangla Dam.

The Unit Cost of Water Supplied by IBP

7. The unit cost of water was estimated separately for kharif and rabi because the components of the project works which are used in each season are different. The investment costs for rabi and kharif water are shown in Table 1.

8. Kharif Water: In kharif, all the link canals and barrages are used. The Indus links (CJ and TP) transfer water into the Jhelum, and the other links transfer water into the Ravi and Sutlej. Mangla, on the other hand, does not play a significant part in operations. The cost of investments for the supply of kharif water therefore excludes Mangla and comprises an arbitrary 50% 2/ of the link and barrage costs and a proportion of the common service costs.

9. Rabi Water: Until Tarbela becomes operational, the Indus links and barrages cannot play their full roles in the system. In rabi, therefore, the investment costs comprise 50% of the non-Indus links and barrages, plus the full cost of Mangla 3/ minus the cost of the thermal alternative to Mangla minus the value of the extra water supplied in November.

1/ This was the marginal relationship between change in water supply and change in cropped area. The average relationship (total water delivered in November ÷ total rabi acreage) was four times larger. Other constraints, such as draft power, reduce the marginal effect below the average.

2/ For project works which are used in both seasons, costs have been allocated equally between seasons.

3/ Including the costs of the non-IBP Power Investments.

Derivation of the Unit Cost of Replacement Water

10. The "benefit streams" associated with the cost streams described are the replacement volumes of kharif and rabi water delivered. By calculating the NPV of the cost and benefit streams at 10%, and dividing the cost (which is in Rs.) by the benefit (which is in acre feet), the unit cost of replacement water is found. The unit cost of rabi replacement water was Rs. 170 and the unit cost of kharif replacement water was Rs. 80 per acre foot at Mangla Dam.

The Value of Replacement Water

11. Average Value at Other Times in the Year: The net economic value of production in the irrigated areas affected by IBP is Rs. 740 per acre (Annex IV). Water deliveries average 3-4 feet per cropped acre. 1/ To estimate the value of production attributable to water, it is assumed that without irrigation the yields 2/ would be reduced by a factor of three and the cropping intensity would be halved. Thus, the comparable value of production per acre would be at most Rs. 130 (since inputs are not reduced by the same amount). The benefit attributable to water 3/ is thus about Rs. 175 per acre foot.

1/ See Special Agricultural Sector Review Vol. II.

2/ See Ibid, Vol. IV.

3/ Rs. (740-130) ÷ 3.5 ft. = Rs. 174/foot.

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DIVISION OF COSTS FOR WATER SUPPLY

	FY61	FY62	FY63	FY64	FY65	FY66	FY67	FY68	FY69	FY70	FY71	FY72	FY73	FY74	FY75	FY76	FY77	FY78	FY79	FY80	FY81-90
Total for Rabi 1/	32.02	447.31	3,027.31	2,154.54	2,116.74	1,078.00	238.87	170.12	-81.10	-152.80	-207.31	-269.40	-191.25	-450.92	-605.80	-661.05	-567.05	-498.55	-567.05	-661.05	-684.55
Total for Kharif 2/	0	112.12	613.67	546.28	604.10	755.70	670.06	568.56	351.60	156.35	90.30	53.75	22.00	16.73	67.55	9.75	9.75	9.75	9.75	9.75	9.75

1/ Includes Mangla (net of savings on thermal alternative), half cost of TSMB and RQBS links, half cost of Sidhnai,Mailsi, Rasul, Qadirabad barrages, proportion of remodelling and common services, less value of incremental water supply (after 1967).

2/ Includes half cost of TSMB, RQBS, CJ and TP links, half cost of Chasma, Marala, Sidhnai,Mailsi, Rasul, Qadirabad barrages, proportion of remodelling and common services.

ANNEX 6
Table 1

EXPENDITURES ON INDUS BASIN AND TARBELA PROJECTS

(June 1960 - June 1975)

(Million Rs)

