A STUDY
ON
PERFORMANCE EVALUATION OF DISTRIBUTORY
IN
RUSHIKULYA IRRIGATION SYSTEM, ORISSA

A DISSERTATION

submitted in partial fulfillment of the
requirements for the award of the degree
of
MASTER OF ENGINEERING
in
WATER RESOURCES DEVELOPMENT

By
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FOR

JITU & JITA.

CANDIDATE'S DECLARATION

I hereby certify that the dissertation entitled, **"A STUDY ON PERFORMANCE EVALUATION OF DISTRIBUTORY IN RUSHIKULYA IRRIGATION SYSTEM, ORISSA,"** which has been presented in partial fulfillment of the requirement for the award of the DEGREE OF MASTER OF ENGINEERING IN WATER RESOURCE DEVELOPMENT and submitted in the Water Resources Development Training Centre, University of Roorkee, Roorkee is an authentic record of my own work carried out during the period from 16th July to 30th November, 2000 under the guidance of Prof. R.P. Singh (Chief Engineer, Retired), Professor, WRDTC, University of Roorkee, Roorkee.

The matter embodied in this dissertation has not been submitted by me for the award of any other degree.

Place: Roorkee

Date: 30.11.2000

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This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

(Prof. R.P. Singh)
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SYNOPSIS

Rushikulya Irrigation system had been in use for the last one century having a CCA of 61,231 Ha. Rushikulya canal system taking off from Janivilly anicut has a CCA of 50,925 Ha having 16 nos. of distributaries with their systems. Distributory No. 2,11,12,13,14 having a total CCA of 13,733 Ha are proposed to be studied in this dissertation. Field studies needed for the dissertation had been carried out during last July, 2000. The dissertation prepared from this study consists of six chapters as mentioned in the contents.

The scope of the study is to examine and evaluate, with recent practices, about the deficiency of engineering infrastructure, existing efficiency in operation, present status of equity in distribution of water, use of available water resources, improvement in irrigation infrastructure, overall yield of crops and impact of socio-economic aspect in the command of canal.

The object of the study is to get both understanding for required suitable improvement in the system for optimal utilization of available resources.

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ABBREVIVATIONS

ABBREVIATIONS USED

M.E.	:	Master in Engineering
WRDTC	:	Water Resources Development Training Centre.
UOR	:	University of Roorkee
DOWR	:	Department of Water Resources
WRD	:	Water Resources Development
CCA	:	Culturable Commanded Area
Irr. Project	:	Irrigation Project
RMC	:	Rushikulya Main Canal
RD	:	Reduced Distance
KM	:	Kilometer
Ha	:	Hectare
Cumecs	:	Cubic Meter Per Second
NOS	:	Numbers
Disty.	:	Distributory
Annex	:	Annexure
IWM	:	Irrigation Water Management
RWS	:	Relative Water Supply
IQR	:	Inter-Quartile Ratio
EC	:	Electro – Conductivity
meq/l	:	milli –equivalent per liter
MO&M	:	Management, Operation and Maintenance
GWT	:	Ground Water Table
HYV	:	High Yield Variety
CWC	:	Central Water Commission
FSL	:	Full Supply Level
RGWD	:	Relative Ground Water Depth
RPP	:	Relative Productivity Potential
CADA	:	Command Area Development Authority

J. E.	:	Junior Engineer
A. E.	:	Assistant Engineer
E. E.	:	Executive Engineer
S. E.	:	Superintending Engineer
AMC	:	Available Moisture Content
U. P.	:	Uttar Pradesh
I. I.	:	Intensity of Irrigation
ISF	:	Irrigation Service fee
EIRR	:	Economic Internal rate of return.

CHAPTER –I
INTRODUCTION

CHAPTER-I

INTRODUCTION

1.1 GENERAL :

The success of an irrigation water delivery system can be measured by how well it meets the objectives of irrigation i.e. delivering an adequate and dependable supply of water in an equitable efficient manner to the users served by the system. In many irrigation systems, inequitable and unreliable water distribution are major water-management problems. In monitoring an evaluating water-delivery system, it is necessary to know how well a system performs in its present state relative to system objectives. This dissertation deals with performance measures (quantifiable) to analyze a water delivery systems in terms of adequacy, equity, timeliness, and sustainability.

A water-delivery system comprises of structural and management components. The structural components comprise of the facilities for conveyance, regulation and measurement of water. The management component is responsible for efficient operation and maintenance of the hydraulic structures to implement water delivery schedules that specify timing and amount of delivery. System performance suffers if either or both the components are deficient. So it is necessary to evaluate the contributions of above four factors to the overall performance of the system.

1.2 DEFINITIONS :

1.2.1 Adequacy : Delivery of Required Amount :

A fundamental concern of water delivery system is to deliver the amount of water required adequately to irrigated crops. The required amount, determined as that needed to achieve the given agricultural policy, is a function of the area of land irrigated, crop consumptive use requirements, crop-water production functions, application losses and cultural practices, such as land preparation and salt leaching. Adequacy of delivery is dependent on water supply, specified delivery schedules, the capacity of hydraulic structures to deliver water according to the schedules, the operation and maintenance of the hydraulic structures.

1.2.2 Equity : Delivery of Fair Amount

Equity, as related to water-delivery systems can be defined as the delivery of a fair share of water to users throughout the system. A share of water represents a right to use a specified amount. The fair share of water may be based on a legal right for water as in a prior appropriation system, or may be set as a fixed proportion of a water supply, as is done in many rotational delivery schemes. Equity of water delivery is a difficult objective to measure because there are many factors that determine the meaning of a "fair share" and because a fair share is often interpreted subjectively. However, it is important to define measures relating to equity so that systems can be designed or rehabilitated to deliver water in an impartial manner to users served by the system. In the present study, equity is defined as ration of volume delivered respectively, to the most favoured upper 25% of command area and the least favoured lowest 25% of command area.

1.2.3 Timeliness: Uniform Delivery Over Time

Timelines means correspondences of water supply to crop water requirements and it relates to distribution of water supply across the season to some utility based standard. The standard is delivered from crop water requirement. Svendsen and small (1990) argued that in the absence of any readily identifiable distinction between reliability and timeliness, the single concept of timeliness would be more useful.

1.2.3.1 Reliability

The concept of reliability means the degree to which the irrigation system and its water deliveries conform to the prior expectation of the users.

Reliability relates to a fairly constant rate of supply.

1.2.3.2 Dependability:

It is defined as the delivery of a relatively uniform amount of water over time (Moledn, 1988). A system which performs in a consistent manner may be considered dependable. Dependability of water delivery is important to farmers; because it allows for proper planning. A system that dependably delivers an inadequate amount of water may be more desirable than one that delivers on the average an adequate yet unpredictable supply.

1.2.4 Sustainability:

Sustainability means long lasting or long existence or long term development of performance. Aspects of physical sustainability that can be affected by irrigation managers relate primarily to over or under supply of irrigation water leading to water-logging or salinity.

$$\text{Sustainability} = \frac{\text{current irrigable area}}{\text{inital total irrigable area}}$$

The initial area refers to total irrigable area in the design of the system or in the latest rehabilitation. Current irrigable area is due to land lost because of salinity, water shortage, low profitability of agriculture due to urban and industrial development.

1.3 Water Delivery Performance:

Performance measures as defined by Molden and Gates (1990) are functions of state variables that have direct impact on the fulfillment of system objectives and incorporate the time and space variability of state variables and account for contributions to system performance from the structural and management components of the system.

1.3.1 Major State Variables:

The major state variables that determine water-delivery-system performance may be defined in terms of an amount of water Q, which may refer to either rate, volume, frequency or duration of water delivery. In present study, we focus on volumes (Ha -m) of water delivery. At a point x in the system and time t, we define the amount Q_D (x,t) to be the actual amount delivered by; the system. The amount Q_R (x,t) is the amount of water required for consumptive use, leaching, land preparation, farm application and conveyance losses downstream of the delivery point x and time t. In a rotation system, the amount scheduled i.e. Q_S (x,t) is prescribed by the organization in charge of water delivery. The amount of water delivered by the system giving perfect operation is the amount deliverable i.e. Q_D (x,t).

1.3.2 Performance Standards:

Performance standards as suggested by Molden and Gates (1990) is given below:

Measures	**Performance class**		
	Good	**Fair**	**Poor**
P_A i.e. Adequacy	0.9~1.00	0.7~0.9	<0.7
P_E i.e. Equity	0.85~1.00	0.70~0.85	<0.70

P_t Timeliness	0.75 ~1.00	0.25~0.75	<0.25
P_S Sustainability	0.95~1.00	0.85~0.95	<0.85

1.4 Study Area

This performance evaluation study has been carried out in the command area of Rushikulya Irrigation project of Ganjam district. Ganjam is one of the most fertile districts of Orissa. As per 1991 census its population is 3,143,120. It covers an area of 12,200 sq km. Hence density of population is 257.633 or say 258 persons per sq km.

The land use pattern of the district is as given in below:

Sl. No.	Description	Area in Thousand Ha	Percent of total
1.	Forest area	589	48.3
2.	Miscellaneous tree crops and grooves	38	3.1
3.	Permanent pastures and other grazing lands	38	3.1
4.	Cultivable waste	5	0.4
5.	Land put to non-agriculture use	60	4.9
6.	Barriers and uncultivable land	3	0.24
7.	Current fallows	2	0.16
8.	Other fallows	5	0.4
9.	Net area sown	480	39.4
Total Geographical Area		**1220**	**100.0**

The total cultivable area of the district is 505 thousand Ha (i.e. 5.05 lakh Ha). As per Irrigation Master Plan it is proposed to provide irrigation to 4.57 lakh Ha (90% of land) through following sources:

(A) Through major and medium irrigation : 2.55 lakh Ha

(B)	Through minor irrigation flow:	1.70 lakh Ha
(C)	Through minor irrigation lift:	0.32 lakh Ha

(A)	Major and medium irrigation projects:		
(a)	Completed project	Area in Ha	
(i)	***Rushikulya system***	***61,231***	
(ii)	Jayamangal	4,580	
(iii)	A part of salia Irr. Project	2,020	
(iv)	Bahuda Irr. Project	8,540	
(v)	Dhanei Irr. Project	3,850	
(vi)	Hiradharabati Irr. Project	5,680	
(vii)	Baghua Irr. Project (stage –I)	3,240	
(viii)	Ghodahada Irr. Project	6,200	
(ix)	Ramanadi Irr. Project	990	
(x)	Daha Irr. Project	4,580	
	Sub total	1,00,911	⟶(a)
(b)	**On –going project**		
(i)	Harabhangi Irr. Project	9,150	
(ii)	Baghua Irr. Project (stage-II)	3,070	
(iii)	Baghalati Irr. Project	2,800	
	Sub total	15,020	⟶(b)
(C)	**Proposed Projects**		
(i)	Cheligarh	10,400	
(ii)	Rushikalya Dam	7,000	
(iii)	Loharakhandi	3,500	

(iv)	Bontha	2,000
(v)	Manibhadra	80,000
(vi)	Lower Harabhangi	8,000
(vii)	Budha nadi Dam	3,400
(viii)	Bagha-Salki-Burtanga	10,000
(ix)	Mahendratanaya	5,000
(x)	Badajore	2,200
(xi)	Neradi Barrage	3,500
(xii)	Others	3,510
	Sub-total	1,38,510 ⟶ (c)

(a) +(b)+(c) = 2,54,441 Ha ≅ 2.55 lakh Ha

(B)	Minor Irrigation flow:	Area in Ha
(a)	Completed	1,34,555
(b)	Ongoing	1,907
(c)	Proposed	32,079
	Total	1,68,541 Ha ≅ 1.70 lakh Ha

(C)	Minor Irrigation Lift	Area in Ha
(a)	Completed	18,000
(b)	Proposed	14,000
	Total	32,000 Ha ≅ 0.32 lakh Ha

(**Source:** Deptt. of water-resources, Government of Orissa)

1.4.1 Rushikulya Irrigation System:

Rushikulya Irrigation System was constructed as a draught relief measure about a century back to provide irrigation to 41,332 Ha. of ayacut during Khariff, though present ayacut is 61, 231 Ha.

This is predominately a diversion weir project with two storage reservoirs (Sorada and Bhanjanagar) upstream and within the command.

(i) Sorada reservoir has a liver storage capacity of 3276 Ha-m.

(ii) Bhanjanagar reservoir has a live storage capacity of 5118 Ha-m.

(iii) Sorismuli anicut (or Gallery anicut) diverts water of Badanadi to Bhanjanagar reservoir.

(iv) A diversion weir (or Padma anicut) across river Padma diverts water of Padma to sorada reservoir.

(v) A diversion weir at Madhoborida (or Madhoborida aricut) diverts water of Badanadi to Rushikulya river.

(vi) An anicut at ***Janivilly*** diverts water of Rushikulya river for providing irrigation through Rushikulya canal.

(vii) Rushikulya canal system consists of Rushikulya Main Canal (RMC) of length 87.5 km with 16 nos of distributaries of total length 230 km and minor and sub-minor of total length 298 km. (Refer to index map and schematic diagram)

1.4.2 Problems and Constraints in Rushikulya Irrigation System:

Due to complexity of regulation points and canal system being old, the problems in RMC are quite alarming and had posed a challenge to O & M staff before modernization. Some of the problems were given below:

(i) Sediment entry into RMC and its branches during monsoon season mainly from ungated inlets along the canals.

(ii) Reduction in carrying capacity due to siltation. Just before modernization the carrying capacity of distributaries under case study had been impaired by 15% to 20% of its head discharge.

(iii) Retrogression in the d/s of Ghodahada Aqueduct (D/S of disty No.2).

(iv) Drainage problems existed in pockets in RMC Command.

(v) Poor communication system in RMC Command due to poor O & M Communication System.

(vi) Non functional service roads on distributaries & minors

(vii) Lack of monitoring & evaluation of cropped area and changes in roster etc.

Major Constraints prevailing in the RMC are identified as motioned below:

(i) Engineering infrastructure constraints.:

Though canal structures have performed very well but could not be relied for present irrigation demands and system operational requirements. Though the design life of structures were 75 ~100 years, they have already performed more than their design life.

(ii) Agricultural practice constraints:

One of the major constraints in this regard is the dominant ever increasing sugarcane cultivation in the command of distributory No. 2 with respect to inequitable distribution of water in tail reaches due to over-irrigation in head reaches. (Table 4, Annexure 4)

(iii) Availability of water:

Insufficient water is available in river Rushikulya during Rabi period (Dec. to May) to meet out increasing demands of intensive agriculture.

(iv) Social Constraints:

There is continuous fragmentation of holdings, which causes problems in revising Warabandi plan. Smallholdings are 62% of number of farms of RMC Command.

(v) Financial Constraints:

The maintenance grants on RMC system is inadequate (only 30% of requirement)

(vi) Administrative Constraints:

Due to lack of facility for monitoring and evaluation, extensive winter touring in the field by SE, E.E, A.E is not being door as it was being done earlier. There is also lack of professional. Interest in postings on O & M works.

Hence NWMP Scheme was envisaged by Govt. of India in disty No. 2,11,12,13 & 14 in Ist phase (1993~95).

CHAPTER –II
INFRASTRUCTURE DETAILS OF PROJECT

CHAPTER-II

INFRASTRUCTURE DETAILS OF PROJECT

2.1 DISTRIBUTORY NO.2:

The command lies between latitude 19^0-30' N to 19^0 35' N and longitude $84^0$35'E to 84^0-46'E and has a CCA of ***3832 Ha.*** and a discharge of ***2.79 Cumecs***. It has ***74numbers*** direct outlets in distributory only. Originally it was extended upto 9 km and subsequently extended to ***20.520 km*** in two phases. It has three nos of minors and one no of sub-minor as shown in schematic diagram.

2.2 DISTRIBUTORY NO. 11:

It takes off from Rushikulya main canal at RD ***65.52 km.*** The length of distributory originally was 20.80 km with an ayacut of 4271 Ha. Subsequently was extended to ***25.00 km*** to irrigate ***4681 Ha.*** of land. Originally design discharge was 3.40 Cumecs; which was increased to ***4.60 Cumecs***. It has ***ten nos*** of offtaking minors and sub-minors and ***75 nos.*** of direct outlet in distributory only.

2.3 DISTRIBUTORY NO. 12:

It takes off form Rushikulya Main Canal (RMC) at R.D ***69.20 km.*** The length of the distributory is ***2.61 km*** to irrigate ***543 Ha*** against 336 Ha as envisaged originally. Its design discharge is ***0.420 Cumecs***. It has one offtaking mionor and ***12 nos.*** of direct outlet in distributory only.

2.4 DISTRIBUTORY NO. 13:

The distributory takes off from RMC at R.D ***71.400 km***. The length of this distributory is ***12.00 km*** to irrigate ***2478 Ha*** of land. Its design discharges is ***1.86 Cumecs*** . It has six nos. of offtaking minors and ***37 nos*** of direct outlets in distributory only.

2.5 DISTRIBUTORY NO. 14:

It takes off from RMC at R.D ***77.100 km*** The length of the distributory is ***10.00km*** to irrigate ***2199 Ha*** of ayacut. Its design discharge is ***1.89 Cumecs*** It has four nos. of off-taking minors and three nos. of sub-minors. It has ***29 nos.*** of direct outlets in distributory itself.

Table No. 1 in Annexure-2 gives salient features of distributaries under case study.

Table No. 2 in Annexure-2 gives detail length of canal embankment, lining, communication facilities, total no. of different structures for distribuaries under investigation.

CHAPTER –III
SURVEY OF LITERATURE

CHAPTER – III

SURVEY OF LITERATURE

3.1 PERFORMANCE

(i) It is the degree to which an organization's products and services respond to the needs of their users

(ii) It is the efficiency with which the organization uses the resources at its disposal.

Achievement of entered level of service (that has been set and agreed upon) is the basis for good operational performance. Operational performance specifically measures the extent to which intentions are being met at any moment & thus requires measurement of actual input & output on a regular basis. Strategic performance assesses the extent to which all available resources (financial resources, natural resources & human resources to operate, maintain & manage irrigation system) have been utilized to achieve the agreed service level efficiently.

$$\text{Agreed service level} = \frac{\text{Intended level of Delivered Resource}}{\text{Required level of considered Resource}}$$

Agreed service level changes with a change in the availability of resources (e.g. water, energy, manpower, and funds).

Target reflects the objectives of mangers of different level. A system manager uses outcome of the annual/seasonal planning process. High-level agency managers use design criteria as their targets. Policy makers think in terms of potential performance with respect to use of natural resources.

The rising cost irrigation development, dissatisfaction with current level of performance and greater awareness of environmental issues are mainly responsible for undertaking performance evaluation. These efforts (by Government agencies associated with irrigation development, funding agencies like World Bank and the water users) are being made on the assumption that it is possible to improve the performance through modern technology and management techniques. The knowledge of pre-improvement phase of performance & projections of performance levels in post-improvement phase is essential for suggesting improvement.

3.2 OBJECTIVES OF IRRIGATION WATER MANAGEMENT:

(i) In richer nations (having larger land units), measuring devices are installed at outlets; which puts more control & responsibility into the hands of the farmer. The farmer can supply water to the crop efficiently, matching supply to growth requirements & to weather.

(ii) The authority's relationship with farmer is good who can charge a realistic price for water as a commodity.

(iii) The authority may not need to trouble itself for equity of water distribution. Farmers can understand & accept the constraint i.e. water deficiency & plan their field activities appropriately to minimize the problem.

(iv) In a canal-fed, small-holder, surface irrigation systems of developing countries like India, the authority's role is to ensure that water is fairly distributed in space & time (WATER-MANAGEMENT), i.e. to deliver water in sufficient quantities, according to a time schedule that matches the requirements for healthy plant growth, and with fair distribution among many users.

3.3 CHARACTERISTICS OF IRRIGATION WATER MANAGEMENT :

(i) There are four phase/levels of water management.

- Water capture (by a "public works" authority) i.e. harnessing of natural resources by dams, barrages, intakes, pumpstations.
- Main system distribution (engineer-managed within a state irrigation or agriculture authority)
- Sub-system distribution i.e. serving area of the order of 50~500ha(farmer-group managed or influenced, but with ill-defined legal/administrative frame work)
- Water applications at the field i.e. last stage (By individual farmers). In this stage, land shaping and grading, and irrigation technique are considered by individual farmer with/without assistance/advice from public authority.