Projects	Estimated Cost (as of 12/1971)	Cumulative Expenditure up to June 1960		June 1961		June 1962		June 1963		June 1964		June 1965		June 1966		June 1967		June 1968		June 1969		June 1970		June 1971		June 1972		June 1973		June 1974		June 1975		Remarks
		Total	Foreign	Total	Foreign	Total	Foreign	Total	Foreign	Total	Foreign	Total	Foreign	Total	Foreign	Total	Foreign	Total	Foreign	Total	Foreign	Total	Foreign	Total	Foreign	Total	Foreign	Total	Foreign	Total	Foreign	Total	Foreign	
Dams																																	
Mangla	3,132.67	23.55	4.65	32.85	8.17	100.68	89.33	739.33	442.76	1,211.88	678.96	1,711.97	956.85	2,286.52	1,185.84	2,742.26	1,351.93	2,988.83	1,504.78	3,060.63	1,523.48	3,063.54	1,454.06	2,993.24	1,444.60	3,006.09	1,457.04	3,025.44	1,459.86	3,030.25	1,460.28	3,058.86	1,474.60	Expenditure on O&M (supplied by Power wing) excluded.
Tarbela	5,636.25	6.82	0.46	24.39	0.42	43.69	7.15	43.90	16.26	63.47	19.33	87.77	30.06	105.84	38.80	146.72	53.91	229.14	73.77	733.59	301.48	1,648.87	724.07	2,588.07	1,221.97	3,545.46	2,020.86	4,336.79	2,221.44	5,160.09	2,355.04	6,291.28	2,831.48	Ongoing project.
Links																																	
I-5	162.25							82.26	47.66	110.70	58.31	132.56	70.74	139.96	74.42	142.21	74.44	155.38	83.92	155.53	83.92	139.30	83.92	139.53	83.92	152.82	83.92	151.87	83.92	241.11	83.92	241.11	83.92	) Transferred for O&M to Irrigation Dept. on 6/30/66.
S-W	246.92							76.25	48.42	185.86	98.33	231.33	114.62	234.53	115.60	244.33	117.61	241.61	115.28	241.41	115.23	241.68	115.26	235.70	115.26	235.70	115.26	235.70	115.26	238.41	116.82	)
M-B	41.20							8.33	4.75	19.70	6.91	24.37	7.35	26.39	7.46	26.60	7.47	27.14	7.58	27.26	7.62	27.96	7.64	27.14	7.64	27.14	7.64	27.14	7.64	29.87	9.25	)
B-J	272.38							1.36	0.82	9.56	0.91	36.86	15.20	99.87	48.35	131.67	64.95	154.96	76.67	142.83	78.80	163.04	79.76	166.80	80.00	165.03	80.00	165.87	80.00	269.09	81.61	Transferred to Irrigation Dept. on 3/1/70.
B-R	309.54							6.76	3.29	37.67	24.74	122.78	65.41	205.83	104.86	264.66	127.49	287.71	136.53	292.17	140.65	297.45	140.66	293.04	140.97	293.04	140.97	292.42	140.97	295.14	144.51	Transferred to Irrigation Dept. on 12/15/66.
R-S	87.04							1.78	0.71	7.83	3.50	8.37	1.96	26.62	6.48	60.56	18.82	81.90	17.98	89.02	20.06	90.21	17.77	80.42	17.36	83.73	18.04	83.73	18.09	86.76	19.21	Transferred to Irrigation Dept. on 5/16/69.
C-J	979.69							4.09	3.17	5.14	2.65	7.98	3.96	11.03	4.98	22.95	9.61	127.71	63.96	186.10	86.46	234.48	101.42	266.40	117.33	276.69	120.19	281.10	120.21	283.66	120.32	285.78	120.32	Wako WAPDA O&M supplied by Federal Government