(ii) The last (farmer) level lacks clear organizational arrangement, which requires "farmer participation". The purpose is to encourage creation of formal organizations of farmers that will have responsibility in this area and also to push the boundary of the lower level management sector farther upstream than in the past.

(iii) The success of IWM must flow from the top down i.e. farmers can not produce well unless intake & distribution systems deliver to them adequate, timely & predictable water-flows.

(iv) At lower level, demand is more than requirement. Hence a body of knowledge on the functioning of systems in to be built to diagnose management deficiencies.

3.4 CAUSES OF POOR PERPORMANCE IN AN IRRIGATION SYSTEM:

(i) Physical causes i.e. insufficient control structures to enable the engineering management to exert theoretically desirable level of control at all junction points of the main system.

(ii) Management deficiencies i.e. the operating manual (which guides the actions of field staff) may be inappropriate to present circumstances or may not exist.

(iii) Insufficient staff to discharge the functions.

(iv) Staffs may lack communications

(v) Social constraints i.e. natural resistance to watering at night.

3.5 PERFORMANCE OBJECTIVES:

The performance of a management system can only be evaluated in terms of its objectives. Irrigation schemes have multiple & sometimes conflicting objectives and the perception about performance will vary depending upon the value attached to the different goals by the person or organization making the assessment. There are different aspects of project performance that may relate to financial, institutional, design, construction & operation of the system.

Smith (1990) gives detailed list of the characteristics of the project performance in respect of financial institutions and socio-economic agricultural operational factors.

Chambers (1984) has listed some of the perception of the good performance by different disciplines & sections of the society.

Small & Svendsen (1990) stated that the goals were crucial to performance evaluation & their clear specification & classification as to whether they were related to inputs, outputs or efficiency is needed. Small & Svendsen conceptualized irrigation purposes within a nested means & end framework in which a narrow purpose is seen as a means of achieving some specified end as follows:

LEVEL OF OBJECTIVE	MEANS	END
Proximate	Operation of irrigation facilities	Supplying water to crops
Intermidiate-1	Supplying water to crops	Sustained increase in agricultural productivity
Intermidiate-2	Sustained increase in agricultural productivity	Increased incomes in rural sector
Intermidiate-3	Increased incomes in rural sector	Rural Economic Development
Ultimate	Rural economic development	(i) Improved livelihood of rural people (ii) Sustained socio-economic development for entire economy.

Here the end of the first level of objective becomes the means of next higher level of objectives. The constraints at different levels influence the performance of other levels.

Here discussion is limited to technical performance at the hydraulic level of water distribution system. Hence success of this irrigation system can be measured by how it supplies the required quantity of water at the right time in an equitable manner to users served by the system.

The water delivery system can have many objectives. Most of them can be included in adequacy, equity, timeliness & water quality. The water delivery management is not & end in itself, but is a means of increasing agricultural productivity in a sustainable manner & ultimately improving the quality of life. Abernethy (1987) has shown how all the objectives can be combined into a single objective of productivity.

3.6 PARMETERS OF IRRIGATION PERFORMANCE:

The performance objectives have to be expressed in terms of measurable quantities called state variables. These state variables are combined in various forms to develop indicators or parameters of performance, Non-exhaustive lists of these indicators can be found in Eisel (1988), Smith (1990) and Svendsen and Small (1990).

Clyma and Lowdermilk (1988) identified the parameters that need to be monitored for diagnosing the performance of irrigation system with a management focus for system outcomes. Those parameters are yield, cropping intensity, variance in yield, cropped area for productivity of agriculture. Also the parameters are volume, flow and time, variance of outlet ratio, dependability, Actual water delivered/scheduled delivery, ratio of actual supply & designed supply for equity & adequacy.

This means that the parameters we need to measure in any evaluation of irrigation performance will be (i) **adequacy** (ii) **equity** (iii) **timeliness** (iv) **sustainability** (v) **reliability** as has been discussed in introduction chapter.

Adequacy, equity & timeliness are primary parameters. Sustainability & Reliability are subsidiary parameters.

The purpose of an irrigation system is, in the end, production of some crop. So any departure from the optimum water supply, whether in regard to adequacy, to equity or to timeliness, has to be evaluated in terms of its impact on crop.

3.6.1 Adequacy :

It means adequate water supply to irrigate crops. The adequacy of water supply is controlled by available supply for distribution, water delivery schedule, capacity of the hydraulic structure to supply water according to schedule and operation and maintenance of the system.

The early measures of adequacy revolved around duty of water. Abernethy (1990) mentioned that the concept of duty is especially suited to water deficit environment. It is approximately related to water – requirement only. The water requirement for a given agricultural policy is a function of the land area, crop consumptive use, application losses and leaching requirement.

Oad and Podmore (1989) suggested that the knowledge of relative water supply (RWS) can be used to specify characteristics, intensity of management. The degree to which capability is actually realized is called intensity of management. By varying intensity, it is possible to match supply with the demand.

$$RWS = \frac{\text{Water supplied to a command area}}{\text{Demand of water in that area}} = \frac{IR + RN}{ET + S \,\&\, P}$$

where,

IR = Mean irrigation application (mm/day)

RN = Mean rainfall (mm/day)

ET = Mean evapo-transpiration (mm/day)

S&P = Seepage and deep percolation (mm/day).

Hence RWS is inverse of water use efficiency. When RWS is low, it represents water scarcity giving rise to higher tensions.

Abernethy (1990) argued that inclusion of percolation losses into demand affected the meaning of RWS. Because if losses where more (may be due to poor water management practices), demand would be more and hence RWS would be low indicating a better management.

Molden and Gates (1990) developed a procedure to determine relative contribution of hydraulic structures and management procedures to water delivery adequacy. As per Clemmens and Bos (1990) :

$$\text{Water deivery performance} = \frac{\text{Amount of water actually delivered}}{\text{Amount of water intended to be delivered}}$$

If the amount of water actually delivered is based on frequent flow measurements, there is greater likelihood that managers can match actual to intended / scheduled flows. If water delivery performance ratio $\approx$ unity, then the management inputs must be effective.

Besides water delivery performance ratio, the following also measures adequacy.

(i) Field application ratio $= \dfrac{ET_p - P_e}{\text{Volume of water delivered at field}}$

Where,

ET_p = Evapo-transpiration by irrigated crop.

P_e = Effective part of precipitation

$ET_p - P_e$ = Volume of irrigation water needed to avoid undesirable stress in the crops throughout the growing cycle.

(ii) Overall performance ratio = $\dfrac{ET_p - P_e}{V_c + V_1}$

Where,

V_c = Volume of irrigation water delivered from river/reservoir

V_1 = Inflow from other sources to conveyance system.

3.6.2 Equity :

It refers to the quality of distribution of a given output. Equity may be defined as the fair share of water to users at different points in the system.

Abernethy (1990) proposed the use of inter-quartile ratio defined as the ratio of volume delivered respectively, to the most favoured upper 25% of command area and the least favoured lowest 25% of the command area. The meaning of IQR is readily grasped by a layman, so it facilitates communication among those involved in the inequity problem. The desirable density of measurements for definition of IQR is in the range 20 – 50 measurement points. Within the land area supplied from each measuring point, it is necessary to make some assumption about the degree of equity that exists downstream. Common value of IQR= 3. There is some degree of co-relation between the incidence of inequity and irregularity in supply. The areas (near canal tails) which are at the bottom of an equity curve (Fig. 3.1) are the most likely to receive their water erratically. Their season totals of water received may include periods of excess supply (for instance, after a mid-season rainfall when every one's requirements are temporarily satisfied).

3.6.3 Timeliness :

Timeliness means correspondence of water supply to crop water requirements and it relates to distribution of water supply across the season to some utility based standard. For many irrigation activities the flow rate must be near the intended flow rate for water use to be effective (Clemmens & Bos, 1990).

The simplest method to access timeliness is to calculate relative productivity potential. Monthly data appear to give a good indication of whether discharge is more or less timely supplied.

3.6.4 Sustainability :

Aspects of physical sustainability that can be affected by irrigation managers relate primarily to over or under supply of irrigation water leading to water logging or salinity.

$$\text{Sustainability} = \frac{\text{Current irrigable area}}{\text{Initial total irrigable area}}$$

The sustainability of irrigation is also determined by the ratio as follows :

$$\text{Relative Ground Water Depth} = \frac{\text{Actual groundwater depth}}{\text{Critical groundwater depth}}$$

The critical groundwater depth mostly depends on the (effective rooting depth) of the crop. If the actual groundwater depth is near the critical depth, the time interval between readings of the ratio should be near one month. One year is suitable for most other purposes.

3.6.5 Water Quality :

The characteristics of irrigation water itself have bearing on the performance of water delivery system. Temperature, sediment and dissolved salts affect the performance of irrigation system. Temperature of irrigation water through its effect on soil can affect the plant growth.

The positive effect of sediment is in its soil building role in sandy soil and supply of nutrients for crops. The negative effect of sediment can be the sealing of soil surface, raised field elevations relative to canal outlets and thereby reduced water supplies.

The effects of salt in irrigation water supplies have been researched and standards are available for various salts for crops in a given soil and climate (Ayers and Westcot, 1988 and Tyagi, 1992).

The relative change of salinity at considered locations within the irrigated area can be quantified by :

$$\text{Relative EC Ratio} = \frac{\text{Actual EC value}}{\text{Critical EC value}}$$

The critical EC-value depends on the salt tolerance of the irrigated crops. If we want to quantify the effect of a certain user on the salinity of the irrigation water in the canal system, we recommend to measure the EC upstream and downstream of the user.

The rate of change of the concentration of organic matter in irrigation water mainly results from either natural fall of leaves and branches from trees and vegetation along with the canal or disposal of trash by humans along the canals. Total dissolved organic matter (% volume), floating matter (% volume), colour and smell are recommended to be measured. An equivalent ratio as shown for EC value should be used.

The major source of chemical pollution may have either a non-agricultural or agricultural source; urban and industrial sewage water flowing into the canal, and pesticides plus fertilizer leached from the root zone. At least concentration of Nitrates

(NO_3^{-1} in meq/l) and of Phosphates (P in meq/l) are to be measured. Equivalent ratios as shown for the EC value should be used.

3.7 THE CONCEPT OF POTENTIAL PRODUCTIVITY :

(i) Irrigation systems are meant for providing water to crops for raising productivity of land and water. The excess or deficit of water supply has impact on crop yield though the effect varies with stage. The effect of water shortage may be reflected within a season where as excess application may not have immediate effect unless it creates conditions of oxygen deficiency. Review works of Doorenbos and Kassam, 1979, enables us to estimate the effect of water deficiencies on crop yield and to differentiate between effects, on ultimate yield, of water shortage that may occur at different stages in crops history. From this kind of information, we can calculate a ratio, between output that can be achieved under this water supply and the output that would have been achieved if the water supply had been ideally matched to the needs of the crop. This ratio is called potential productivity index of Abernethy (1984, 1986). It produces a number in the range 0 to 1 which would be obtainable under a given water supply regime. The execution of this calculation should take account of soil characteristics. Because, in practice, water is supplied irregularly, and what matters is not precise timeliness of delivery, but the state of the moisture content in the root zone. The potential productivity index is worked out on the basis of weekly or ten-daily averages of water inputs and outputs, with allowances for field seepage loss based on whatever local observations may be obtainable. Such an index would, in one value, sum up the system's performance in meeting crop demand fairly well if relevant data for adequacy and timeliness could be collected.

(ii) Productivity means production per unit of input. We may have a land productivity (tonnes/hectare) or yield. We may have water productivity (kg of crop/m^3 of water) or water use efficiency. Hence, input means hectare of land or m^3 of water in case of land or water respectively. Where the water management is a focus, water may be the dominant constraint on output. Fig. 3.2 (derived from Abernethy, 1985, 1986) is an observed history of water deliveries throughout one season to a land unit in Sri Lanka, where rice was the sole crop. In the figure the crop water requirement (inclusive of a seepage allowance, and with deduction made for effective rainfall) is shown. From this we see that in the early and late stages of the season deliveries were in excess of needs, where as in the middle of the season there was not enough water. If we are in conditions of overall water deficiency in this particular system, we must regard water productivity as an important facet of good management performance. We must equally be concerned with the water waste implied by the periods of over-supply. Using this reasoning, and yield versus water deficit co-efficient provided by Doorenbos & Kassam, we find that this particular water supply regime would give a land productivity (yield) of 88.0%; but gives a potential water productivity of 66.8% (i.e. less than land productivity for adequate water supply system as in case of south-east Asian rice systems); but water productivity exceeds land productivity in water deficient systems such as much of Pakistan.

The concept of potential productivity, as a numerical parameter, enables us to link adequacy and timeliness into one number or indicator of performance.

3.8 MANAGEMENT DEFECTS IN A SYSTEM :

Fig. 3.3 illustrates one way in which we can use the concept of potential productivity of water P (%) in diagnosis of the management defects in a system. P_o represents ideal case i.e. water productivity under optimally controlled conditions, with uniform distribution of water at times closely matched to crop need, and with comprehensive lining for seepage control. P_1 represents maximum attainable performance level, which depends upon available set of canals, regulators etc. As time passes, P_1 regresses to the left due to deterioration of canals and structures. The area $P_o - P_1$ is attributable to the set of physical facilities. P_2 represents the potential productivity that could be achieved, if we operate the available facilities in full accordance with operating rules. Because there are many practical constraints: the number of staff, their hours of working, distance between structures etc. These constraints will be reflected in the operating rules that are supposed to guide field staff actions. Hence $P_1 - P_2$ is attributable to the constraints upon operation rules. P_3 represents the curve that we find from direct measurement of the water distribution as it actually occurs in the system. $P_2 - P_3$ is attributable to the execution of those rules in the field. P_4 represents actual crop production obtained in the field as a proportion of the theoretically available output of the same crop, under same levels of inputs and agricultural practices, but with perfect water supply. $P_3 - P_4$ is attributable to the water application activities of individual farmers.

3.9 ECONOMIC VIABILITY OF INDICATOR :

The system manager is most likely to be concerned with the financial resources available at system level and the source of those funds. He is less concerned with overall profitability of the agriculture and least concerned with overall profitability of the irrigation project that created the system.

3.10 FINANCIAL VIABILITY OF IRRIGATION SYSTEMS :

One set of indicators concerns with efforts to raise revenues from water users that help to support management, operation and maintenance (M, O & M) costs as follows :

(i) $$\text{Total financial viability} = \frac{\text{Actual MO \& M allocation}}{\text{Total MO \& M requirements}}$$

(ii) $$\text{Return on investment} = \frac{\text{Gross value of output}}{\text{Investment for irrigation system}}$$

3.11 SOCIAL VIABILITY :

If long term sustainability of irrigation is an objective and if improving and maintaining social well being is ultimately important, then social viability is relevant from a strategic management perspective.

(i) $$\text{Administrative performance} = \frac{\begin{matrix}\text{Equivalent water rights} & + \text{ Equivalent water rights} \\ \text{paid current year} & \text{paid previous years}\end{matrix}}{\text{Total equivalentwater rights due to current year}}$$

Equivalent water rights are expressed in m^3/ha. Delayed payment of water charges may cause major annual fluctuation in above indicator of "administrative viability" which is quantified as moving average over 3 – 5 years.

(ii) $$\text{Irrigation employment generation} = \frac{\text{annual day / ha labour by schme}}{\text{Annual number of official working days}}$$

CHAPTER –IV
STUDY OF PROJECT

CHAPTER –IV

STUDY OF PROJECT

4.1 IRRIGATION SYSTEM IN STUDY AREA:-

The area selected for performance evaluation lies in the command of distributory no.2, 11,12, 13, 14 which takes off from Rushikulya main canal. Measurement of water supply i.e. discharges were taken near fifteen no. of villages in head reach, middle reach and tail reaches of distributory No. 2,11,12,13,14. (Table No.15 (a) to 19 (c) Annexure – 4)

4.2 TOPOGRAPHY OF THE COMMAND:

Topography of the command is gently sloping. The natural ground slope is defined with a well- developed drainage network draining mostly to river Rushikulya.

The area is draught-prone with annual rainfall of 1179mm (Table No.1, Annexure –4)

The principal crop is paddy in the entire command. In the existing command paddy is grown under irrigated condition. The farmers are aware of modern and improved method of cultivation. The average yield of early paddy in irrigated and non-irrigated area is 30 and 20 quintal per Ha respectively. The average yield of medium paddy in irrigated and non-irrigated area is 40 and 30 quintal per ha respectively. The average yield of HYV. Paddy in irrigated and non-irrigate area is 45 and 35 quintal per Ha. respectively. The average yield of sugarcane in irrigated and non-irrigated area is 125 and 75 quintal/Ha respectively. The average yield of groundnut irrigated and non-irrigated area is 20 and 10 quintal per Ha respectively. The average yield of vegetable in irrigated and non-irrigated area is 80 and 50 quintal per Ha respectively.

4.3 CLIMATOLOGY AND HYDROLOGY:

The climate of the command of Rushikulya Irrigation system is tropical monsoon climate. It is characterized by general wetness of the air. There are three distinct seasons in the area. The winter season from November to the end of February is followed by hot summer from March to the middle of June & the wet monsoon from mid-June to the end of October. The area experiences heavy rainfall from Southwest monsoon i.e. from June to September followed by slow rainfall due to Northeast monsoon i.e. from October to December. (Table-1, Annexure: 4)

The average annual rainfall is 1179 mm falling mostly during Southwest monsoon (64.97%). Followed by Northeast monsoon (24.26%).

Temperature & humidity are high throughout the year. (Table No. 2, Annexure: 4). The mean Maximum monthly temperature ranges from 27.9^{0}C to 32.5^0 C and the mean minimum temperature range from 17.6^{0}C to 26.8^{0}C. The mean monthly relative humidity ranges from 76.6% to 87.1%

The rain gauges were established in the command one at Dhanugaon during 1981 and other at Brahmapur during 1968; where daily observations of rainfall is taken. The monthly abstract for nineteen years (i.e. 1981 to 1999) of one raingauge station situated at Brahmapur (vicinity of the command area) is furnished in table No.1 Annexure: 4. Other climatic parameter such as temperature, humidity, wind velocity, sunshine percentage, No. of rainy days in a month along with monthly mean rainfall for the Gopalpur I.M.D. station is furnished monthwise in Table No. 2, Annexure: 4.

4.4 WATER QUALITY

It may be mentioned that people residing in the area have been using water from Rushikulya River for their domestic use and no harmful effects have been observed so far.

4.5 GROUND WATER TABLE:

A study has been made to observe the depth of ground water from surface of earth in fifteen different wells located in head reach, middle reach & tail reach of distributory No. 2, 11, 12, 13 & 14. The average area of influence for each well comes to 140~1900 ha. The results of pre-monsoon depth of GWT & post-monsoon depth of GWT after modernization are enclosed in table No. 3. Annexure: 4 along with depth of GWT during monsoon after modernization (1999). The results show that the ground water reaches the root zone only during monsoon and decreases effective rainfall in monsoon. A C^{++} program for pumping test is attached in appendix-IV for conjunctive use.

4.6 CROPPING PATTERN:

Cropping pattern & irrigation areas under different crops were taken from the records of irrigation department & are enclosed as Table No. 4, Annexure: 4

It is studied that the additional Rabi cultivation is becoming a habit of the cultivators, which was not in practice before modernization step.

The Rabi cultivation is cultivated in 7.74% of total command area under consideration. Groundnut & vegetables are the two Rabi crops, which is being cultivated in the command Area.

4.7 CROP WATER REQUIREMENT:

Monthly crop water requirement has been calculated for individual crop and furnished from table No. 5 to table No.10 of Annexure 4 with its abstract showing monthly gross irrigation requirement in table No. 11 to table No. 13 of Annexure 4.

The data of Gopalpur IMD Station (very near to command area under consideration) is furnished as follow to calculate Pan Evaporation (EP) for different months by Christiansen method.

(i) Location: Gopalpur, Ganjam, Orissa.

(ii) Latitude of command Area: 19^0 N to 20^0N: i.e. $19^0 30'$ N (Average)

(iii) Elevation of the command area: +5 to 15m above msl i.e. +10m (Average)

(iv) Average monthly mean maximum temp. = 30.84^0C at Gopalpur IMD station.

(v) Average monthly mean minimum temp. at Gopalpur IMD station = 23.29^0C.

(vi) Average monthly Mean temp. at Gopalpur IMD station = 27.07^0C

(vii) Monthly mean relative Humidity percent at 08.30 Hours at Gopalpur IMD station = 82.38.

(viii) Monthly mean relative Humidity percent at 17.30 Hours at Gopalpur IMD station = 81.08.

(ix) Monthly mean relative Humidity percent (in average) at Gopalpur IMD station = 81.73.

(x) Monthly mean wind velocity (Average) at Gopalpur IMD station (in km/day) = 229.875.

(xi) Monthly mean sun-shine percentage at Gopalpur IMD station =50

(xii) Monthly mean rainfall (mm) at Gopalpur IMD station = 98.25.

(xiii) No. of rainy days in a year =64 .

But for calculation of Pan-evaporation of different months, month-wise data should be taken from table No. 2, Annexure 4,

Mean monthly rainfall is also available in table No. 2, Annexure 4.

As per instruction of central water commission (CWC), 80% chance rainfall has been utilized for calculating effective rainfall in various reaches of canal. The factor for this chance rainfall has been adopted from the table No. 11 of the reference guide i.e. Average ratios applicable to effective rainfall in "A Guide for Estimating irrigation water requirement", by water management division, Ministry of irrigation, Government of India.

4.7.1 Effective Rainfall:

Effective rainfall supplies a portion of the consumptive use by crops. Effective rainfall means portion of total rainfall that can effective (i.e. 80% chance here).

In humid areas (i.e. in command areas of project under consideration), storms of large magnitude and high intensity occur frequently during the crop season. These storms often bring down water in excess of that which can be stored in the soil profile for consumptive use. This excess water is lost either as surface run-off or as percolation below the root zone. When such storms occur soon after an application of irrigation water, almost all the rainfall may be lost as run-off. Thus in this command area having average annual rainfall of 1179 mm and monsoon rainfall of 933 mm (during June 10 to

November 15, i.e. during Khariff crop season), the effectiveness of rainfall is relatively high.

4.7.2 Soil Characteristics :

Characteristics of soil influence the rate of infiltration, moisture holding capacity and moisture movement in the soil body; this ultimately affects the extent of effective rainfall. The soil depth, texture, structure and organic matter content of the soil influence the infiltration, permeability and moisture retention capacity of a soil. A higher infiltration rate reduces surface run-off, which increases effective rainfall. This occurs in command area under investigation due to sandy-loam type of soil in majority cases.

4.7.3 Initial Soil Moisture Content

The effective rainfall is affected by the moisture content available in the soil at the time of rainfall. The higher the moisture content, the lower the infiltration rate and higher the surface run-off which decreases effective rainfall in irrigation command of canal. The lower the moisture content, the higher the infiltration rate and lower the surface run-off which increases effective rainfall in non-irrigated command of canal. Hence in an average 80% chance rainfall has been utilized for calculating effective rainfall in canal command as per instruction of CWC.

4.7.4 Management Practices

Soil management practices, which affect the physical characteristics of, soil like infiltration, permeability, and water retention capacity, influence the extent of effective rainfall. Water conservation practices like bunding, terracing, ridging increases effectiveness of rainfall in command area under consideration.

4.7.5 Consumptive Use Rate

Where consumptive use rate of a crop is high, available moisture in the soil profile gets depleted rapidly, thus providing storage capacity at a relatively rapid rate for subsequent rainfall. When a substantial storm occurs, the amount of water required to bring the moisture in the profile back to the field capacity level would be relatively large and losses due to run-off/deep percolation would be relatively small. Hence, effective rainfall is more.

4.7.6 Net Irrigation Requirement

Net irrigation requirement depends upon capacity of soil profile at root zone depth to store readily available moisture for plant use. When capacity of soil profile at root zone depth is low, only a small percentage of the precipitation may be sufficient to fill the soil profile to field capacity and effective rainfall will be low and hence net irrigation requirement will be high.

4.8 CALCULATION OF PAN-EVAPORATION FOR DIFFERENT MONTHS BY CHRISTIANSEN METHOD

The theory and calculation of pan-evaporation has been given in Appendix – I.

4.9 CANAL OPERATION PLAN :

Within the framework of diversion head work operating rules, water distribution has been guided by the following principles.

(i) The main canal is operating continuously during land preparation, crop establishment and flowering stage of crop and intermittently during nursery and post-flowering stage.

(ii) Canal runs at FSL during continuos / intermittent supply as far as possible.

(iii) During October ~ January for vegetables and December ~ February for groundnut, partial water supply becomes necessary in distribution No. 2; which is being supplied equitably.

(iv) The off-takes from main canal has been operated on "ON & OFF" mode.

(v) The off-takes of minors has been proportionately distributed with gates. It is operated on "ON & OFF" mode.

(vi) The outlets in distributaries, minors and sub-minors are provided with proportional distributor without gate.

(vii) 266 nos. of outlets have been replaced under NWMP scheme as these were old and obsolete and their sill levels have been fixed so as to receive proportional discharge.

(viii) Farmers' committee has been formed for each outlet to watch and distribute the water among the farmers equitably.

4.10 RELATIVE WATER SUPPLY (RWS) FOR ADEQUACY

These principles have been followed for water distribution in all command. Specific delivery schedules, canal discharges etc. required for each command have been prepared according to crop water requirement. In Table No. 14(c) of Annexure – 4, the monthly water requirement (demand) in volume and discharge along with the days required in each month for the distributaries to remain open are indicated.

In Table 15 (a,b,c) to 19 (a,b,c) the monthly drawl of water (supply) at head, middle and tail reaches through the distributary No. 2, 11, 12, 13 & 14 respectively are given.

In Table 20 (a) & 20 (b) relative water supply before modernization of distributary No. 2, 11, 12,1 3 & 14 from June to November and from December to May respectively for head, middle and tail reaches are given (month-wise).

In Table 21(a) & 21(b), relative water supply after modernization of distributory No. 2,11, 12, 13 & 14 from June to November and from December to May respectively from head middle and tail reaches are given (monthwise).

In Table 22(a) & 22(b); abstract of relative water supply seasonwise i.e. from June to November and from December to May for pre-modernization and post-modernization condition respectively are given for different distributaries.

4.11 RELATIVE PRODUCTIVITY POTENTIAL FOR ADEQUACY AND TIMELINESS

In Table 23(a) & 23(b) water delivery performance in terms of relative productivity potential before modernization is mentioned. In Table 24(a) & 24(b) water delivery performance in terms of relative productivity potential after modernization is given. Crop production in these tables is collected from data's of agricultural department (blockwise collection). Table 25(a) & 25(b) gives abstract of relative productivity potential before and after modernization respectively.

4.12 INTER QUARTILE RATIO (IQR) FOR EQUITY :

Table 26(a) & 26(b) represents IQR before and after modernization for the canal system selected. Data of average volume (ha-m) delivered to the most favored upper 25% of CCA and average volume (ha-m) delivered to the least favored lowest 25% of CCA before and after modernization are collected from register of irrigation department.

4.13 RELATIVE GROUNDWATER DEPTH AND SUSTAINABILITY :

Sustainability relates to over or under supply of irrigation water leading to waterlogging or salinity.

Waterlogging of the land occurs when water table rises and soil in root zone of the plant gets saturated and air circulation is stopped. The yield of the crop is usually affected when depth of watertable below the land surface is equal to or less than the values given below for different crops i.e. below effective rooting depth.

Sl.No.	Type of Crop	Average effective rooting depth (metre)
1.	Paddy (or Rice)	0.60
2.	Sugarcane	0.9
3.	Groundnut	0.75
4.	Vegetables	0.40

Annexure – 4: Table 27(a), 27(b), 27(c) & 27(d) gives RGWD for paddy, sugarcane, groundnut and vegetables respectively.

Annexure – 4: Table 28 gives sustainability of irrigable area for last 19 years. Sustainability means long lasting or long-term existing or long term consistency in crop yield.

CHAPTER –V
DISCUSSION ON STUDY

CHAPTER-V

DISCUSSION ON STUDY

Agricultural Growth with social justice depends mostly on the development of water-resources and its proper distribution, as water is one of the prime inputs for adopting the modern technology of agriculture. The National Commission on Agriculture has estimated that when all the water-resources have been developed only about 110 million hectares of cropped area out of a gross sown area of about 210 million hectares (in future) can be irrigated provided the most efficient use of irrigation is made through water distribution, minimizing losses in conveyance, preparation of fields and adoption of suitable cropping pattern taking into account soil & agro-climatic factors.

Satisfactory distribution and efficiency of irrigation water use depends on:

a) Efficiency of the conveyance system (0.8~0.9 in our case) from head of the canal upto each outlet of about 40 ha block.

b) Operation and regulation efficiency of the canal system.

c) Efficiency of the conveyance system and equitable distribution of water within the 40 ha block.

d) Field application (evaporation) efficiency (0.6~0.9 in our case).

Improvement in the efficiency of the conveyance system upto the outlet of 40 ha block is receiving adequate attention.

5.1 ROTATIONAL SYSTEM OF CANAL IRRIGATION

The responsibility for development of water resources for irrigation upto the irrigation outlet (commanding an area of about 10 to 40 ha) rests with the state irrigation department. The distribution of water beyond such outlets has been left to the farmers although it is expected that the state departments of agriculture/irrigation would provide farmers technical guidance. But due to lack of water distribution system within the outlet command (field channels) upto each holding and there being no organized institutional arrangement for allocation & distribution of water among the numerous farmers within each outlet command in this area under case study, the efficiency of water use within the outlet commands had been very low before modernization. The cultivators who are responsible for distribution of water among themselves seldom join together to construct field channels, maintain & operate the field channels to achieve equitable distribution of water among themselves. As a result, the method of water distribution in this area under case study had been one of continuous flooding under which water flows from one field to the next. In such an arrangement, the farmers did not have any control over the water. The farmers in the head reaches & those socially prominent utilized bulk of the available water, denying the tail-enders and the weaker sections their due share. This resulted in excessive irrigation in some areas leading to waterlogging (See table 27 (a), and scarcity of water in other areas causing reduction in yield. Therefore to ensure the availability of water to each & every farmers within the outlet command independently and on an equitable basis, a system of field channels were constructed by CADA, ORISSA and rotational method of distribution was adopted within the outlet command after modernization.

5.2 RECENT FIELD MANAGEMENT PRACTICES:

(a) Paddy during Khariff

The distributaries run continuously during the period of transplanting of paddy and thereafter the supplies are rotated depending upon the rainfall. (See table 14(d) Annexure:4)

b) Paddy during Rabi

All the minors & S/M from the particular distributary (Disty. No. 2) don't run simultaneously and are opened in rotation within a period of one week for which a distribuory runs at a time. The outlets are fixed depending on field requirement. The water supply is controlled with the help of Head regulators of minors & S/MS. The water supply level varies from time to time depending on the requirement. (see table 14 (e), Annexure: 4

c) Distribution of water within the outlet command:

The farmers have rotation system of distribution of water among themselves on $1\frac{1}{2}$ to 4 days basis for paddy crops and a large interval other crops. Here the water allocation is for a specified crop in a season. Penalty is levied for any deviation, especially if paddy is grown in an unspecified area or season.

d) Regulation Of Canal System

The downstream control system of regulation envisages the demand of the farmers being judged & reported by J.E to A.E, minorwise & distributary-wise taking into account the rainfall, area under different crops and crop water requirements. The A.E's report demands the E.E & S.E, to control the releases of the main canal. Care is taken to limit demands within the water available in a particular crop season. The regulation order for the release of water in different distributary and minors are issued on the basis of demand from the field. Generally the distributory or minor is run with 10% over or upto 20% below the full capacity depending on the demand.

Regulation of the system is facilitated through a set of gauges duly calibrated from time to time, fixed on all channels from the distributory to the minor at the head of the channels & at every 15~20 km, depending upon the location of the structures like falls, escapes & regulators. Readings are reported daily through a system of telegram & telephone to all concerned officers of the irrigation department. Regulators & various types of gates are used to control the flow of water.

5.3 LIMITATION OF EXISTING ENGINEERING INFRASTRUCTURE:

a) Canal System

i) The canal capacities & control structures were inadequate for meeting peak demand at the right time, for which modernization was needed.

ii) Inadequate maintenance of the canal system due to lack of funds & inadequate technical attention for which equity, adequacy, timeliness & sustainability deviates from ideal conditions.

iii) Some of the canal systems are designed for a rigid cropping pattern & 100% intensity of irrigation in a crop season, which leaves little choice for more efficient use of water. (See table 14(c); Annexure: 4)

iv) Lack of or inadequate provision for drainage system which limits the choice of crop & intensity of irrigation. (See table 4, Annexure 4)

b) Regulation Of Canal System

The upstream control system is inefficient & does not satisfy to the farmer in terms of timely & reliable supply. Hence downstream control system is adopted in our case.

c) Distribution of water among the farmers within the outlet command

i) Absence of any institutional or regular system for equitable distribution of water among the farmers.

ii) Eratic rainfall in Khariff Season.

iii) Defective Waraband design (Punjab) i.e. quantity of water per ha among the tail end farmers is less compared to those in upper reach because of losses in earthen field channels not being taken in to account.

iv) Defective Osrabandi System (U.P) i.e. user groups are formed on the basis of inter-personal relationship leading to wastage of water due to scattered field.

v) The fixation of cropping pattern is less acceptable to the farmers due to wide fluctuation of market rate for various crops from year to year.

5.4. EQUITY

IQR has been taken as a measure of equity. From 26(a); Annexure: 4 average equity is 0.755 before modernization for the system under case study. From table 26(b); Annexure: 4, average equity is 0.995 after modernization for the system under case study, i.e. performance is good (0.85~1.00). Form table 26(b); Annexure : 4, the IQR value at the lowest discharge of 0.420 cumecs (in Disty No. 12) is 0.787 & it increases to 1.576 at the highest discharge of 4.60 Cumecs with an average value of 1.005. In otherwords, the farms located in the highest discharge canal is receiving nearly turice the watersupply to the lowest discharge canal.

5.5. RELATIVE WATER SUPPLY (RWS)

RWS (Table No: 22(a) & 22(b); Annexure: 4) for adequacy varies across the distributory, season wise & reach wise . Distributory No. 2 has relatively higher adequacy of about 49% & 77% respectively before and after modernization as compared to disty. No. 12 with lower adequacy of 32% and 74% respectively before & after modernization.

RWS values during Khariff season, (i.e June to Nov.) when crop water requirement are partly met by rainfall, were higher by 3%~13% as compared to Rabi season (i.e. December to May). There is marked variation in RWS along the distributory with the values at the head exceeding those at the tail by 25% (Disty No. 2. i.e. 61% at head reach in Khariff & 36% in tail reach in Rabi in Rabi; table No. 22(a); Annexure:4)

The average value at the head of distributory No.2 in Rabi is 50% as against 36% in tail reach in Rabi. (Table No. 22(a); Annexure: 4). Such large difference of 14% obviously call for immediate modernization & decreases the difference from 14% to 7% (see table No. 22(b); Annexure: 4).

Before modernization adequacy was in poor performance class i.e.<0.70 (see table No.22 (a); Annexure: 4) & after modernization adequacy is in fair performance class i.e. 0.7~0.9 (see table No. 22(b); Annexure: 4)

5.6 PRODUCTIVITY OF WATER DELIVERY

The computed values of productivity are given in Table No.25(a) & 25(b); Annexure: 4. Like RWS, the productivity of water delivery is higher in the head reaches of all the distributaries, the average value during Khariff (June to Nov.) being 0.228 in head reach as against 0.198 in tail reach (Table 25 (a); Annexure: 4)

The relative productivity potential is higher during Rabi (Dec. to May) as compared to Khariff (June to Nov). (See Table 25(a) and 25(b); Annexure: 4). This may be due to occurrence of rain during supply periods in Khariff Season. In such cases, Supply is rendered surplus. Higher sensitivity of crops grown during Khariff (June to Nov) to moisture stress could also be the reason for low water productivity.

The values of productivity are lower than seasonal RWS. Compare Table 22(a) with 25(a) and 22(b) with 25(b) of Annexure: 4). It speaks of the mismatch between Supply and Demand with respect to time.

Before modernization average productivity was 0.207 (See Table 25(a); Annexure: 4) i.e. poor timeliness performance class. After modernization average productivity is 0.350(See Table No.25(b); Annexure: 4) i.e. Fair timeliness performance class. Individually Disty. No.2 has fair timeliness performance i.e. (0.25~0.75) because of cultivation of both Khariff and Rabi crop.

Sustainability (Table No.28, Annexure: 4) comes under good performance class after modernization.

Actual MO & M allocation in 1999 to 2000 was Rs. 241.00 per ha; whereas total MO & M requirement is Rs. 700.00 per ha. Hence financial viability is 0.344 i.e. very low.Av. Gross value of extra output is Rs. 4433.33 per ha(95-96); investment for irrigation system is Rs. 2758.32 per ha.(Investment is Rs. 378.80 lakh for irrigating 13,733 Ha land)

Besides irrigation employment generation is 576 per ha (i.e. increase by 40%) and per capita income increases by 30% after modernization (Report from District Headquarter).

Table no. 29 (Annexure:4) gives abstract of performance standards before and after modernization. Table no 30(a) (Annexure:4) gives proposed project benefit (Net) as in 1992-93. Table no.30.(b) (Annexure:4) gives actual project benefit as in 1999-2000. Table 31(a) (Annexure:4) gives Ethnic composition and their land. Table 31(b) (Annexure:4) gives land distribution of different category farmers as collected from Tehasil office. Table 32 (Annexure:4) gives operation and maintenance Budget and Expenditure from 1990-91 to 1999-2000. Table 33 (a) (Annexure:4) gives Irrigation Service Fee collection before and after modernization. Table 33(b) (Annexure:4) compares Expenditure and collection from1990-91 to 1999-2000. Table (Statement) 34 (Annexure:4) gives present Benefit –Cost ratio. Table 35(a) and 35(b) (Annexure:4) gives abstract of average Demand and Supply indifferent distributaries before and after modernization respectively. Table 36(a) (Annexure:4) gives seepage loss in canals. Table 36(b) (Annexure:4) gives cost needed to prevent canal seepage. Table 37(Annexure:4) gives Extra water requirement (Ha-m) from private tube-well after modernization. Table 38 (Annexure:4) gives no, Discharge rate, working hour, working days, head, H.P., hiring charge of private tube-well. Table 39 (Annexure:4) gives land irrigated by different type of irrigation. Table 40 (Annexure:4) gives cost economy for different types of irrigation. Figure 4.1 to 4.20 explains it diagrammatically.

CHAPTER –VI
CONCLUSION AND SUGGESTION FOR FUTURE STUDY AND RESEARCH

CHAPTER – VI

CONCLUSIONS AND SUGGESTION FOR FUTURE STUDY AND RESEARCH

6.1 CONCLUSIONS

The art and science of evaluating the performance of irrigation system is still in evolving stage. There is lack of field studies to correctly evaluate the usefulness of performance indicators. Further, no uniform standards are available to judge the performance as good or bad. Evaluation of water delivery perfomance using the currently available measures indicated that major shortcomings in the system were :

(a) Lack of volumetric equity due to non-compensation of time for the water lost in conveyance and larger size unit command areas.

(b) Temporal mismatch between supply and demand, mainly due to system capacity constraint which makes it difficult to meet peak demand efficiently. Also fixed frequency schedules that are in vogue do not necessarily match with the demand for water.

These problems are amenable to solution with certain modification in the existing system. Some of the improvements are as follows :

(i) Provision of optimum unit command size (i.e. 40 ha).

(ii) Provision of variable Warabandi time schedule from head to tail to compensate for the conveyance losses.

(iii) Provision of auxiliary storage at water course level during peak supply period for releasing stored water during peak demand period.

(iv) Intra-seasonal change in water delivery schedules to provide irrigation at more critical stages.

6.2 SUGGESTION FOR FUTURE STUDY AND RESEARCH

6.2.1 Proper Land Development

There are generally small holdings, which should be consolidated. The land is usually partitioned along with every division of the family. It results in a decrease in the size of the holding after every partition. Partitioning of land can be prevented by proper legislation.

Proper grading of land is necessary for border strip method / check method / furrow method. Ploughing of the land should be done at the proper time and to the required depth. Organic and inorganic manures should be applied wherever required.

A large number of CADA have now been created to look into problem of land development, field channel construction, drainage at the farm level for deriving maximum benefits from the existing irrigation potential.

6.2.2 Construction of Water Courses and Field Channels

The responsibility of state irrigation department ends after bringing enough water upto canal outlet. But due to being non-educated, cultivators could not construct, operate and maintain the field channels and regulate the structures on the water courses properly. Hence water courses and field channels are being constructed by the department at the cultivator's cost; but are handed over to cultivators for proper maintenance. However, cultivators should construct field channels under CADA programme having free loan facility.