T-P	139.67							1.01	0.59	1.67	0.83	4.23	1.00	12.28	2.38	37.29	7.24	85.37	5.03	99.32	11.37	111.28	14.01	117.73	15.20	118.59	15.44	119.60	15.44	122.08	17.92	)
Sub-total	1,448.59					46.65	13.80	182.34	108.41	372.09	194.18	568.48	281.00	736.51	364.75	929.87	417.73	1,139.04	508.60	1,253.54	543.91	1,307.79	561.74	1,329.20	577.15	1,353.00	581.44	1,354.88	581.46	1,358.70	591.37	1,466.23	592.53	
Barrages																																	
Sidhnai	170.38							77.43	68.36	120.66	68.95	146.32	83.40	160.05	88.39	166.03	90.22	163.10	90.23	163.70	90.20	163.74	90.20	160.69	90.23	160.78	90.23	160.87	90.23	160.87	90.23	) Transferred for O&M to Irrigation Dept. on 6/30/66.
Mailsi	144.29							48.06	38.70	115.26	56.86	127.69	69.63	134.28	63.67	135.06	63.28	132.13	64.59	134.26	64.57	134.13	64.59	131.72	64.59	131.72	64.59	131.80	64.59	131.80	64.59	)
Rasul	197.61							0.70	0.43	1.28	0.42	3.64	1.10	66.37	34.51	141.33	73.51	164.41	81.26	172.29	86.23	177.06	86.00	178.13	86.19	181.23	87.36	182.08	87.36	183.24	87.37	188.59	89.31	With WAPDA O&M supplied by Federal Government.
Qadirabad	251.30							1.57	0.65	8.64	3.73	93.25	46.56	194.13	95.28	226.83	105.24	234.18	108.72	235.30	107.93	235.33	107.94	235.50	107.95	235.43	107.95	235.44	107.95	239.16	108.89	Transferred to Irrigation on 12/1/68.
Marala	248.76							16.36(1)	9.17	18.11(1)	9.44	23.97	4.90	97.74	41.60	182.73	87.01	216.15	98.11	228.60	106.90	252.16	108.92	239.01	110.44	242.79	111.41	241.43	111.54	249.26	111.54	252.74	113.48	) Will WAPDA O&M supplied by Federal Government.
Chashma	533.66							0.43	0.02	0.27	0.05	5.97	0.77	14.11	1.67	48.99	7.29	128.18	31.24	229.32	94.96	304.72	96.74	337.20	87.74	363.59	98.86	371.58	98.92	374.90	98.69	381.68	80.77	)
Sub-total	1,545.79					32.35	1.43	144.47	107.83	264.30	139.43	388.83	197.36	656.69	325.12	903.67	429.26	1,042.15	471.12	1,163.47	549.09	1,249.12	564.37	1,282.25	546.64	1,315.58	560.40	1,321.06	559.93	1,334.21	560.17	1,354.74	548.77	
Remodelling	84.63					16.81	0.90	22.37	0.38	26.64	0.35	62.96	1.03	65.34	1.83	66.36	1.83	64.75	1.85	65.35	1.88	78.21	5.33	78.20	5.33	78.21	5.33	78.46	5.33	78.85	5.33			
Gen. Serv.	Inc.in above					25.06	0.46	52.31	30.81	85.36	38.70	107.17	41.72	94.33	58.19	117.68	89.63	146.54	105.12	150.62	210.72	158.81	118.81	164.12	120.43	167.27	120.97	188.07	122.71	186.94	122.55	188.94	122.55	
Grand Total	11,847.54	30.37	5.11	57.24	8.59	265.02	12.37	1,184.23	706.45	2,021.74	1,040.17	2,924.18	1,510.02	3,992.52	1,974.53	4,904.56	2,341.93	5,613.64	2,668.04	6,427.20	3,000.54	7,565.73	3,408.30	8,441.08	3,978.05	9,463.13	4,446.04	10,376.72	4,755.52	11,414.05	5,099.94	12,491.87	5,660.76	