6.2.3 Selection of Efficient Method of Application of Water

Flooding method is most common, but it is inefficient and leads to wastage of water through deep percolation and evaporation. Hence border strip method / furrow method / sprinkler method / drip method depending on soil type, ground slope, crop type, climate should be encouraged.

6.2.4 Introducing Volumetric Assessment of Water

It is the general practice to charge the water rates based on the irrigated area. Hence cultivators have the tendency to use excess water because the charges are fixed, which leads to wastage of water and inefficient application. By introducing the volumetric assessment, in which charges are based on the volume of water actually used by the cultivators, wastage is reduced. For encouraging some minimum use, a lower rate may sometimes be charged upto a limiting depth of water depending on type of crop. It requires installation, calibration, and maintenance of a large of water meters. It is a task to keep records and to prevent tampering of meters.

The water rate should be charged according to time of supply of water. It rate is same throughout the crop period, cultivators have a tendency to delay irrigation till last moment expecting some rainfall. It leads to concentration of demand over a short period and very little demand during rest of crop period. By introducing a differential water rate for different periods, demand will be made more uniform. Charges should be high for summer months to discourage field cropping because of higher consumptive use of water.

6.2.5 Introducing Roster System

It is the general practice that all the cultivators take their supply from the water-course simultaneously. The supply has to be continued for a long time so that all cultivators get the required water for irrigation. This leads to uneconomical use of water because of increased losses. The water is used more effectively in a roster system i.e. water is supplied to the cultivators of a water course turn by turn i.e. at an interval of 10 to 14 days depending upon the type of crop.

The wastage of water is reduced because the large size stream is used for a small period. This method is suitable for drought conditions. It needs efficient staff for outlet operation.

6.2.6 Lining of Field Channels and Water Courses

About 35% to 50% of water is lost in the water course and field channels beyond the outlet; which can be reduced either by lining channels or by closed conduits. Unlined water courses are shallow and are susceptible to weed growth which reduces conveying capacity.

6.2.7 Proper Maintenance of Irrigation System

It includes clearance of sediments and weeds and repair of cracks and holes in canal banks. Negligence in maintenance may lead to breaches and to loss of irrigation water. If sediments and weeds are not removed, conveying capacity is reduced. Scouring of the canal bed and sides increases the wetted perimeter and seepage losses. The possibility of undermining of structures can not be denied. It may cause a substantial lowering of the FSL and a loss of command. Generally canal system is closed in May and June for maintenance and repair of structures. This would give more production.

6.2.8 Discouraging Irrigation during Extreme Summer

Evapotranspiration (or conjunctive use) is high in May and June. Hence irrigation during night should be encouraged to reduce loss.

6.2.9 Selection of Crops

By proper selection of high yielding crops, the effective use of water is made. The irrigation engineer should be in close touch with agronomist and cultivators before taking decisions about water supply.

6.2.10 Improving Agronomic Practice

A basic knowledge of agronomic science is needed for effective use of water. The lack of knowledge leads to wastage of water. Untimely application of water and in doses higher than the actual requirements of the plants result in the wastage of water. Moreover, it is injurious to land and plant and results in low crop yield.

There is no reduction in yield of wheat, jowar, bajra, even when the available moisture content (AMC) is depleted by 50% or so. Rice does not require constant submergence of water all the time (except tillering stage). By keeping a standing depth of water over the rice field, large percolation and evaporation loss occurs.

Different soils have different water holding capacity. The field irrigation requirement should be worked out with due regard to effective rainfall during crop period and field losses. Knowing field irrigation requirements, the frequency of application of water and depth of water in each application can be determined. For proper utilization of water, an irrigation schedule should be prepared. Losses can be reduced by proper selection of irrigation method, size of stream, duration of irrigation run.

6.2.11 Adopting Intensive Irrigation

In extensive irrigation, irrigation benefits are extended to as large an area as possible. In intensive irrigation and small irrigation projects, efficiency is high, control is better, return is quick and high, water-logging is avoided.

6.2.12 Making Conjunctive Use of Water

It makes utilization of both the surface water and ground water. In the surface irrigation, there is recharge of ground water and water table rises which may create water-logging. In well irrigation, water table goes down because of withdrawal of ground water. By making the conjunctive use of water, ill effects of both are eliminated. This is achieved by adopting the well irrigation in a part of command area of the canal. On an average, if about one-third of the command area is irrigated by well irrigation and two-thirds by canals, the maximum utilization of the available potential is generally achieved.

6.2.13 Drainage

Adequate provision and maintenance of drainage system is essential.

6.2.14 Training

Organizing and training farmers for distributing water among themselves within the outlet command, and at a later time to operate the minor.

6.2.15 Water Rate

The water rate for various crops should have an inter-relationship which would encourage the irrigation of light irrigated crops even during Khariff, for bringing about stability in the production and utilization of available water.

6.2.16 Warabandi

In the projects where field channels have been constructed, Warabandi should be introduced at least on two distributaries on a trial basis. Where the system is already in vogue, Warabandi may be improved upon and extended to all projects.

6.2.17 Downstream Control System

Downstream control system of canal regulation may first be tried with necessary administrative support. Based on this experience needed legislation and organization requirements should be arrived at and detailed guidelines prepared by each state for introducing it in all irrigation projects together with Warabandi. (i.e. system of equitable distribution of water among the farmers within the outlet command on a weekly or multiple of a week basis).

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APPENDICES

APPENDIX-1

CALCULATION OF PAN-EVAPORATIN FOR DIFFERENT MONTHS BY CHRISTIANSEN METHOD:

The water Management Division of the Ministry of Agriculture has been using the popular Christiansen Method in which pan evaporation is computed from the climatolgical data as follows:

$$\mathbf{EP = 0.459\ R.C_t.\ C_w.C_h.\ C_s.\ C_e}$$

Where, EP = computed pan evaporation equivalent to class-A pan evaporation in mm.

R = Extra-terrestrial radiation, in same evaporation unit as EP i.e. in mm (From Table1of reference guide)

C_t = Co-efficient of temperature = $0.393 + 0.02796t + 0.0001189\ t^2$ (or from table 2 of reference guide)

t = temperature in ^{0}C

C_W = Co-efficient of wind velocity based on mean wind velocity (Km/day) at 0.5 meter above ground.

$= 0.708 + 0.0034\ W - 0.0000038W^2$

(or from Table –3 of reference Guide)

W = mean wind velocity in Km/day at 0.5meter above ground.

C_h = Co-efficient of relative humidity

$= 1.250 - 0.0087\ H + 0.75 \times 10^{-4}H^2 - 0.85 \times 10^{-8}\ H^4$

(or from table-4 of reference Guide)

H = mean relative humidity at noon.

C_s = Co-efficient for percent of possible sun-shine hour

$= 0.542 + 0.008S - 0.78 \times 10^{-4}S^2 + 0.62 \times 10^{-6}S^3$

(or from table –5 of reference Guide)

S = mean sunshine percent.

C_e = Co-efficient of elevation

$= 0.97 \times 0.00984\ E$

(or from table-6 of reference Guide)

E = Elevation expressed in hundreds of meter

C_u or ET crop $= K_C .EP$

Where, C_u = consumptive use for a specific period.

ET crop = crop evapo-transpiration

K_c = crop factor of that period

EP = calculated pan-evaporation of that period.

EVAPORATION CALCULATION (EP) FOR DIFFERENT MONTHS

JANUARY:

For latitude 19^0 30′ N; mean monthly values of extra terrestrial radiation (R) is:

$$R = 347.22 + \left(\frac{381.00 - 347.22}{5}\right)(0.5) = 350.6mm$$ (or from table-1 of reference guide)

From table –2 of guide:

For mean temp. 22.85°C; Co-efficient of temperature (C_t) is:

$$C_t = 1.092 + \left(\frac{1.11 - 1.092}{23.33 - 22.78}\right) (22.85 - 22.78) = 1.094$$

From table - 3 of guide:

For wind velocity W= 101 Km/ day

Co-efficient of wind velocity is:

C_W=1.012

From table –4 of guide :

For mean relative humidity 77.65% ,

Co-efficient of humidity is :

$$C_h = 0.726 - \left(\frac{0.726 - 0.713}{1.00}\right)(0.65) = 0.718$$

From table –5 of guide

For sunshine percent $\frac{11hr}{24hr} = 46\%$

Co-efficient of percent of possible sunshine hour is :

C_s=0.805

From table-6 of guide

For average elevation of 10m;

Co-efficient of elevation C_e is :

$$C_e = 0.970 + \left(\frac{0.973 - 0.970}{30}\right)(10) = 0.971$$

EP=(0.459) (350.6)(1.094)(1.012)(0.718)(0.805)(0.971)=99.991mm $\simeq$ **100mm**

FEBRUARY:

From table –1;

For latitude $19^0 30'$N

$$R = 353.82 + \left(\frac{378.21 - 353.82}{5}\right)(0.5) = 356.26$$

From table-2;for monthly mean temp. 24.7^0C;

$$C_t = 1.148 + \left(\frac{1.167 - 1.148}{25.00 - 24.44}\right)(24.7-24.44) = 1.157$$

From table –3; for wind velocity =92Km/day;

C_W=0.988

From table –4; for relative humidity = 80.65

C_h=0.686-(0.686-0.671)(0.65)=0.676

From table –5 ; for sunshine percent $= \frac{11.5hr}{24hr} = 48\%$

C_s=0.815

From table –6; for average elevation 10m;

C_e=0.971

EP=(0.459)(356.26)(1.57)(0.988)(0.676)(0.815)(0.971)=99.998mm $\simeq$ **100mm**

MARCH:

From table-1:

For latitude $19^0 30'$ N;

$$R = 445.52 + \left(\frac{461.26 - 445.52}{5.00}\right)(0.5) = 447.1\text{mm}$$

From table-2:

For monthly mean temp.26.85^0C;

$$C_t = 1.224 + \left(\frac{1.243 - 1.224}{27.22 - 26.67}\right)(26.85 - 26.67) = 1.230$$

From table –3:

For wind velocity =246Km/day;

C_w=1.130

From table –4:

For average relative humidity 82.95%;

C_h=0.642

From table –5:

For sun-shine percent $= \frac{12\text{hr}}{24\text{hr}}$ =50%;

C_s=0.825

From table-6:

For average elevation 10m;

C_e=0.971

EP= (0.459)(447.1)(1.230)(1.130)(0.642)(0.825)(0.971)=170.06 $\simeq$ **170mm**

APRIL:

From table-1:

For latitude $19^0 30'N$;

$R=471.17\left(\frac{473.2-471.17}{5.0}\right)(0.5)=471.37mm$

From table –2;

For average monthly temp.of 28.15^0C

$C_t=1.262+\left(\frac{1.281-1.262}{28.33-27.78}\right)\ (28.15-27.78)=1.275$

From table –3;

For average wind velocity= 674 Km/day

$C_W=1.55$

From table –4;

For average relative humidity =83.35%;

$C_n=0.641-\left(\frac{0.641-0.625}{84-83}\right)(83.35-83.0)=0.635$

From table –5;

For sun-shine percentage $\frac{12.6hr}{24.0hr}$ =52.5%

$C_s=0.834$

From table –6

For average elevation of 10m;

$C_e=0.971$

EP=(0.459)(471.37)(1.275)(1.55)(0.635)(0.834)(0.971)=219.87 mm $\simeq$ **220mm**

MAY:

From table –1: for Lat. $19^0 30'$N;

$$R=512.06-\left(\frac{512.06-505.97}{5}\right)(0.5)=511.45$$

From table –2:

For average monthly temp. of 29.6^0C;

$$C_t=1.320+\left(\frac{1.339-1.320}{30.00-29.44}\right)(29.6-29.44)=1.325$$

From table –3:

For wind velocity 871Km/day;

C_h=1.624

From table-4:

For average relative humidity 85.3%;

$$C_h=0.609-\left(\frac{0.609-0.592}{86-85}\right)(85.3-85.0)=0.604$$

From table –5:

For sunshine percent; $\frac{13.10hr}{24.00hr} = 54.5\%$

C_s=0.844.

From table –6

For average elevation 10m;

C_e=0.971

EP=(0.459)(511.45)(1.325)(1.624)(0.604)(0.844)(0.971)=250.04 $\simeq$ **250mm**

JUNE:

From table –1: For lat. $19^0 30'N$;

$$R = 494.28 - \left(\frac{494.28 - 479.80}{5.00}\right)(0.5) = 492.83$$

From table –2:

For average monthly temp. of 29.6^0C;

$C_t = 1.325$

From table –3:

For wind velocity 137 Km/day;

$C_w = 1.100$

From table-4:

For average monthly relative humiduty 84.2%;

$$C_h = 0.625 - \left(\frac{0.625 - 0.609}{85.0 - 84.0}\right)(84.2 - 84.0) = 0.622$$

From table –5:

For sun-shine percentage $\frac{13.30hr}{24.00hr} = 0.554 = 55.4\%$

$C_s = 0.854$

From table –6:

For average elvation 10m;

$C_e = 0971$

EP=(0.459)(492.83)(1.325)(1.100)(0.622)(0.854)(0.971)=170.05 mm $\simeq$ **170mm**

JULY:

From table –1:

For lat. $19^0 30'N$;

$R=509.02-\left(\frac{509.02-496.57}{20-15}\right)(20.0-19.5)=507.78$

From table –2:

For mean monthly temp. 28.9^{0}C;

C_t=1.300

From table –3:

For wind velocity 107 Km/day;

C_w=1.027

From table –4:

For mean monthly relative humidity 86.25%;

$C_h=0.592-\left(\frac{0.592-0.574}{87-86}\right)(86.25-86.0)=0.588$

From table –5:

For sunshine percentage i.e $\frac{13.20hr}{24.00hr}=0.55=55\%$

C_s=0.844

From table-6:

For average elevation 10m;

C_e=0.971

EP=(0.459)(507.78)(1.300)(1.027)(0.588)(0.844)(0.971)=149.95mm $\simeq$ **150mm**

AUGUST:

From table –1:

For lat. 19^{0}30′N;

$R=497.08-\left(\frac{497.08-494.03}{20-15}\right)(20.0-19.5)=496.78$

From table-2:

For mean monthly temp. 28.75^{0}C;

$C_t=1.281+\left(\frac{1.300-1.281}{28.89-28.33}\right)(28.75-28.33)=1.295$

From table –3:

For wind velocity 121.5 Km/day;

C_w=1.063

From table-4:

For mean monthly relative humidity 86.1%;

$C_h=0.592-\left(\frac{0.592-0.574}{87-86}\right)(86.1-86.0)=0.590$

From table-5:

For sun-shine percentage $\frac{12.8hr}{24.0hr}$ =0.53=53%

C_s=0.834

EP=(0.459)(496.78)(1.295)(1.063)(0.590)(0.834)(0.971)=149.97mm $\simeq$ **150mm**

SEPTEMBER:

From table –1:

For lat. 19^{0}30′N;

$R=450.09+\left(\frac{459.99-450.09}{20-15}\right)(20.0-19.5)=451.08$

From table –2:

For mean monthly temp. 28.8^{0}C;

$C_t=1.281+\left(\frac{1.300-1.281}{28.89-28.33}\right)(28.80-28.33)=1.297$

From table –3:

For wind velocity 160 km/day;

C_w=1.153

From table –4:

For average monthly relative humidity 85.25%

$C_h=0.609-\left(\frac{0.609-0.592}{86-85}\right)(85.25-85.00)=0.605$

From table-5:

For sun shine percentage $\frac{12.30hr}{24.00hr}$=0.51=51%

C_s=0.825

From table –6:

For average elevation 10m;

C_e=0.971

EP=(0.459)(451.08)(1.297)(1.153)(0.605)(0.825)(0.971)=150.06 mm **≃150mm**

OCTOBER:

From table –1:

For lat. 19^0-30′N;

$$R = 413.00 + \left(\frac{436.12 - 413.0}{20 - 15}\right)(20.0\text{-}19.5) = 415.31$$

From table-2:

For mean monthly temp. 28.1^0C;

$$C_t = 1.262 + \left(\frac{1.281 - 1.262}{28.33 - 27.78}\right)(28.10\text{-}27.78) = 1.273$$

From table-3:

For wind velocity 92 km/day;

C_w= 0.987

From table-4:

For av. Monthly relative humidity 80.0% ;

C_h = 0.686

From table-5:

For sunshine percentage $\frac{11.7hr}{24.0hr}$ = 0.49=49%

C_s = 0.815

From table-6:

For av. Elevation 10m;

C_e = 0.971

EP=(0.459)(415.31) (1.273)(0.987) (0.686) (0.815) (0.971)

= 130.03 mm $\simeq$ **130 mm**

NOVEMBER:

From table-1:

For lat. $19^0 30'$N;

$$R=349.00+\left(\frac{379.73-349.00}{20-15}\right)(20.0-19.5)=352.07$$

From table-2:

For mean monthly temp. 25.45^0C;

$$C_t= 1.167+\left(\frac{1.186-1.167}{25.56-25.00}\right)(25.45-25.00)= 1.182$$

From table-3:

For wind velocity 52 km/day;

$$C_w = 0.863+\left(\frac{0.877-0.863}{53-48}\right)(52-48)=0.874$$

From table-4:

For mean monthly relative humidity 73.6%;

$$C_h =0.773-\left(\frac{0.773-0.762}{74-73}\right)(73.6-73.0)=0.766$$

From table-5:

For sunshine percentage $\frac{11.00hr}{24.00hr}$=0.47= 47%

C_s = 0.805

From table-6:

For av. Elevation 10m;

C_e= 0.971

EP=(0.459) (352.07) (1.182) (0.874) (0.766) (0.805) (0.971)

=99.96mm$\simeq$ **100mm**

DECEMBER:

From table-1:

For lat. $19^0 30'N$;

$$R = 333.76+\left(\frac{369.06-333.76}{20-15}\right)(20.0-19.5)=337.29$$

From table-2:

For mean monthly temp. 23.05^0C;

$$C_t=1.092+\left(\frac{1.110-1.092}{23.33-22.78}\right)(23.05-22.78)=1.100$$

From table-3:

For wind velocity 105 km/day;

$C_W = 1.021$

From table-4:

For mean monthly relative humidity 75.4%

$$C_h=0.75-\left(\frac{0.750-0.738}{76-75}\right)(75.4-75.0)=0.745$$

From table-5:

For sunshine percentage $\frac{10.90hr}{24.00hr}$ =0.45 i.e. 45%

Cs=0.796

From table-6:

For av. elevation 10m;

C_e =0.971

EP = (0.459) (337.29) (1.100) (1.021) (0.745) (0.796) (0.971)

= 100. 12mm $\simeq$ **100mm**

LIST OF TABLES

ANNEXURE-1

Table-1

SALIENT FEATURES OF RUSHIKULYA IRRIGATION SYSTEM:

LOCATION:

STATE	:	Orissa
District	:	Ganjam
Latitude	:	19^0 N to 20^0 N
Longitude	:	84^0 30^1 E to 85^0 E
Elevation	:	+5m to +15m

RESERVOIRS:

Bhanjanagar Reservoir

Sorada Reservoir

DIVERSION WEIRS:

(i) Gallery Anicut across Badanadi at sorismali

(ii) Madharbarida Anicut across Badanadi at Madhabarida.

(iii) *Janivilly Anicut* across Rushikulya at Janivilly.

(iv) Padma Anicut across Padma at sorada.

CATCHMENT AREAS:

(i) Bhanjanagar Reservoir ... 65 sq.km

(ii) Sorada Reservoir .... 19 sq.km

(iii) Gallery Anicut .... 430 sq.km

(iv) Madhabarida Anicut .... 2255 sq.km

(v) Janivilly Anicut .... 1813 sq.km

(vi) Padma Anicut .... 498 sq.km

5080 sq.km

DISTRIBUTION SYSTEM

MAIN CANALS

(i) Gallery Canal .... 10.50 Km

(ii) Mahandadi Canal......................... 31.00 Km

(iii) Rushikulya Canal......................... 87.50 Km

(v) Distributaries, minors & s/m ......528.00 Km

COMMAND AREA:

(i) Gallery Anicut to Bhanjanagar reservoir: 808Ha

(ii) Bhanjanagar Reservoir 1342Ha

(iii) Madhabarida Anicut 8156Ha

(iv) Rushikulya canal taking off

from *Janivilly Anicut*.............. 50,925Ha

Cincluding

13,733Ha

Under NWMP)

61,231 Ha

BENEFITS:

Improvement to CCA (under NWMP)..... 13,733 Ha

Cost of improvement (NWMP)............... 378.80 Lakh

TABLE NO: 1
ANNEXURE: 2
Salient Features of Distributors (With System) Under Case Study

Serial No.	Name of canal	Length (KM)	CCA(Ha)	Design Discharge (cumecs)	No. of direct outlet including tail cluster
1	2	3	4	5	6
1	Distributay No. 2	20.52	1880.21	2.79	74
2	Mahupadar S/M	0.87	133.60	0.0935	4
3	Pital Minor	8.625	921.58	0.69	39
4	Minor No. I	3.017	536.60	0.41	14
5	Minor No. II	1.804	360.01	0.28	14
Sub-Total		**$\sum$= 34 .836**	**$\sum$=3832.00**		**$\sum$=145**
6	Distributary No. 11	25.00	2141.00	4.60	175
7	Jhahdonkoli Minor	1.270	406.00	0.284	10
8	Badagumula Minor	1.430	140.00	0.098	10
9	Luhajore Minor	0.912	240.00	0.168	7
10	Narendrapur Minor	1.060	168.00	0.118	10
11	Ambapur Minor	1.615	139.00	0.107	8

12	Raghunath-pur Minor	1.920	150.00	0.153	9
13	Pathara Minor	1.825	445.00	0.342	6
14	Sindhigaon Minor	2.300	537.00	0.412	20
15	Musidipalam Minor	1.410	193.00	0.148	7
16	Aruapalli Minor	1.710	122.00	1.200	15
Sub-Total		**∑=40.452**	**∑=4681.00**		**∑=277**
17	Distributary No. 12	2.610	409.00	0.420	13
18	Bankeyapali Minor	0.622	134.00	0.128	3
Sub-Total		**∑=3.232**	**∑=543.00**		**∑=16**
19	Distributary No. 13	12.000	1036.00	1.86	52
20	"A" Minor	4.220	699.00	0.52	19
21	"B" Minor	1.800	336.00	0.26	9
22	"C" Minor	1.700	137.00	0.10	9
23	"D" Minor	0.600	19.00	0.02	3
24	"E" Minor	2.900	141.00	0.108	10
25	"F" Minor	1.552	110.00	0.08	9
Sub-Total		**∑=24.772**	**∑=2478.00**		**∑=110**
26	Distributary No. 14	10.00	623.00	1.89	39
27	Majhidiho Minor	1.44	318.00	0.23	13
28	Sanathana Minor	5.00	571.00	0.42	22

29	Right Minor	1.40	63.00	0.08	2
30	Baghala Sub-Minor	1.40	88.00	0.11	4
31	Left Minor	3.20	244.00	0.32	13
32	Gopinathpur Sub-Minor	2.00	119.00	0.15	6
33	Damodarpur Sub-Minor	0.60	173.00	0.13	3
Sub - Total		$\sum$=25.04	$\sum$=2199.00		$\sum$=102
Grand Total		**128.332**	**13,733.00**		**650**

ANNEXURE: 2

TABLE NO. 2 : DETAILS OF INFRASTRUCTURE OF DISTRIBUTARIES ALONG WITH ITS SYSTEM

Sl No.	Name of canal	Lining length (km) for slope protection	Road communication length (km) for inspection of vehicle	No of structures (Renovation)								No. of structures (new construction / replacement)							Total no. of renovated structures	Total no. of newly constructed/ replaced structures	Total no. of structures renovated replaced
				Head Regulator	Canal syphon	Fall	Cross Regulator	Drainage syphon	Surplus escape	Inlet	Outlet	Cross Regulator	Drainage syphon	Measuring device i.e. standing wave flumes	Inlet	Outlet	Canal syphon	Escape			
1.	Distributory No. 2	1.400	10.00	1	8	2	2	15	7	12	40	2	-	5	5	27	1	-	87	40	127
2.	Mahupadar S/M	0.023	-	1	-	-	-	1	-	-	1	-	-	1	-	2	-	-	3	3	6
3.	Pital Minor	0.100	-	1	2	10	-	2	-	-	10	-	-	1	1	15	-	-	25	17	42
4.	Minor No. 1	0.073	-	1	-	6	-	-	-	-	5	-	-	1	-	10	-	-	12	11	23
5.	Minor No. 2	0.038	-	1	-	6	-	-	-	-	5	-	-	1	-	6	-	-	12	7	19
Sub-total of disty No. 2. & system		**1.634**	**10.00**	**5**	**10**	**24**	**2**	**18**	**7**	**12**	**61**	**2**	**-**	**9**	**6**	**60**	**1**	**-**	**139**	**78**	**217**
6.	Distributory No. 11	2.400	10.00	1	1	2	-	-	6	10	13	10	-	11	16	110	-	12	33	159	192
7.	Jhadonkoli Minor	0.036	-	1	1	2	-	-	3	-	2	-	-	1	2	8	-	3	9	14	23
8.	Badagumula Minor	0.036	-	1	-	2	-	-	-	2	2	-	-	1	-	8	-	3	7	12	19
9.	Luhajore Minor	0.036	-	1	-	-	-	-	2	2	2	-	-	1	-	5	-	-	7	6	13
10.	Narendrepur Minor	0.036	-	1	-	-	-	-	-	-	3	-	-	1	-	7	-	-	4	8	12
11.	Ambapur Minor	0.0345	-	1	-	-	-	-	-	-	3	-	-	1	-	5	-	-	4	6	10
12.	Raghunathpur Minor	0.036	-	1	-	1	-	-	-	-	4	-	-	1	-	5	-	-	6	6	12
13.	Pathara Minor	0.036	-	1	-	1	-	-	-	-	2	-	-	1	-	4	-	-	4	5	9
14.	Sidhigaon Minor	0.036	-	1	-	-	-	-	-	-	4	-	-	1	-	16	-	-	5	17	22
15.	Musidipalam Minor	0.036	-	1	-	-	-	-	-	-	2	-	-	1	-	5	-	-	3	6	9
16.	Aruapalli Minor	0.036	-	1	-	1	-	-	-	-	3	-	-	1	-	12	-	-	5	13	18

Sub-total of disty No. 11 & system		**2.7585**	**10.00**	**11**	**2**	**9**	**-**	**-**	**11**	**14**	**40**	**10**	**-**	**21**	**18**	**185**	**-**	**18**	**87**	**252**	**339**
17.	Distributory No. 12	0.326	0.945	1	-	2	-	-	-	-	2	1	-	2	-	11	-	-	5	14	19
18.	Bankeyapalli Minor	0.036	-	1	-	-	-	-	-	-	-	-	-	1	-	3	-	-	1	4	5
Sub-total of disty No. 12 & system		**0.362**	**0.945**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**1**	**-**	**3**	**-**	**14**	**-**	**-**	**6**	**18**	**24**
19.	Distributory No. 13	0.638	3.39	1	-	1	-	2	2	2	30	6	-	7	-	2	-	-	38	15	53
20.	"A" Minor	-	-	1	-	4	-	-	2	-	10	-	-	1	-	1	-	-	17	2	19
21.	"B" Minor	-	-	1	-	-	-	-	-	-	8	-	-	1	-	1	-	-	9	2	11
22.	"C" Minor	-	-	1	-	-	-	-	-	-	5	-	-	1	-	1	-	-	6	2	8
23.	"D" Minor	-	-	1	-	-	-	-	1	-	2	-	-	1	-	1	-	-	4	2	6
24.	"E" Minor	-	-	1	2	1	-	-	1	-	7	-	-	1	-	1	-	-	12	2	14
25.	"F" Minor	-	-	1	-	-	-	-	-	-	8	-	-	1	-	-	-	-	9	1	10
Sub- total of disty No. 13 & system		**0.638**	**3.39**	**7**	**2**	**6**	**-**	**2**	**6**	**2**	**70**	**6**	**-**	**13**	**-**	**7**	**-**	**-**	**95**	**26**	**121**
26.	Distributory No. 14	0.500	3.000	1	1	-	-	-	5	6	28	3	-	4	-	-	-	-	41	7	48
27.	Majhidiho Minor	-	-	1	4	-	-	-	2	-	7	-	-	1	-	-	-	-	14	1	15
28.	Sanathana Minor	0.063	-	1	3	4	-	-	1	9	22	-	-	1	-	-	-	-	40	1	41
29.	Right Minor	-	-	1	-	-	-	-	2	1	2	1	-	2	-	-	-	-	6	3	9
30.	Baghala S/M	-	-	1	-	2	-	-	1	-	3	-	-	1	-	-	-	-	7	1	8
31.	Left Minor	0.036	-	1	-	4	-	-	2	1	12	2	-	3	-	-	-	-	20	5	25
32.	Gopinathpur S/M	0.036	-	1	-	3	-	-	1	-	6	-	-	1	-	-	-	-	11	1	12
33.	Damodarpur S/M	-	-	1	-	-	-	-	-	-	2	-	-	1	-	-	-	-	3	1	4
Sub-total of disty No. 14 & system		**0.635**	**3.00**	**8**	**8**	**13**	**-**	**-**	**14**	**17**	**82**	**6**	**-**	**14**	**-**	**-**	**-**	**-**	**142**	**20**	**162**
Grand total of distributory No. 2,11,12,13,14 & their systems		**6.0275**	**27.335**	**33**	**22**	**54**	**2**	**20**	**38**	**45**	**255**	**25**	**-**	**60**	**24**	**266**	**1**	**18**	**469**	**394**	**863**

TABLE NO.1
ANNEXURE-4
MONTHLY RAINFALL AT BRAHMAPUR RAINGAUGE STATION:
UNIT:mm

S. L. No.	Year	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual total	South west mons -oon (June to sept)	North east mons -oon (oct to dec)	Monsoon total	Remark
1	1981	8	7	84	13	91	95	57	381	368	47	-	-	1151	901	47	948	
2	1982	-	9	92	46	1	81	136	233	152	30	9	-	789	602	39	641	
3	1983	5	56	6	24	44	200	315	241	170	202	17	11	1291	926	230	1156	
4	1984	12	3	-	81	52	68	264	191	149	14	-	-	834	672	14	686	
5	1985	17	16	4	35	121	121	302	402	275	-	-	-	1293	1100	-	1100	
6	1986	17	26	8	-	112	155	152	175	131	369	375	15	1535	613	759	1372	
7	1987	14	-	40	51	19	66	101	101	103	124	211	3	833	371	338	709	
8	1988	-	24	19	23	37	67	272	82	289	107	-	-	920	710	107	817	
9	1989	-	-	-	15	19	370	174	390	138	79	-	4	1189	1072	83	1155	
10	1990	-	90	96	29	184	388	103	226	163	166	393	2	1840	880	561	1441	
11	1991	11	3	-	80	50	72	265	195	150	8	-	-	834	682	8	690	
12	1992	3	55	6	23	43	198	315	241	169	201	17	11	1282	923	229	1152	

Average before NWMP		7	24	30	35	64	157	205	238	188	112	85	3.8 ≃ 4	1149.2 ≃1149	787.6 ≃ 788 i.e 68.58 %	201.3 ≃ 201 i.e 17.49 %	988.9 ≃ 989 i.e 86.07%	
13	1993	8	9	9	6	11	81	136	133	152	230	16	11	802	502	257	759	
14	1994	9	7	8	13	31	357	295	368	381	447	239	137	2292	1401	823	2224	
15	1995	10	22	7	21	35	65	70	80	87	105	21	6	529	302	132	434	
16	1996	17	-	-	13	17	368	272	388	336	277	80	28	1796	1364	385	1749	
17	1997	11	10	9	7	18	38	101	38	261	165	29	11	698	438	205	643	
18	1998	13	-	21	33	40	65	144	124	374	196	212	51	1273	707	459	1166	
19	1999	16	5	9	-	44	52	98	39	199	368	376	14	1220	388	758	1146	
Overall average after NWMP		9	18	22	27	51	153	188	212	213	165	105	16	1179	766 i.e 64.97 %	286 i.e 24.26 %	1052 i.e 89.23%	

TABLE NO.2
ANNEXURE –4
CLIMATIC DATA AT GOPALPUR IMD STATON

Month	Monthly mean max. Temp. in ^{0}c	Monthly mean min. temp in ^{0}c	Monthly mean temp in ^{0}c	Monthly mean relative humidity percent (H)			Monthly mean wind velocity(w). in km/day	Monthly mean sun shine percentage	Monthly mean rainfall (mm)	N0.of rainy days in a month
				08.30 hours	17.30 hour	average				
1	2	3	4	5	6	7	8	9	10	11
Jan	*27.9*	17.8	22.85	81.0	74.3	77.65	101.0	46	9	0.8
Feb	29.2	20.2	24.70	81.0	80.3	80.65	92.0	48	18	1.5
March	30.7	23.0	26.85	80.7	85.2	82.95	246.0	50	22	1.2
April	31.1	25.2	28.15	84.8	81.9	83.35	674.0	52	27	1.7
May	*32.5*	26.7	29.60	84.0	86.6	85.30	871.0	54	51	3.8
June	32.4	*26.8*	29.60	83.1	85.3	84.20	137.0	56	153	10.5
July	31.7	26.1	28.90	86.1	86.4	86.25	1070	54	188	11.9
Aug	31.5	26.0	28.75	85.1	*87.1*	86.10	121.5	52	212	11.6
Sept	32.0	25.6	28.80	84.8	85.7	85.25	160.0	50	213	10.6
Oct	32.1	24.1	28.10	83.0	77.0	80.00	92.0	48	165	6.0
Nov.	30.5	20.4	25.45	*76.6*	70.6	73.60	52.0	46	105	2.8
Dec.	28.5	*17.6*	23.05	78.3	72.5	75.40	105.0	44	16	1.2
Average	30.84	23.29	27.07	82.38	81.08	81.73	229.875km/ day i.e. 9.578 km/hr.	50	98.25	5.3
NOTE : Mean daily max^m duration of Bright sun shine hour for 19^{0}30'N latitude C from table –16 of guide for different month.									**Σ= 1179 mm**	Σ=63.6 Say 64 in a Year

Annexure -4
Table No. 3
Depth of ground water level (1999) in Rushikulya Irrigation System.

Name of Village	Location in the command	Depth to ground water in Mtr.		
		Pre-Monsoon	Monsoon	Post-Monsoon
1	2	3	4	5
Distributary N0.2				
Dasamunduli	Head Reach	4.67	1.26	2.69
Choramaria	Middle Reach	4.83	1.33	2.79
Narendrapur	Tail Reach	4.85	1.34	2.78
Distributary N0.11				
Mahulapalli	Head Reach	7.00	0.50	3.70
Narendrapur	Middle Reach	7.10	0.42	3.60
Golabandha	Tail Reach	6.90	0.40	3.20
Distributary N0.12				
Sinkulipalli	Head Reach	6.00	0.30	3.00
Palasi	Middle Reach	7.20	0.50	3.20
Marpalli	Tail Reach	6.80	0.60	3.10
Distributary N0.13				
Hugulapata	Head Reach	6.10	0.30	2.80
Bhabandha	Middle Reach	6.60	0.25	2.50
Sikharapur	Tail Reach	6.80	0.35	3.10
Distributary N0.14				
Karanditola	Head Reach	8.00	0.20	2.70
Bhatakumuruda	Middle Reach	7.50	0.25	3.10
Nimapalli	Tail Reach	7.20	0.30	2.90

TABLE NO. 4: ANNEXURE:4 (EXISTING CROPING PATTERN)

Serial No.	Name of Crop		Disty. No. 2 Head Reach Area (ha)	Disty. No. 2 Middle Reach Area (ha)	Disty. No. 2 Tail Reach Area (ha)	Disty. No. 11 Head Reach Area (ha)	Disty. No. 11 Middle Reach Area (ha)	Disty. No. 11 Tail Reach Area (ha)	Disty. No. 12 Head Reach Area (ha)	Disty. No. 12 Middle Reach Area (ha)	Disty. No. 12 Tail Reach Area (ha)	Disty. No. 13 Head Reach Area (ha)	Disty. No. 13 Middle Reach Area (ha)	Disty. No. 13 Tail Reach Area (ha)	Disty. No. 14 Head Reach Area (ha)	Disty. No. 14 Middle Reach Area (ha)	Disty. No. 14 Tail Reach Area (ha)	Total area in Ha	% area
1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	KHARIFF	Early Paddy (21st June to 30th Sept.)	99	225	245	197	334	129	36	112	105	635	113	845	136	247	697	4.155	30.26
2	KHARIFF	Medium Paddy (21st June to 20th Oct.)	81	183	199	-	-	-	-	-	-	-	-	-	-	-	-	463	3.37
3	KHARIFF	H.Y.V Paddy (21st June to 15th Nov.)	453	1,030	1,117	1,201	2,035	785	42	128	120	353	63	469	141	256	722	8,915	64.92
4	Sugarcane		35	79	86	-	-	-	-	-	-	-	-	-	-	-	-	200	1.45
Sub-total			668	1.517	1.647	1.398	2.369	914	78	240	225	988	176	1.314	277	503	1.419	13.	100.
			3.832			4.681			543			2.478			2.199			733	00

Serial No.	Name of Crop		Disty. No. 2			Disty. No. 11			Disty. No. 12			Disty. No. 13			Disty. No. 14			Total area in Ha	% area
			Head Reach Area (ha)	Middle Reach Area (ha)	Tail Reach Area (ha)	Head Reach Area (ha)	Middle Reach Area (ha)	Tail Reach Area (ha)	Head Reach Area (ha)	Middle Reach Area (ha)	Tail Reach Area (ha)	Head Reach Area (ha)	Middle Reach Area (ha)	Tail Reach Area (ha)	Head Reach Area (ha)	Middle Reach Area (ha)	Tail Reach Area (ha)		
1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
5	RABI	Ground-nut (1st Dec. to 15th March)	87	198	215	-	-	-	-	-	-	-	-	-	-	-	-	500	3.64
6		Vegetables (10th Oct. to 31st Jan.)	98	223	242	-	-	-	-	-	-	-	-	-	-	-	-	563	4.10
Sub-total			185	421	457	-	-	-	-	-	-	-	-	-	-	-	-	1.063	7.74

ANNEXURE:4

TABLE:5
CROP WATER REQUIREMENT (DEMAND)

SEASON: Kharaiff
CROP : Early Paddy
CROP DURATION: 21ST JUNE TO 3Oth SEPTEMBER (102 days)

SL.No.	ITEM	UNIT	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	MEAN MONTHLY RAINFALL	mm	-	-	-	-	-	153	188	212	213	-	-	-	TABLE 1, ANNEXURE:2
2.	80% CHANCE OF MEAN MONTHLY RAINFALL =SL NO. 1X0.852	mm	-	-	-	-	-	130	160	180	181	-	-	-	FROM TABLE-11 OF REFERENCE GUIDE, FOR 80% CHANCE & AVERAGE ANNUAL REAINFALL OF 1243mm. AVERAGE RATIOS APPLICABLE TO EFFECTIVE RAINFALL =0.852
3.	PAN EVAPORATI-ON (EP)	mm	-	-	-	-	-	170	150	150	150	-	-	-	CHRISTIANSEN METHOD FROM APPENDIX 1
4.	NO. OF DAYS IN MONTH FOR WATER REQUIREME-NT BY CROP	DAYS	-	-	-	-	-	10	31	31	30	-	-	-	FROM CROP DURATION MENTIONED AT TOP
5.	DAYS OF GROWTH UPTO MID OF MONTH	DAYS	-	-	-	-	-	10/2=5	10+31/ 2=26	57	87	-	-	-	CUMULATIVE DAYS FROM START UPTO MID OF CURRENT MONTH
6.	% OF GROWTH UP TO MID OF MONTH	%	-	-	-	-	-	5	25	55	85	-	-	-	(SL NO. 5 / CROP DURATION) x100
7.	CROP FACTOR (Kc)	-	-	-	-	-	-	0.90	1.10	1.30	1.00	-	-	-	FROM TABLE-8 OF REFERENCE GUIDE