1/ Including expenditure on M.R. Link.

Notes (a) Project-wise break up for Links and Barrages up to June 1962 is not available; the expenditure given against Mangla and Tarbela up to 6/60 and 6/61 also includes the expenditure on common services.
(b) Based on the data furnished by the Comptroller, IBP, from the Quarterly Financial Statements.

Source: Budget Officer, Office of the Comptroller, IBP, B-74, Wapda House, Lahore.

PAKISTAN

EXPENDITURES ON INDUS BASIN AND TARBELA PROJECTS, FY61-FY75

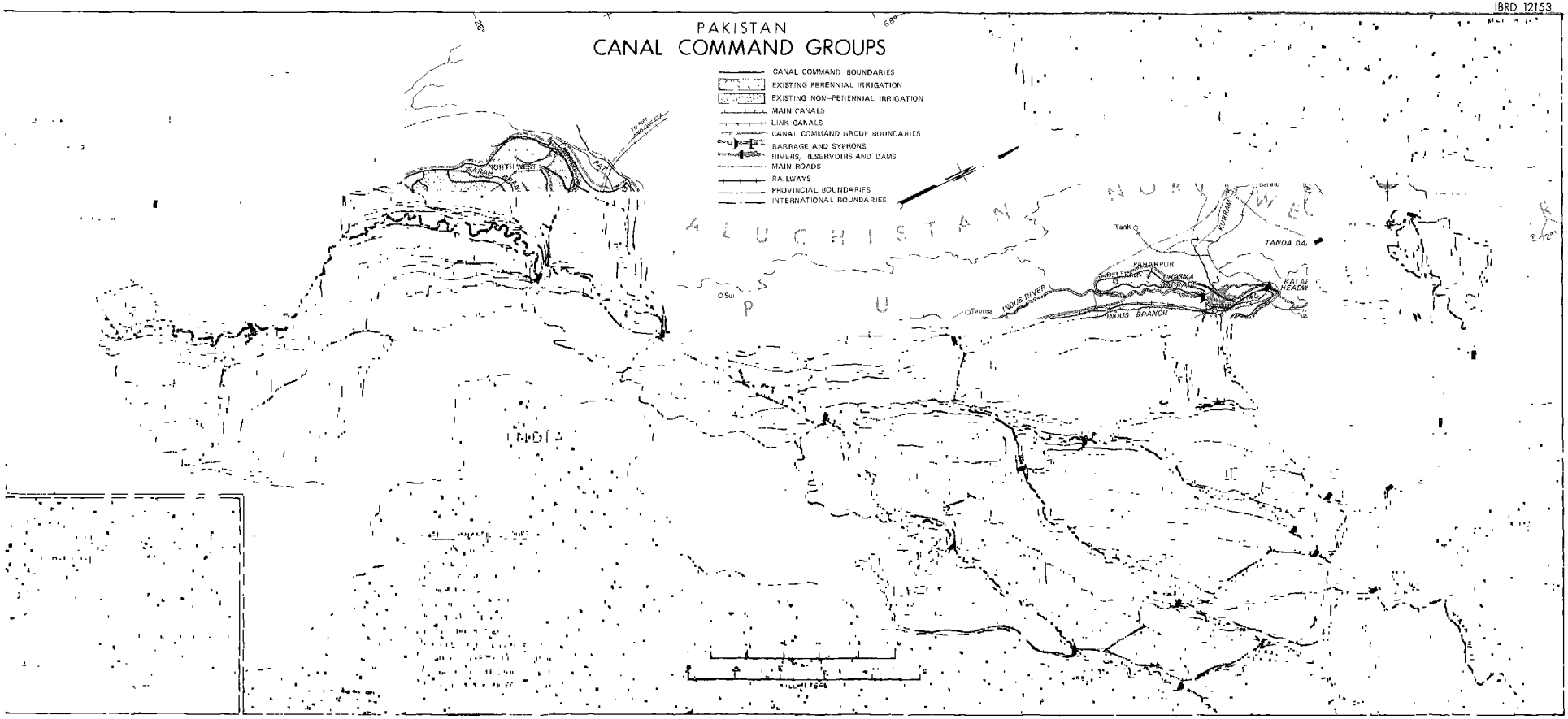
(Adjusted to 1975 Prices)