8.	CONSUM-PTIVE USE (Cu)	mm	-	-	-	-	-	1.70x 0.9x10/ 30 =51	165	195	150	-	-	-	(SL. NO. 3x SL. NO.7x SL.NO. 4) / TOTAL NO. OF DAYS IN A MONTH
9.	REQ. FOR LAND PREPRATION	mm	-	-	-	-	-	90	25	50	-	-	-	-	FROM LOCAL EXPERIENCE
10.	PERCOL-ATION LOSS @ 3 mm /day	mm	-	-	-	-	-	30	93	93	90	-	-	-	DURING MAJOR PART OF MONSOON ONLY i.e. JUNE ~OCTOBER ONLY
11.	TOTAL WATER REQUIR-EMENT	mm	-	-	-	-	-	171	283	338	240	-	-	-	(SL. NO. 8+ S L. NO. 9 +SL. NO. 10) / **TOTAL =1032 mm =103.2 cm= Δ =1.032 metre**
12.	EFFECFTIVE RAINFALL (Re)	mm	-	-	-	-	-	130	160	180	181	-	-	-	SAME AS SL NO. 2
13.	NET IRRIGATION REQUIRE-MENT (NIR)	mm	-	-	-	-	-	41	123	158	59	-	-	-	SL. NO. 11-SL. NO. 12
14.	FIELD EVAPO-RATION EFFICIENCY	-	-	-	-	-	-	0.6	0.9	0.9	0.9	-	-	-	
15.	FIELD IRRIGATION REQUIRE-MENT (FIR)	mm	-	-	-	-	-	68	137	176	66	-	-	-	SL. NO. 13 / SL. NO. 14
16.	CONVEY-ANCE EFFICIENCY	-	-	-	-	-	-	0.9	0.9	0.9	0.9	-	-	-	
17.	GROSS-IRRIGATION REQUIRE-MENT (GIR)	mm	-	-	-	-	-	**76**	**152**	**196**	**73**	-	-	-	SL. NO. 15 / SL. NO. 16
															Σ = 497 mm

ANNEXURE:4

TABLE:6
CROP WATER REQUIREMENT (DEMAND)

SEASON: Kharaiff
CROP : Medium Paddy
CROP DURATION :21ST JUNE TO 20th OCTOBER (122 days)

SL.No.	ITEM	UNIT	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	MEAN MONTHLY RAINFALL	mm	-	-	-	-	-	153	188	212	213	165	-	-	TABLE 1, ANNEXURE:2
2.	80% CHANCE OF MEAN MONTHLY RAINFALL =SL NO. 1X0.852	mm	-	-	-	-	-	130	160	180	181	141	-	-	FROM TABLE-11 OF REFERENCE GUIDE, FOR 80% CHANCE & AVERAGE ANNUAL REAINFALL OF 1243mm, AVERAGE RATIOS APPLICABLE TO EFFECTIVE RAINFALL =0.852
3.	PAN EVAPORATION (EP)	mm	-	-	-	-	-	170	150	150	150	130	-	-	CHRISTIANSEN METHOD FROM APPENDIX 1
4.	NO. OF DAYS IN MONTH FOR WATER REQUIREMENT BY CROP	DAYS	-	-	-	-	-	10	31	31	30	20	-	-	FROM CROP DURATION MENTIONED AT TOP
5.	DAYS OF GROWTH UPTO MID OF MONTH	DAYS	-	-	-	-	-	5	26	57	87	112	-	-	CUMULATIVE DAYS FROM START UPTO MID OF CURRENT MONTH

6.	% OF GROWTH UP TO MID OF MONTH	%	-	-	-	-	-	4	21	47	71	92	-	-	(SL NO. 5 / CROP DURATION) x100
7.	CROP FACTOR (Kc)	-	-	-	-	-	-	0.88	1.06	1.27	1.19	0.86	-	-	FROM TABLE-8 OF REFERENCE GUIDE
8.	CONSUMPTIVE USE (Cu)	mm	-	-	-	-	-	50	159	19 1	179	72	-	-	(SL. NO. 3x SL. NO.7x SL.NO. 4) / TOTAL NO. OF DAYS IN A MONTH
9.	REQUIREMENT FOR LAND PERPARATION	mm	-	-	-	-	-	90	25	50	-	-	-	-	FROM LOCAL EXPERIENCE
10.	PERCOLATION LOSS @ 3 mm /day	mm	-	-	-	-	-	30	93	93	90	60	-	-	DURING MAJOR PART OF MONSOON ONLY i.e. JUNE ~OCTOBER ONLY
11.	TOTAL WATER REQUIREMENT	mm	-	-	-	-	-	170	277	334	269	132	-	-	(SL. NO. 8+ SL. NO. 9 +SL. NO. 10)
12.	EFFECFTIVE RAINFALL (Re)	mm	-	-	-	-	-	130	160	180	181	141	-	-	SAME AS SL NO. 2
13.	NET IRRIGATION REQUIREMENT (NIR)	mm	-	-	-	-	-	40	117	154	88	-	-	-	SL. NO. 11-SL. NO. 12
14.	FIELD EVAPORATION EFFICIENCY	-	-	-	-	-	-	0.6	0.9	0.9	0.9	0.9	-	-	
15.	FIELD IRRIGATION REQUIREMENT (FIR)	mm	-	-	-	-	-	67	130	171	98	-	-	-	SL. NO. 13 / SL. NO. 14
16.	CONVEYANCE EFFICIENCY	-	-	-	-	-	-	0.9	0.9	0..9	0.9	0.9	-	-	
17.	GROSS-IRRIGATION REQUIREMENT (GIR)	**mm**	-	-	-	-	-	**74**	**144**	**190**	**109**	-	-	-	SL. NO. 15 / SL. NO. 16
															Σ = 517 mm

ANNEXURE:4

TABLE:7
CROP WATER REQUIREMENT (DEMAND)

SEASON: Kharif
CROP : H. Y.V. PADDY
CROP DURATION :21ST JUNE TO 15th NOV. (148 days)

SL.No.	ITEM	UNIT	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	MEAN MONTHLY RAINFALL	mm	-	-	-	-	-	153	188	212	213	165	105	-	TABLE 1. ANNEXURE:2
2.	80% CHANCE OF MEAN MONTHLY RAINFALL =SL NO. 1X0.852	mm	-	-	-	-	-	130	160	180	181	141	89	-	FROM TABLE-11 OF REFERENCE GUIDE. FOR 80% CHANCE & AVERAGE ANNUAL REAINFALL OF 1243mm . AVERAGE RATIOS APPLICABLE TO EFFECTIVE RAINFALL =0.852
3.	PAN EVAPORATION (EP)	mm	-	-	-	-	-	170	150	150	150	130	100	-	CHRISTIANSEN METHOD FROM APPENDIX 1
4.	NO. OF DAYS IN MONTH FOR WATER REQUIREMENT BY CROP	DAYS	-	-	-	-	-	10	31	31	30	31	15	-	FROM CROP DURATION MENTIONED AT TOP
5.	DAYS OF GROWTH UPTO MID OF MONTH	DAYS	-	-	-	-	-	5	26	57	87	118	141	-	CUMULATIVE DAYS FROM START UPTO MID OF CURRENT

															MONTH
6.	% OF GROWTH UP TO MID OF MONTH	- %	-	-	-	-	-	4	18	39	59	80	95	-	(SL NO. 5 CROP DURATION) x100
7.	CROP FACTOR (Kc)	-	-	-	-	-	-	0.88	1.03	1.20	1.30	1.10	0.80	-	FROM TABLE-8 OF REFERENCE GUIDE
8.	CONSUMPTIVE USE (Cu)	mm	-	-	-	-	-	50	155	180	195	143	40	-	(SL. NO. 3x SL. NO.7x SL.NO. 4)/ TOTAL NO. OF DAYS IN A MONTH
9.	REQUIREMENT FOR LAND PERPARATION	mm	-	-	-	-	-	90	25	50	-	-	-	-	FROM LOCAL EXPERIENCE
10.	PERCOLATION LOSS @ 3 mm /day	mm	-	-	-	-	-	30	93	93	90	93	45	-	DURING MAJOR PART OF MONSOON ONLY i.e. JUNE ~OCTOBER ONLY
11.	TOTAL WATER REQUIREMENT	mm	-	-	-	-	-	170	273	323	285	236	85	-	(SL. NO. 8+ SL. NO. 9 +SL. NO. 10)
12.	EFFECFTIVE RAINFALL (Re)	mm	-	-	-	-	-	130	160	180	181	141	89	-	SAME AS SL NO. 2
13.	NET IRRIGATION REQUIREMENT (NIR)	mm	-	-	-	-	-	40	113	143	104	95	-	-	SL. NO. 11-SL. NO. 12
14.	FIELD EVAPORATION EFFICIENCY	-	-	-	-	-	-	0.6	0.9	0.9	0.9	0.9	0.9	-	
15.	FIELD IRRIGATION REQUIREMENT (FIR)	mm	-	-	-	-	-	67	126	159	116	106	-	-	SL. NO. 13 / SL. NO. 14
16.	CONVEYANCE EFFICIENCY	-	-	-	-	-	-	0.9	0.9	0.9	0.9	0.9	0.9	-	
17.	GROSS-IRRIGATION REQUIREMENT (GIR)	mm	-	-	-	-	-	74	140	177	129	118	-	-	SL. NO. 15 / SL. NO. 16
															Σ = 638 mm

TABLE:8
ANNEXURE:4

CROP WATER REQUIREMENT (DEMAND)

SEASON: PERENNIAL
CROP : SUGARCANE
CROP DURATION : 1ST JAN TO 31st DECEMBER (365 days)

SL.No.	ITEM	UNIT	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	MEAN MONTHLY RAINFALL	mm	9	18	22	27	51	153	188	212	213	165	105	16	TABLE 1, ANNEXURE:2
2.	80% CHANCE OF MEAN MONTHLY RAINFALL =SL NO. 1X0.852	mm	8	15	19	23	43	130	160	180	181	141	89	14	FROM TABLE-11 OF REFERENCE GUIDE, FOR 80% CHANCE & AVERAGE ANNUAL REAINFALL OF 1243mm, AVERAGE RATIOS APPLICABLE TO EFFECTIVE RAINFALL =0.852
3.	PAN EVAPORATION (EP)	mm	100	100	170	220	250	170	150	150	150	130	100	100	CHRISTIANSEN METHOD FROM APPENDI x 1
4.	NO. OF DAYS IN MONTH FOR WATER REQUIREMENT BY CROP	DAYS	31	28	31	30	31	30	31	31	30	31	30	31	FROM CROP DURATION MENTIONED AT TOP
5.	DAYS OF GROWTH UPTO MID OF MONTH	DAYS	16	45	75	105	136	166	197	228	258	289	319	350	CUMULATIVE DAYS FROM START UPTO MID OF CURRENT MONTH
6.	% OF GROWTH UP TO MID OF MONTH	%	4	12	21	29	37	45	54	62	71	79	87	96	(SL NO. 5 / CROP DURATION) x100
7.	CROP FACTOR (Kc)	-	0.5	0.54	0.61	0.73	0.82	0.87	0.90	0.88	0.74	0.69	0.56	0.50	FROM TABLE-7 OF REFERENCE

															GUIDE
8.	CONSUMPTIVE USE (Cu)	mm	50	54	104	161	205	148	135	132	111	90	56	50	(SL. NO. 3x SL. NO.7x SL.NO. 4) ÷ TOTAL NO. OF DAYS IN A MONTH
9.	REQUIREMENT FOR LAND PREPARATION	mm	-	-	-	-	-	-	-	-	-	-	-	-	FROM LOCAL EXPERIENCE NO WATER REQUIRED SINCEE PERENINIAL CROP
10.	PERCOLATION LOSS @ 3 mm /day	mm	-	-	-	-	-	90	93	93	90	93	-	-	DURING MAJOR PART OF MONSOON ONLY i.e. JUNE ~OCTOBER ONLY
11.	TOTAL WATER REQUIREMENT	mm	50	54	104	161	205	238	228	225	201	183	56	50	(SL. NO. 8+ SL. NO. 9 +SL. NO. 10)
12.	EFFECFTIVE RAINFALL (Re)	mm	8	15	19	23	43	130	160	180	181	141	89	14	SAME AS SL NO. 2
13.	NET IRRIGATION REQUIREMENT (NIR)	mm	42	39	85	138	162	108	68	45	20	42	-	36	SL. NO. 11-SL. NO. 12
14.	FIELD EVAPORATION EFFICIENCY	-	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	
15.	FIELD IRRIGATION REQUIREMENT (FIR)	mm	53	49	106	173	203	135	85	56	25	53	-	45	SL. NO. 13 / SL. NO. 14
16.	CONVEYANCE EFFICIENCY	-	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	
17.	GROSS-IRRIGATION REQUIREMENT (GIR)	mm	**66**	**61**	**133**	**216**	**254**	**169**	**106**	**70**	**31**	**66**	-	**56**	SL. NO. 15 / SL. NO. 16
															Σ = 1228 mm

TABLE:9
ANNEXURE:4

CROP WATER REQUIREMENT (DEMAND)

SEASON: RABI
CROP : GROUNDNUT
CROP DURATION : 1ST DEC TO 15th MARCH (105 days)

SL.No.	ITEM	UNIT	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	MEAN MONTHLY RAINFALL	mm	9	18	22	-	-	-	-	-	-	-	-	16	TABLE 1, ANNEXURE:2
2.	80% CHANCE OF MEAN MONTHLY RAINFALL =SL NO. 1X0.852	mm	8	15	19	-	-	-	-	-	-	-	-	14	FROM TABLE-11 OF REFERENCE GUIDE. FOR 80% CHANCE & AVERAGE ANNUAL REAINFALL OF 1243mm, AVERAGE RATIOS APPLICABLE TO EFFECTIVE RAINFALL =0.852
3.	PAN EVAPORATION (EP)	mm	100	100	170	-	-	-	-	-	-	-	-	100	CHRISTIANSEN METHOD FROM APPENDIX 1
4.	NO. OF DAYS IN MONTH FOR WATER REQUIREMENT BY CROP	DAYS	31	28	15	-	-	-	-	-	-	-	-	31	FROM CROP DURATION MENTIONED AT TOP
5.	DAYS OF GROWTH UPTO MID OF MONTH	DAYS	47	76	98	-	-	-	-	-	-	-	-	16	CUMULATIVE DAYS FROM START UPTO MID OF CURRENT MONTH
6.	% OF GROWTH UP TO MID OF MONTH	%	45	72	93	-	-	-	-	-	-	-	-	15	(SL NO. 5 / CROP DURATION) x100

7.	CROP FACTOR (Kc)	-	0.85	0.93	0.67	-	-	-	-	-	-	-	-	0.35	FROM TABLE-7 OF REFERENCE GUIDE
8.	CONSUMPTIVE USE (Cu)	mm	85	93	55	-	-	-	-	-	-	-	-	35	(SL. NO. 3x SL. NO.7x SL.NO. 4) / TOTAL NO. OF DAYS IN A MONTH
9.	REQUIREMENT FOR LAND PERPARATION	mm	-	-	-	-	-	-	-	-	-	-	-	75	FROM LOCAL EXPERIENCE
10.	PERCOLATION LOSS @ 3 mm /day	mm	-	-	-	-	-	-	-	-	-	-	-	-	DURING MAJOR PART OF MONSOON ONLY i.e. JUNE ~OCTOBER ONLY
11.	TOTAL WATER REQUIREMENT	mm	85	93	55	-	-	-	-	-	-	-	-	110	(SL. NO. 8+ SL. NO. 9 +SL. NO. 10)
12.	EFFECFTIVE RAINFALL (Re)	mm	8	15	19	-	-	-	-	-	-	-	-	14	SAME AS SL NO. 2
13.	NET IRRIGATION REQUIREMENT (NIR)	mm	77	78	36	-	-	-	-	-	-	-	-	96	SL. NO. 11-SL. NO. 12
14.	FIELD EVAPORATION EFFICIENCY	-	0.8	0.8	0.8	-	-	-	-	-	-	-	-	0.8	
15.	FIELD IRRIGATION REQUIREMENT (FIR)	mm	96	98	45	-	-	-	-	-	-	-	-	120	SL. NO. 13 / SL. NO. 14
16.	CONVEYANCE EFFICIENCY	-	0.8	0.8	0.8	-	-	-	-	-	-	-	-	0.8	
17.	GROSS-IRRIGATION REQUIREMENT (GIR)	mm	**120**	**123**	**156**	-	-	-	-	-	-	-	-	**150**	SL. NO. 15 / SL. NO. 16
															$\Sigma = 449$ mm

TABLE:10
ANNEXURE:4

CROP WATER REQUIREMENT (DEMAND)

SEASON: RABI
CROP : VEGETABLES
CROP DURATION : 10^{ST} OCT. TO 31^{th} JAUNUARY (113 days)

SL.No.	ITEM	UNIT	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	MEAN MONTHLY RAINFALL	mm	9	-	-	-	-	-	-	-	-	165	105	16	TABLE 1, ANNEXURE:2
2.	80% CHANCE OF MEAN MONTHLY RAINFALL =SL NO. 1X0.852	mm	8	-	-	-	-	-	-	-	-	141	89	14	FROM TABLE-11 OF REFERENCE GUIDE, FOR 80% CHANCE & AVERAGE ANNUAL REAINFALL OF 1243mm , AVERAGE RATIOS APPLICABLE TO EFFECTIVE RAINFALL =0.852
3.	PAN EVAPORATION (EP)	mm	100	-	-	-	-	-	-	-	-	130	100	100	CHRISTIANSEN METHOD FROM APPENDIX 1
4.	NO. OF DAYS IN MONTH FOR WATER REQUIREMENT BY CROP	DAYS	31	-	-	-	-	-	-	-	-	21	30	31	FROM CROP DURATION MENTIONED AT TOP
5.	DAYS OF GROWTH UPTO MID OF MONTH	DAYS	98	-	-	-	-	-	-	-	-	11	36	67	CUMULATIVE DAYS FROM START UPTO MID OF CURRENT MONTH
6.	% OF GROWTH UP	%	87	-	-	-	-	-	-	-	-	10	32	59	(SL NO. 5 / CROP

	TO MID OF MONTH														DURATION) x100
7.	CROP FACTOR (Kc)	-	0.48	-	-	-	-	-	-	-	-	0.30	0.56	0.65	FROM TABLE-7 OF REFERENCE GUIDE
8.	CONSUMPTIVE USE (Cu)	mm	48	-	-	-	-	-	-	-	-	26	56	65	(SL. NO. 3x SL. NO.7x SL.NO. 4) / TOTAL NO. OF DAYS IN A MONTH
9.	REQUIREMENT FOR LAND PERPARATION	mm	-	-	-	-	-	-	-	-	-	75	-	-	FROM LOCAL EXPERIENCE
10.	PERCOLATION LOSS @ 3 mm /day	mm	-	-	-	-	-	-	-	-	-	63	-	-	DURING MAJOR PART OF MONSOON ONLY i.e. JUNE -OCTOBER ONLY
11.	TOTAL WATER REQUIREMENT	mm	48	-	-	-	-	-	-	-	-	164	56	65	(SL. NO. 8+ SL. NO. 9 +SL. NO. 10)
12.	EFFECFTIVE RAINFALL (Re)	mm	8	-	-	-	-	-	-	-	-	141	89	14	SAME AS SL NO. 2
13.	NET IRRIGATION REQUIREMENT (NIR)	mm	40	-	-	-	-	-	-	-	-	23	-	41	SL. NO. 11-SL. NO. 12
14.	FIELD EVAPORATION EFFICIENCY	-	0.8	-	-	-	-	-	-	-	-	0.8	0.8	0.8	
15.	FIELD IRRIGATION REQUIREMENT (FIR)	mm	50	-	-	-	-	-	-	-	-	29	-	51	SL. NO. 13 / SL. NO. 14
16.	CONVEYANCE EFFICIENCY	-	0.8	-	-	-	-	-	-	-	-	0.8	0.8	0.8	
17.	GROSS-IRRIGATION REQUIREMENT (GIR)	mm	63	-	-	-	-	-	-	-	-	36	-	64	SL. NO. 15 / SL. NO. 16
															$\Sigma = 163$ mm

ANNEXURE: 4

TABLE NO 11: MONTH-WISE GROSS-IRRIGATION REQUIREMENT IN HEAD REACHES OF DIFFERENT DISTRIBUTARIES

SERIAL NO	NAME OF THE DISTRIBUTAYRY	NAME OF THE CROP		AREA IN Ha.	JANUARY DEPTH (mm)	JANUARY VOLUME (Ha-m)	FEBRUARY DEPTH (mm)	FEBRUARY VOLUME (Ha-m)	MARCH DEPTH (mm)	MARCH VOLUME (Ha-m)	APRIL DEPTH (mm)	APRIL VOLUME (Ha-m)	MAY DEPTH (mm)	MAY VOLUME (Ha-m)	JUNE DEPTH (mm)	JUNE VOLUME (Ha-m)	JULY DEPTH (mm)	JULY VOLUME (Ha-m)	AUGUST DEPTH (mm)	AUGUST VOLUME (Ha-m)	SEPTEMBER DEPTH (mm)	SEPTEMBER VOLUME (Ha-m)	OCTOBER DEPTH (mm)	OCTOBER VOLUME (Ha-m)	NOVEMBER DEPTH (mm)	NOVEMBER VOLUME (Ha-m)	DECEMBER DEPTH (mm)	DECEMBER VOLUME (Ha-m)	REMARKS i.e INDIVIDUAL AREA IN HEAD REACH.
1	2	3		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1	DIS-TRI-BU-TARY NO.2	KHARIFF	Early Paddy	99	-	-	-	-	-	-	-	-	-	-	76	8	152	15	196	19	73	7	-	-	-	-	-	-	Early Paddy Area =1103Ha Medium Paddy Area =81 Ha HYV Paddy Area =2190 Ha Sugar cane Area=35 Ha Groundnut Area = 87 Ha Vegetables Area =98Ha
			Medium Paddy	81	-	-	-	-	-	-	-	-	-	-	74	6	144	12	190	15	109	9	-	-	-	-	-	-	
			H.Y.V. Paddy	453	-	-	-	-	-	-	-	-	-	-	74	34	140	63	177	80	129	58	118	53	-	-	-	-	
		Sugar-cane (Perennial)		35	66	2	61	2	133	5	21 6	8	254	9	169	6	106	4	70	2	31	1	66	2	-	-	56	2	
		RABI	Groundnut	87	120	10	123	11	56	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	150	13	

			Vegetables	98	63	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	36	4	-	-	64	6	
			Sub-total	668 (No. Rabi)		18		13		10		8		9		54		94		116		75		59		-		21	Early Paddy Area =1103Ha Medium Paddy Area =81 Ha HYV Paddy Area =2190 Ha Sugar cane Area=35 Ha Groundnut Area = 87 Ha Vegetables Area =98Ha
2	DISTRIBUTARY NO.11	KHARIFF	Early Paddy	197	-	-	-	-	-	-	-	-	-	-	76	15	152	30	196	39	73	14	-	-	-	-	-	-	
			H.Y.V. Paddy	1201	-	-	-	-	-	-	-	-	-	-	74	89	140	168	177	213	129	155	118	142	-	-	-	-	
		Sub-total		1398		-		-		-		-		-		104		198		252		169		142		-		-	
3	DISTRIBUTARY NO.12	KHARIFF	Early Paddy	36	-	-	-	-	-	-	-	-	-	-	76	3	152	5	196	7	73	3	-	-	-	-	-	-	
			H.Y.V. Paddy	42	-	-	-	-	-	-	-	-	-	-	74	3	140	6	177	7	129	5	118	5	-	-	-	-	
		Sub-total		78		-		-		-		-		-		6		11		14		8		5		-		-	
4	DISTRIBUTARY NO.13	KHARIFF	Early Paddy	635	-	-	-	-	-	-	-	-	-	-	76	48	152	97	196	124	73	46	-	-	-	-	-	-	
			H.Y.V. Paddy	353	-	-	-	-	-	-	-	-	-	-	74	26	140	49	177	62	129	46	118	42	-	-	-	-	
		Sub-total		988		-		-		-		-		-		74		146		186		92		42		-		-	
5	DISTRIBUTARY NO.14	KHARIFF	Early Paddy	136	-	-	-	-	-	-	-	-	-	-	76	10	152	21	196	27	73	10	-	-	-	-	-	-	
			H.Y.V. Paddy	141	-	-	-	-	-	-	-	-	-	-	74	10	140	20	177	25	129	18	118	17	-	-	-	-	
		Sub-total		277		-		-		-		-		-		20		41		52		28		17		-		-	
GRAND TOTAL				3.409		18		13		10		8		9		258		490		620		372		265		-		21	

ANNEXURE: 4

TABLE NO 12: MONTH-WISE GROSS-IRRIGATION REQUIREMENT IN MIDDLE REACHES OF DIFFERENT DISTRIBUTARIES

SERIAL NO	NAME OF THE DISTRIBUTARY	NAME OF THE CROP		AREA IN Ha.	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER		REMARKS i.e INDIVIDUAL AREA IN MIDDLE REACH.
					DEPTH (mm)	VOLUME (Ha-m)	DEPTH (mm)	VOLUME (Ha-m)	DEPTH (mm)	VOLUME (Ha-m)	DEPTH (mm)	VOLUME (Ha-m)	DEPTH (mm)	VOLUME (Ha-m)	DEPTH (mm)	VOLUME (Ha-m)	DEPTH (mm)	VOLUME (Ha-m)	DEPTH (mm)	VOLUME (Ha-m)	DEPTH (mm)	VOLUME (Ha-m)	DEPTH (mm)	VOLUME (Ha-m)	DEPTH (mm)	VOLUME (Ha-m)	DEPTH (mm)	VOLUME (Ha-m)	
1	2	3		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1	DISTRIBUTARY NO.2	KHARIFF	Early Paddy	225	-	-	-	-	-	-	-	-	-	-	76	17	152	34	196	44	73	16	-	-	-	-	-	-	Early Paddy Area =1031Ha Medium Paddy Area =183 Ha HYV Paddy Area =3512 Ha Sugarcane Area = 79 Ha Groundnut Area =19 8 Ha Vegetables Area =223Ha
		KHARIFF	Medium Paddy	183	-	-	-	-	-	-	-	-	-	-	74	14	144	26	190	35	109	20	-	-	-	-	-	-	
		KHARIFF	H.Y.V. Paddy	1030	-	-	-	-	-	-	-	-	-	-	74	76	140	144	177	182	129	133	118	122	-	-	-	-	
			Sugar-cane (Perennial)	79	66	5	61	5	133	11	216	17	254	20	169	13	106	8	70	5	31	2	66	5	-	-	56	4	
		RABI	Groundnut	198	120	24	123	24	56	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	150	30	
		RABI	Vegetables	223	63	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	36	8	-	-	64	14	
			Sub-total	1517 (no. Rabi)		43		29		22		17		20		120		212		266		171		135		-		48	
2	DISTRIBUTARY NO.11	KHARIFF	Early Paddy	334	-	-	-	-	-	-	-	-	-	-	76	25	152	51	196	65	73	24	-	-	-	-	-	-	
		KHARIFF	H.Y.V. Paddy	2035	-	-	-	-	-	-	-	-	-	-	74	151	140	285	177	360	129	263	118	240	-	-	-	-	
			Sub-total	2369		-		-		-		-		-		176		336		425		287		240		-		-	

3	DISTRIBUTARY NO.12	KHARIFF	Early Paddy	112	-	-	-	-	-	-	-	-	-	-	76	9	152	17	196	22	73	8	-	-	-	-	-	-	Early Paddy Area =1031Ha Medium Paddy Area =183 Ha HYV Paddy Area =3512 Ha Sugarcane Area = 7 Ha Groundnut Area =1[illegible] Ha Vegetable Area =223Ha
			H.Y.V. Paddy	128	-	-	-	-	-	-	-	-	-	-	74	9	140	18	177	23	129	17	118	15	-	-	-	-	
		Sub-total		240		-		-		-		-		-		18		35		45		25		15		-		-	
4	DISTRIBUTARY NO.13	KHARIFF	Early Paddy	113	-	-	-	-	-	-	-	-	-	-	76	9	152	17	196	22	73	8	-	-	-	-	-	-	
			H.Y.V. Paddy	63	-	-	-	-	-	-	-	-	-	-	74	5	140	9	177	11	129	8	118	7	-	-	-	-	
		Sub-total		176		-		-		-		-		-		14		26		33		16		7		-		-	
5	DISTRIBUTARY NO.14	KHARIFF	Early Paddy	247	-	-	-	-	-	-	-	-	-	-	76	19	152	38	196	48	73	18	-	-	-	-	-	-	
			H.Y.V. Paddy	256	-	-	-	-	-	-	-	-	-	-	74	19	140	36	177	45	129	33	118	30	-	-	-	-	
		Sub-total		503		-		-		-		-		-		38		74		93		51		30		-		-	
GRAND TOTAL				4,805		43		29		22		17		20		366		683		862		550		427		-		48	

ANNEXURE: 4

TABLE NO 13 : MONTH-WISE GROSS-IRRIGATION REQUIREMENT IN TAIL REACHES OF DIFFERENT DISTRIBUTARIES

SERIAL NO	NAME OF THE DISTRIBUTARY		NAME OF THE CROP	AREA IN Ha.	JANUARY DEPTH (mm)	JANUARY VOLUME (Ha-m)	FEBRUARY DEPTH (mm)	FEBRUARY VOLUME (Ha-m)	MARCH DEPTH (mm)	MARCH VOLUME (Ha-m)	APRIL DEPTH (mm)	APRIL VOLUME (Ha-m)	MAY DEPTH (mm)	MAY VOLUME (Ha-m)	JUNE DEPTH (mm)	JUNE VOLUME (Ha-m)	JULY DEPTH (mm)	JULY VOLUME (Ha-m)	AUGUST DEPTH (mm)	AUGUST VOLUME (Ha-m)	SEPTEMBER DEPTH (mm)	SEPTEMBER VOLUME (Ha-m)	OCTOBER DEPTH (mm)	OCTOBER VOLUME (Ha-m)	NOVEMBER DEPTH (mm)	NOVEMBER VOLUME (Ha-m)	DECEMBER DEPTH (mm)	DECEMBER VOLUME (Ha-m)	REMARKS i.e INDIVIDUAL AREA IN TAIL REACH.
1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1	DISTRIBUTARY NO.2	KHARIFF	Early Paddy	245	-	-	-	-	-	-	-	-	-	-	76	19	152	37	196	48	73	18	-	-	-	-	-	-	Early Paddy Area =2021Ha Medium Paddy Area =199 Ha HYV Paddy Area =3213 Ha Sugarcane Area =86 Ha Groundnut Area =215Ha Vegetables Area =242Ha
		KHARIFF	Medium Paddy	199	-	-	-	-	-	-	-	-	-	-	74	15	144	29	190	38	109	22	-	-	-	-	-	-	
		KHARIFF	H.Y.V. Paddy	1117	-	-	-	-	-	-	-	-	-	-	74	83	140	156	177	198	129	144	118	132	-	-	-	-	
			Sugar-cane (Perennial)	86	66	6	61	5	133	11	216	19	254	22	169	15	106	9	70	6	31	3	66	6	-	-	56	5	
		RABI	Groundnut	215	120	26	123	26	56	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	150	32	
		RABI	Vegetables	242	63	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	36	9	-	-	64	15	
			Sub-total	1647 (no. Rabi)		47		31		23		19		22		132		231		290		187		147		-		52	
2	DISTRIBUTARY NO.11	KHARIFF	Early Paddy	129	-	-	-	-	-	-	-	-	-	-	76	10	152	20	196	25	73	9	-	-	-	-	-	-	
		KHARIFF	H.Y.V. Paddy	785	-	-	-	-	-	-	-	-	-	-	74	58	140	110	177	139	129	101	118	93	-	-	-	-	
			Sub-total	914		-		-		-		-		-		68		130		164		110		93		-		-	

3	DISTRIBUTARY NO.12	KHARIFF	Early Paddy	105	-	-	-	-	-	-	-	-	-	-	76	8	152	16	196	21	73	8	-	-	-	-	-	-	Early Paddy Area =2021Ha Medium Paddy Area =199 Ha HYV Paddy Area =3213 Ha Sugarcane Area =86 Ha Groundnut Area =215Ha Vegetables Area =242Ha
			H.Y.V. Paddy	120	-	-	-	-	-	-	-	-	-	-	74	9	140	17	177	21	129	15	118	14	-	-	-	-	
		Sub-total		225		-		-		-		-		-		17		33		42		23		14		-		-	
4	DISTRIBUTARY NO.13	KHARIFF	Early Paddy	845	-	-	-	-	-	-	-	-	-	-	76	64	152	128	196	166	73	62	-	-	-	-	-	-	
			H.Y.V. Paddy	469	-	-	-	-	-	-	-	-	-	-	74	35	140	66	177	83	129	61	118	55	-	-	-	-	
		Sub-total		1314		-		-		-		-		-		99		194		249		123		55		-		-	
5	DISTRIBUTARY NO.14	KHARIFF	Early Paddy	697	-	-	-	-	-	-	-	-	-	-	76	53	152	106	196	137	73	51	-	-	-	-	-	-	
			H.Y.V. Paddy	722	-	-	-	-	-	-	-	-	-	-	74	53	140	101	177	128	129	93	118	85	-	-	-	-	
		Sub-total		1419		-		-		-		-		-		106		207		265		144		85					
GRAND TOTAL				5.519		47		31		23		19		22		422		795		1010		587		394		-		52	

TABLE NO 14(a)
Annexure: 4
Gross Irrigation Water Requirement in Different Months (June to Nov.)

Sl.No	Name of Canal	Description	June			July			August			September			October			November			Remarks
			Head reach	Middle reach	Tail reach	Head reach	Middle reach	Tail reach	Head reach	Middle reach	Tail reach	Head reach	Middle reach	Tail reach	Head reach	Middle reach	Tail reach	Head reach	Middle reach	Tail reach	
1	Ditsy. No. 2	Irriga-tion water Requ-arem-nt(Ha-m)	54	120	132	94	212	231	116	266	290	75	171	187	59	135	147	-	-	-	Design Discharge a head =2.7 Cumecs, a middle reach=2.32 Cumecs & tai reach=1.21Cu-mecs.
		Cum-ulativ-e Irrigat-ion water requir-ment (Km)	306	252	132	537	443	231	672	556	290	433	358	187	341	282	147	-	-	-	

2	Ditsy. No. 11	Irriga-tion water Requ-ireme-nt (Ha-m)	104	176	68	198	336	130	252	425	164	169	287	110	142	240	93	-	-	-	Design Discharge at head =4.60 Cumecs, at middle reach=3.62 Cumecs & tail reach=1.99Cumecs.
		Cum-ulativ-e Irrigat-ion water requir-ment (Km)	348	244	68	664	466	130	841	589	164	566	397	110	475	333	93	-	-	-	
3	Ditsy. No. 12	Irriga-tion water Requ-ireme-nt (Ha-m)	6	18	17	11	35	33	14	45	42	8	25	23	5	15	14	-	-	-	Design Discharge at head =0.42 Cumecs, at middle reach=0.36 Cumecs & tail reach=0.16 Cumecs.
		Cum-ulativ-e Irrigat-ion water requir-ment (Km)	41	35	17	79	68	36	101	87	42	56	48	23	34	29	14	-	-	-	

4	Ditsy. No. 13	Irrigat-ion water Requ-ireme-nt (Ha-m)	74	14	99	146	26	194	186	33	249	92	16	123	42	7	55	-	-	-	Design Discharge head =1.8 Cumecs, middle reach=1.16 Cumecs & t reach=1.04Cumecs.
		Cum-ulativ-e Irrigat-ion water requir-ment (Km)	187	113	99	366	220	194	468	282	249	231	139	123	104	62	55	-	-	-	
5	Ditsy. No. 14	Irrigat-ion water Requ-ireme-nt (Ha-m)	20	38	106	41	74	207	52	93	265	28	51	144	17	30	85	-	-	-	Design discharge head =1. Cumecs, middle reach=1.69 Cumecs & t reach=1.34 Cumecs.
		Cum-lative Irrigat-ion water requir-ment (Km)	164	144	106	322	281	207	410	358	265	223	195	144	132	115	85	-	-	-	

Table No. 14(b)
Annexure: 4
Gross Irrigation Water Requirement in Different Months (Dec to May)

Sl. No.	Name of Canal	Description	December			Januray			February			March			April			May			Remarks
			Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	
1	Distributary No. 2	Irrigation water Requirement (Ha-m)	21	48	52	18	43	47	13	29	31	10	22	23	8	17	19	9	20	22	
		Cumulative Irrigation water requirment (Km)	121	100	52	108	90	47	73	60	31	55	45	23	44	36	19	52	42	22	
		Design discharge (cumescs)	2.79	2.32	1.21	2.79	2.32	1.21	2.79	2.32	1.21	2.79	2.32	1.21	2.79	2.32	1.21	2.79	2.32	1.21	
2	Distributary No.11	Irrgation water requirment (Ha-m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

		Irrgation water requi-rement (Ha-m)	Cumulative Irrigation water Requ-irement (Ha-m)	Design Discharge (Cumecs)	Cumulative irrigation. water Requ-irement (Ha-m)	Design Disc-hage (Cumecs)
3	Distributary No.12	-	-	0.42	-	4.60
		-	-	0.42	-	3.62
		-	-	0.16	-	1.99
		-	-	0.42	-	4.60
		-	-	0.36	-	3.62
		-	-	0.16	-	1.99
		-	-	0.42	-	4.60
		-	-	0.36	-	3.62
		-	-	0.16	-	1.99
		-	-	0.42	-	4.60
		-	-	0.36	-	3.62
		-	-	0.16	-	1.999
		-	-	0.42	-	4.60
		-	-	0.36	-	3.62
		-	-	0.16	-	1.99
		-	-	0.42	-	4.60
		-	-	0.36	-	3.62
		-	-	0.16	-	1.99

4	Distributary N0.13	Irrigation water requir-ement (Ha-m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Cumulative irrigation water requirement (Ha-m)	-	-	-	-	-	-	-	-	-		-	-	-		-	-	-	-
		Design discharge (cumecs)	1.56	1.16	1.04	1.86	1.16	1.04	1.86	1.16	1.04	1.86	1.16	1.04	1.86	1.16	1.04	1.86	1.16	1.04
5	Distributary N0.14	Irrigation water require-ment (Ha-m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Cumulative irrigation water requir-ement (Ha-m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Design discharge (cumecs)	1.89	1.69	1.34	1.89	1.69	1.34	1.89	1.69	1.34	1.89	1.69	1.34	1.89	1.69	1.34	1.89	1.69	1.34

TABLE NO.: 14 (c)
ANNEXURE:4
MONTHLY CANAL DISCHARGE AT HEAD REGULATOR

Sl No.	Name of Canal	Items	Unit	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	Remarks
1.	Distributory No. 2	Full supply discharge	Cumecs	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	
		Water Required	Ha-m	306	537	672	433	341	-	121	108	73	55	44	51	
		Dates of opening of canal	-	1to 15	1 to 25	1 to 30	1 to 20	1 to 15	-	1 to 10	1 to 10	1 to 5	1 to 5	1 to 5	1 to 5	
		Actual flow	Cumecs	2.36	2.49	2.59	2.51	2.63	-	1.40	1.25	1.69	1.27	1.02	1.18	
2.	Distributory No. 11	Full supply discharge	Cumecs	4.6	4.6	4.6	4.6	4.6	-	-	-	-	-	-	-	
		Water required	Ha-m	348	664	841	566	475	-	-	-	-	-	-	-	
		Dates of opening of canal	-	1 to 10	1 to 20	1 to 25	1 to 15	1 to 15	-	-	-	-	-	-	-	
		Actual flow	Cumecs	4.03	3.84	3.89	4.37	3.67	-	-	-	-	-	-	-	
3.	Distributory No.12	Full supply discharge	Cumecs	0.42	0.42	0.42	0.42	0.42	-	-	-	-	-	-	-	
		Water Required	Ha-m	41	79	101	56	34	-	-	-	-	-	-	-	
		Dates of opening of canal	-	1to 15	1 to 25	1 to 30	1 to 20	1 to 10	-	-	-	-	-	-	-	
		Actual flow	Cumecs	0.32	0.37	0.39	0.32	0. 39	-	-	-	-	-	-	-	
4.	Distributory No. 13	Full supply discharge	Cumecs	1.86	1.86	1.86	1.86	1.86	-	-	-	-	-	-	-	
		Water Required	Ha-m	187	366	468	231	104	-	-	-	-	-	-	-	
		Dates of opening of canal	-	1to 15	1 to 25	1 to 30	1 to 15	1 to 10	-	-	-	-	-	-	-	
		Actual flow	Cumecs	1.44	1.69	1.81	1.78	1.20	-	-	-	-	-	-	-	
5.	Distributory No. 14	Full supply discharge	Cumecs	1.89	1.89	1.89	1.89	1.89	-	-	-	-	-	-	-	
		Water Required	Ha-m	164	322	410	223	132	-	-	-	-	-	-	-	
		Dates of opening of canal	-	1to 10	1 to 20	1 to 25	1 to 15	1 to 10	-	-	-	-	-	-	-	
		Actual flow	Cumecs	1.89	1.86	1.89	1.72	1.52	-	-	-	-	-	-	-	