Rs. Million

	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign
	FY61		FY62		FY63		FY64		FY65		FY66		FY67		FY68		FY69		FY70		FY71		FY72		FY73		FY74		FY75	
Mangla	16.18	15.84	-35.99	365.22	770.09	1,661.12	614.51	1,039.28	630.50	1,203.52	757.3	976.0	666.1	697.5	215.5	641.9	72.8	76.6	203.1	1.9	-148.7	1.9	19.7	3.6	26.9	3.6	5.3	0.4	14.2	14.3
Tarbela	49.30	-0.18	33.93	30.28	-24.03	42.81	42.90	13.50	33.92	46.13	22.6	37.5	59.0	63.4	143.8	83.4	652.8	933.6	1,039.9	1,979.4	817.6	1,979.4	399.8	1,120.4	1,258.7	5.9	649.6	362.5	648.7	476.4
Links																														
T-S					93.42	224.00	43.65	51.26	26.07	49.14	7.2	18.8	5.1	0.0	8.4	39.8	0.3	0.0	-0.5	0.0	-5.7	0.0	0.0	0.0	0.4	0.0	0.0	0.0	86.6	1.6
S-M					75.14	227.57	155.16	219.60	73.50	69.18	4.5	0.4	0.4	0.0	1.1	0.4	0.0	0.1	1.4	0.0	-1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	1.6
M-B					9.66	22.32	23.94	9.50	10.57	1.89	74.0	138.2	34.9	69.7	31.7	48.2	5.5	9.6	2.6	0.5	0.7	0.5	0.6	0.3	0.2	0.0	0.7	0.0	0.8	1.6
R-Q					2.53	3.85	19.73	-3.56	30.32	69.61	104.6	169.6	82.8	95.0	27.1	45.5	6.4	8.6	0.2	1.0	0.6	1.0	0.0	0.0	-0.7	0.0	-0.1	0.0	1.1	1.6
Q-B					9.36	15.46	24.59	94.38	110.10	174.88	32.3	20.4	64.0	25.6	37.1	21.7	13.0	8.5	-15.2	0.2	0.2	0.2	4.8	1.1	0.0	0.0	0.0	0.0	1.4	1.6
B-S					2.88	3.33	0.67	3.47	12.75	1.89	4.8	4.4	16.7	19.4	115.9	228.1	78.9	92.3	69.1	49.3	33.8	49.3	17.3	4.5	7.3	0.0	3.4	0.0	2.1	0.0
C-J					5.18	10.19	1.48	2.11	3.87	5.54	16.0	5.9	46.2	20.6	69.3	-9.4	61.1	25.9	20.5	4.2	11.0	4.2	2.9	0.3	-4.3	0.0	1.0	0.0	1.9	2.4
T-P					1.40	2.77	0.57	1.49	6.22	0.30																				
Subtotal			88.15	62.10	199.61	444.66	269.82	378.26	274.42	372.46	250.2	360.1	267.6	239.3	290.9	364.0	165.0	145.5	78.8	55.4	26 .4	55.4	25.6	6.4	2.9	0.0	-7.9	10.9	108.3	2.1
Barrages																														
Sidhnai					24.48	321.29	110.34	2.59	28.50	62.13	21.0	21.4	9.5	7.6	-6.7	0.0	1.3	-0.1	0.0	0.1	-6.4	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0
Mailsi					25.21	181.89	127.55	79.90	21.65	16.21	8.5	13.0	-0.3	6.8	0.2	-3.0	-1.9	0.0	-0.3	0.0	-5.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Rasul					1.53	0.61	0.70	1.27	4.25	2.92	70.3	143.6	82.7	162.9	34.7	33.3	10.0	13.4	7.2	0.6	1.8	0.6	3.8	1.7	1.2	0.0	1.4	0.0	3.4	1.9
Qadir					3.02	2.11	15.05	5.63	99.45	192.76	125.1	209.4	52.3	41.8	8.9	14.6	4.1	-3.1	0.1	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.8	1.9
Marala					43.55	0.79	4.00	1.18	-26.50	19.17	93.7	157.8	111.9	194.5	53.4	42.8	8.0	36.0	3.3	5.4	11.1	5.4	5.3	1.4	-2.3	0.1	4.9	0.0	5.5	1.9
Chasma					1.10	0.09	0.28	0.13	11.70	3.09	17.3	3.8	67.2	23.6	127.0	100.5	148.4	138.0	122.2	1.8	62.9	1.8	28.0	17.4	14.1	-1.0	3.4	0.7	4.5	2.0
Subtotal			83.48	6.43	15.44	500.08	257.94	90.72	139.05	296.31	338.2	549.3	323.9	437.3	217.6	188.4	170.2	184.2	132.7	8.1	64.8	8.1	37.1	20.6	13.0	-0.9	10.1	0.7	15.3	7.9
Remodelling			44.84	0.90	14.52	0.84	5.98	-0.13	94.10	2.92	4.2	3.4	1.8	0.0	-3.7	0.0	1.2	0.1	20.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.2	0.0
Com. Service			66.36	2.07	-8.31	142.64	65.41	34.71	34.47	12.98	-58.3	70.8	-2.5	107.8	14.7	94.2	3.3	33.1	0.2	5.7	7.7	5.7	5.1	0.8	22.2	8.8	1.3	-0.2	0.0	0.0
Total	65.49	15.66	550.80	17.01	609.17	3,262.16	1,256.58	1,556.36	1,206.47	1,934.35	1,312.4	1,997.3	1,316.1	1,540.5	878.9	1,372.1	1,058.7	1,672.1	1,475.5	2,050.8	767.8	2,050.8	487.6	1,151.9	1,324.0	17.5	658.9	374.4	787.0	500.8

ANNEX 6
Table 3

IBRD 12153


PAKISTAN
CANAL COMMAND GROUPS
CANAL COMMAND BOUNDARIES
EXISTING PERENNIAL IRRIGATION
EXISTING NON-PERENNIAL IRRIGATION
MAIN CANALS
LINK CANALS
CANAL COMMAND GROUP BOUNDARIES
BARRAGE AND SYPHONS
RIVERS, RESERVOIRS AND DAMS
MAIN ROADS
RAILWAYS
PROVINCIAL BOUNDARIES
INTERNATIONAL BOUNDARIES
INDIA
Tank
PAHARPUR
INDUS RIVER
INDUS BRANCH
TANDA DA
KOTAI HEADW