TABLE N0. 14(d) WEEKLY ROSTER: KHARIF (1999)
ANNEXURE: 4

DISCHARGE IN CUMECS

Sl.No.	Name of the Canal	June					July				August					September				October				November				
		1	8	15	22	29	6	13	20	27	3	10	17	24	31	7	14	21	28	5	12	19	26	2	9	16	23	30
1.	Distributory N0.2	-	-	0.929	1.032	0.897	0.617	0.778	0.598	0.173	0.550	0.615	0.623	0.619	0.100	0.878	0.879	0.753	-	-	1.105	1.35	0.175	-	-	-	-	-
2.	Mahupadar s/m	-	-	0.079	-	-	-	-	-	0.083	-	-	-	-	0.087	-	-	0.084	-	-	-	-	0.088	-	-	-	-	-
3.	Pital Minor	-	-	-	0.961	-	-	-	0.575	-	-	0.598	-	-	-	-	-	0.580	-	-	-	0.608	-	-	-	-	-	-
4.	Minor No. I	-	-	0.317	-	-	0.335	-	-	-	0.384	-	-	-	-	0.337	-	-	-	-	-	0.354	-	-	-	-	-	-
5.	Minor No. II	-	-	-	-	0.213	-	0.225	-	-	-	-	0.234	-	-	-	0.227	-	-	-	0.943	-	-	-	-	-	-	-

6.	Disty. No. 11	-	-	0.46	2.62	2.10	1.61	1.01	0.07	-	0.45	1.29	1.41	0.74	-	1.70	2.36	0.31	-	-	1.00	2.36	0.31	-	-	-	-	-
7.	Jhadonkoli Minor	-	-	0.249	-	-	-	0.237	-	-	0.24	-	-	-	-	-	-	0.264	-	-	-	-	0.227	-	-	-	-	-
8.	Badagumula Minor	-	-	0.086	-	-	-	0.012	0.07	-	0.083	-	-	-	-	0.093	-	-	-	-	0.078	-	-	-	-	-	-	-
9.	Luhajore Minor	-	-	-	0.146	-	-	0.219	-	-	-	-	-	0.143	-	0.160	-	-	-	-	0.134	-	-	-	-	-	-	-
10.	Narendrapur Minor	-	-	0.103	-	-	-	0.140	-	-	-	-	-	0.142	-	0.160	-	-	-	-	0.134	-	-	-	-	-	-	-
11.	Ambapur Minor	-	-	-	0.094	-	-	0.089	-	-	0.091	-	-	-	-	0.102	-	-	-	-	0.085	-	-	-	-	-	-	-
12.	Raghunathpur Minor	-	-	-	0.134	-	-	0.128	-	-	-	-	-	0.129	-	0.145	-	-	-	-	0.122	-	-	-	-	-	-	-

13.	Pathara Minor	-	-	-	0.300	-	0.100	0.185	-	-	-	-	-	0.289	-	0.325	-	-	-	-	0.273	-	-	-	-	-	-	-
14.	Sidhigaon Minor	-	-	-	0.701	-	0.344	-	-	-	-	0.348	-	-	-	-	0.391	-	-	-	-	0.329	-	-	-	-	-	-
15.	Musidipalam Minor	-	-	-	-	0.130	0.124	-	-	-	-	0.125	-	-	-	-	0.141	-	-	-	-	0.118	-	-	-	-	-	-
16.	Aruapalli Minor	-	-	-	-	1.051	1.002	-	-	-	-	-	1.015	-	-	-	1.14	-	-	-	-	0.957	-	-	-	-	-	-
17.	Disty. No.12	0.135	0.164	0.021	-	-	0.09	0.12	0.10	0.09	0.09	0.12	0.10	0.05	0.09	0.13	0.10	-	-	0.29	0.10	-	-	-	-	-	-	-
18.	Bankeyapalli Minor	0.100	-	-	-	-	-	0.113	-	-	-	0.119	-	-	-	-	0.10	-	-	0.119	-	-	-	-	-	-	-	-
19.	Disty. No. 13	0.10	0.60	0.74	-	-	0.27	0.40	0.48	0.66	0.51	0.43	0.39	0.36	-	0.66	1.00	0.12	-	0.36	0.84	-	-	-	-	-	-	-

20.	"A" Minor	0.02	0.60	-	-	-	0.05	0.40	-	-	0.475	-	-	-	-	0.47	-	-	-	0.32	-	-	-	-	-	-	-	-
21.	"B" Minor	-	-	0.19	-	-	0.22	-	-	-	-	0.23	-	-	-	-	0.23	-	-	-	0.15	-	-	-	-	-	-	-
22.	"C" Minor	0.08	-	-	-	-	-	-	0.09	-	-	0.10	-	-	-	0.10	-	-	-	-	0.07	-	-	-	-	-	-	-
23.	"D" Minor	-	-	0.01	-	-	-	-	0.01	-	0.015	-	-	-	-	0.02	-	-	-	0.01	-	-	-	-	-	-	-	-
24.	"E" Minor	-	-	0.08	-	-	-	-	0.09	-	-	0.10	-	-	-	-	-	0.10	-	-	0.07	-	-	-	-	-	-	-
25.	"F" Minor	-	-	0.07	-	-	-	-	0.07	-	-	-	0.08	-	-	-	0.08	-	-	-	0.05	-	-	-	-	-	-	-
26.	Disty. No. 14	1.29	0.60	-	-	-	0.60	0.70	0.56	-	0.42	0.53	0.64	0.30	-	0.75	0.85	0.12	-	0.46	1.06	-	-	-	-	-	-	-

27.	Majhidiho Minor	-	0.23	-	-	-	0.22	-	-	-	-	0.23	-	-	-	0.21	-	-	-	0.18	-	-	-	-	-	-	-	-
28.	Sanathana Minor	0.40	-	-	-	-	-	-	0.40	-	0.40	-	-	-	-	0.38	-	-	-	-	0.33	-	-	-	-	-	-	-
29.	Right Minor	-	0.11	-	-	-	-	-	0.11	-	-	0.11	-	-	-	-	-	0.10	-	0.09	-	-	-	-	-	-	-	-
30.	Baghala S/M	-	0.07	-	-	-	-	-	0.07	-	-	0.07	-	-	-	-	-	0.06	-	0.05	-	-	-	-	-	-	-	-
31.	Left Minor	0.38	-	-	-	-	-	0.37	-	-	-	-	0.38	-	-	0.35	-	-	-	-	0.31	-	-	-	-	-	-	-
32.	Gopinathpur Minor	0.09	-	-	-	-	-	0.09	-	-	-	-	0.09	-	-	0.08	-	-	-	-	0.07	-	-	-	-	-	-	-
33.	Damodarpur S/M	0.13	-	-	-	-	-	0.13	-	-	-	-	0.13	-	-	0.12	-	-	-	-	0.100	-	-	-	-	-	-	-

TABLE N0. 14(e) WEEKLY ROSTER: RABI (1999-2000)
ANNEXURE:4

DISCHARGE IN CUMECS

Sl.No.	Name of Canal	December				January				February				March					April				May			
		7	14	21	28	4	11	18	25	1	8	15	22	1	8	15	22	29	5	12	19	26	3	10	17	24
1.	Disty. No. 2	0.5	0.9	-	-	0.38	0.87	-	-	1.69	-	-	-	1.27	-	-	-	-	1.02	-	-	-	1.18	-	-	-
2.	Mahupadar S/M	0.05	-	-	-	0.05	-	-	-	0.06	-	-	-	0.05	-	-	-	-	0.04	-	-	-	0.04	-	-	-
3.	Pital Minor	0.33	-	-	-	0.30	-	-	-	0.40	-	-	-	0.30	-	-	-	-	0.25	-	-	-	0.28	-	-	-
4.	Minor No. I	-	0.19	-	-	-	0.17	-	-	0.23	-	-	-	0.17	-	-	-	-	0.14	-	-	-	0.16	-	-	-

5.	Minor No. II	-	0.13	-	-	-	0.12	-	-	0.16	-	-	-	0.12	-	-	-	-	0.10	-	-	-	0.11	-	-	-

TABLE No: 15(a) Annexure 4 Monthly Drawl (Ha-m) of Water At Head Of Disty No 2

Sl. No.	Year	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1981	94	98	461	244	347	-	-	60	30	15	49	14	Before modernization
2	1982	158	189	306	310	427	-	-	52	34	19	56	52	
3	1983	87	190	374	530	437	-	104	136	26	7	19	18	
4	1984	52	280	741	509	-	-	-	87	28	30	70	82	
5	1985	72	195	336	324	553	-	-	106	50	60	35	90	
6	1986	80	90	434	468	414	-	-	97	41	23	72	7	
7	1987	98	330	496	220	355	-	-	90	34	76	28	24	
8	1988	109	321	435	389	363	-	-	81	32	38	6	23	
9	1989	81	118	381	373	413	-	13	85	28	34	23	55	
10	1990	72	295	492	387	148	-	-	89	4	25	13	26	
11	1991	80	282	398	320	190	-	-	86	29	27	16	52	
12	1992	52	190	336	215	153	-	-	55	35	29	24	13	
Average before modernization		*86*	*215*	*433*	*357*	*300*	-	*10*	*85*	*31*	*28*	*34*	*38*	
13	1993	-	-	-	-	-	-	-	-	-	-	-	-	Modern-ization
14	1994	-	-	-	-	-	-	-	-	-	-	-	-	
15	1995	214	403	571	368	289	-	-	-	-	-	34	40	After mod-erniz-ation
16	1996	223	424	551	364	307	-	96	90	55	46	35	41	
17	1997	230	409	529	372	313	-	100	87	57	45	35	42	
18	1998	251	440	558	354	310	-	86	80	51	43	36	35	
19	1999	245	446	578	376	303	-	90	88	53	48	37	37	
20	2000	239	430				-		85	49	43	33	39	
Average after modernization		**234**	**425**	**557**	**368**	**306**	-	**93**	**86**	**53**	**45**	**35**	**39**	

TABLE No: 15(b) Annexure 4 Monthly Drawl (Ha.-m) of Water At Middle of Disty. No 2

Sl. No.	Year	Month												Remarks
		June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	1981	68	67	379	171	291	-	-	43	25	11	42	6	Before modernization
2	1982	117	130	248	220	354	-	-	37	28	14	47	29	
3	1983	64	133	299	382	358	-	73	99	21	5	16	9	
4	1984	38	199	585	372	-	-	-	64	22	23	57	40	
5	1985	53	140	262	240	282	-	-	80	40	5	28	45	
6	1986	59	66	334	351	327	-	-	74	32	18	58	4	
7	1987	72	244	377	167	277	-	-	69	26	61	22	12	
8	1988	81	241	325	300	280	-	-	63	24	31	5	12	
9	1989	59	90	282	291	314	-	11	67	21	28	18	30	
10	1990	53	227	359	306	111	-	-	71	3	21	10	14	
11	1991	58	220	287	256	141	-	-	70	21	23	12	29	
12	1992	34	151	271	172	73	-	-	43	25	24	9	3	
Average before modernization		*63*	*159*	*334*	*269*	*234*	-	*7*	*65*	*24*	*22*	*27*	*19*	
13	1993	-	-	-	-	-	-	-	-	-	-	-	-	Modernization
14	1994	-	-	-	-	-	-	-	-	-	-	-	-	
15	1995	175	306	457	276	238	-	80	-	-	-	28	31	After modernization
16	1996	181	326	435	277	243	-	84	67	46	36	29	32	
17	1997	184	319	413	286	244	-	76	66	48	35	28	33	
18	1998	198	348	430	276	239	-	69	62	42	34	29	28	
19	1999	191	357	460	300	236	-	71	69	43	39	29	30	
20	2000	180	336				-		66	36	36	25	32	
Average after modernization		**184**	**332**	**439**	**283**	**240**	-	**76**	**66**	**43**	**36**	**28**	**31**	

TABLE No: 15(c) Annexure 4 Monthly Drawl (Ha.-m) of Water At Tail of Disty. No 2

Sl. No.	Year	Month												Remarks
		June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	1981	36	29	194	76	121	-	-	14	9	5	21	2	Before modernization
2	1982	58	59	125	99	126	-	-	12	10	7	24	7	
3	1983	31	61	150	175	124	-	31	34	8	3	8	3	
4	1984	18	92	289	173	-	-	-	23	9	11	28	13	
5	1985	24	66	128	113	109	-	-	29	17	3	14	15	
6	1986	26	32	161	168	124	-	-	27	14	9	27	1	
7	1987	31	119	179	81	103	-	-	26	12	30	10	5	
8	1988	34	119	152	148	102	-	-	24	12	16	2	5	
9	1989	24	45	130	145	112	-	5	26	10	14	8	12	
10	1990	21	115	162	155	38	-	-	28	2	11	4	6	
11	1991	22	113	127	131	48	-	-	28	11	12	5	12	
12	1992	11	62	123	132	37	-	-	29	18	11	5	3	
Average before modernization		*28*	*76*	*160*	*133*	*87*	-	*3*	*25*	*11*	*11*	*13*	*7*	
13	1993	-	-	-	-	-	-	-	-	-	-	-	-	moder-nization
14	1994	-	-	-	-	-	-	-	-	-	-	-	-	
15	1995	88	145	234	129	122	-	42	-	-	-	14	15	After modernization
16	1996	89	157	220	131	123	-	43	29	24	17	14	16	
17	1997	90	155	206	138	122	-	39	29	24	17	14	17	
18	1998	95	172	212	135	118	-	35	28	21	17	14	14	
19	1999	91	178	203	152	105	-	36	31	21	20	14	15	
20	2000	93	189				-		33	20	19	14	19	
Average after modernization		**91**	**166**	**215**	**137**	**118**	-	**39**	**30**	**22**	**18**	**14**	**16**	

TABLE No: 16(a) Annexure 4 Monthly Drawl (Ha.-m) of Water At Head of Disty. No. 11

Sl. No.	Year	Month												Remarks
		June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1981	63	398	512	474	110	-	-	-	-	-	-	-	Before Modernization
2	1982	260	332	355	211	72	-	-	-	-	-	-	-	
3	1983	118	420	419	523	181	-	-	-	-	-	-	-	
4	1984	231	466	257	184	-	-	-	-	-	-	-	-	
5	1985	-	416	271	378	127	-	-	-	-	-	-	-	
6	1986	-	349	342	469	146	-	-	-	-	-	-	-	
7	1987	71	286	197	272	38	-	-	-	-	-	-	-	
8	1988	99	312	335	242	27	-	-	-	-	-	-	-	
9	1989	132	885	411	433	150	-	-	-	-	-	-	-	
10	1990	76	340	304	230	46	-	-	-	-	-	-	-	
11	1991	130	367	318	220	-	-	-	-	-	-	-	-	
12	1992	116	320	260	184	-	-	-	-	-	-	-	-	
Average before modernization		*108*	*366*	*332*	*318*	*75*	-	-	-	-	-	-	-	
13	1993	-	-	-	-	-	-	-	-	-	-	-	-	Moder-nization
14	1994	-	-	-	-	-	-	-	-	-	-	-	-	
15	1995	261	564	715	475	332	-	-	-	-	-	-	-	After Modernization
16	1996	271	551	690	458	347	-	-	-	-	-	-	-	
17	1997	278	531	639	447	361	-	-	-	-	-	-	-	
18	1998	285	518	664	464	390	-	-	-	-	-	-	-	
19	1999	264	544	698	487	394	-	-	-	-	-	-	-	
20	2000	282	538	-	-	-	-	-	-	-	-	-	-	
Average after modernization		**274**	**541**	**681**	**466**	**365**	-	-	-	-	-	-	-	

TABLE No: 16(b) Annexure 4 – Monthly Drawl (Ha.m) of Water At Middle of Disty. No. 11

Sl. No.	Year	Month												Remarks
		June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1981	42	195	328	284	64	-	-	-	-	-	-	-	Before Modernization
2	1982	169	166	224	129	41	-	-	-	-	-	-	-	
3	1983	76	214	260	324	101	-	-	-	-	-	-	-	
4	1984	146	242	157	116	-	-	-	-	-	-	-	-	
5	1985	-	220	163	242	69	-	-	-	-	-	-	-	
6	1986	-	188	202	305	77	-	-	-	-	-	-	-	
7	1987	43	157	114	180	20	-	-	-	-	-	-	-	
8	1988	58	175	191	162	14	-	-	-	-	-	-	-	
9	1989	77	219	230	294	75	-	-	-	-	-	-	-	
10	1990	43	197	167	159	19	-	-	-	-	-	-	-	
11	1991	73	217	172	154	-	-	-	-	-	-	-	-	
12	1992	65	186	144	171	-	-	-	-	-	-	-	-	
Average before modernization		*66*	*198*	*196*	*210*	*40*	-	-	-	-	-	-	-	
13	1993	-	-	-	-	-	-	-	-	-	-	-	-	Modern-ization
14	1994	-	-	-	-	-	-	-	-	-	-	-	-	
15	1995	183	367	479	309	229	-	-	-	-	-	-	-	After Moder-nization
16	1996	187	364	455	302	236	-	-	-	-	-	-	-	
17	1997	189	356	415	299	242	-	-	-	-	-	-	-	
18	1998	191	352	425	316	257	-	-	-	-	-	-	-	
19	1999	174	375	436	344	266	-	-	-	-	-	-	-	
20	2000	174	364				-	-	-	-	-	-	-	
Average after modernization		**183**	**363**	**442**	**314**	**246**	-	-	-	-	-	-	-	

TABLE No: 16(c) Annexure 4 Monthly Drawl (Ha.-m) of Water At Tail of Disty. No. 11

Sl. No.	Year	Month												Remarks
		June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1981	13	40	102	52	20	-	-	-	-	-	-	-	Before Modernization
2	1982	52	37	67	25	12	-	-	-	-	-	-	-	
3	1983	22	50	75	68	9	-	-	-	-	-	-	-	
4	1984	42	61	44	26	-	-	-	-	-	-	-	-	
5	1985	-	58	43	57	18	-	-	-	-	-	-	-	
6	1986	-	52	51	75	19	-	-	-	-	-	-	-	
7	1987	11	46	28	46	5	-	-	-	-	-	-	-	
8	1988	14	53	44	44	3	-	-	-	-	-	-	-	
9	1989	17	69	49	82	15	-	-	-	-	-	-	-	
10	1990	9	65	33	46	7	-	-	-	-	-	-	-	
11	1991	3	73	32	46	-	-	-	-	-	-	-	-	
12	1992	21	20	56	69	-	-	-	-	-	-	-	-	
Average before modernization		*17*	*52*	*52*	*53*	*9*	-	-	-	-	-	-	-	
13	1993	-	-	-	-	-	-	-	-	-	-	-	-	moderniz ation
14	1994	-	-	-	-	-	-	-	-	-	-	-	-	
15	1995	55	92	139	74	66	-	-	-	-	-	-	-	After Moder-nization
16	1996	54	95	127	76	66	-	-	-	-	-	-	-	
17	1997	53	96	112	78	65	-	-	-	-	-	-	-	
18	1998	52	99	11	85	67	-	-	-	-	-	-	-	
19	1999	45	109	116	102	66	-	-	-	-	-	-	-	
20	2000	41	103				-	-	-	-	-	-	-	
Average after modernization		**50**	**99**	**121**	**83**	**66**	-	-	-	-	-	-	-	

TABLE No: 17(a) Annexure 4 Monthly Drawl (Ha.-m) of Water At Head of Disty. No. 12

Sl. No.	Year	Month												Remarks
		June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1981	-	32	36	41	11	-	-	-	-	-	-	-	Before Modernization
2	1982	6	16	17	11	1	-	-	-	-	-	-	-	
3	1983	20	32	34	40	4	-	-	-	-	-	-	-	
4	1984	13	32	30	34	8	-	-	-	-	-	-	-	
5	1985	-	43	35	28	7	-	-	-	-	-	-	-	
6	1986	-	38	16	40	9	-	-	-	-	-	-	-	
7	1987	15	22	20	14	7	-	-	-	-	-	-	-	
8	1988	10	34	23	40	10	-	-	-	-	-	-	-	
9	1989	16	42	41	40	14	-	-	-	-	-	-	-	
10	1990	5	34	49	41	8	-	-	-	-	-	-	-	
11	1991	8	32	34	33	7	-	-	-	-	-	-	-	
12	1992	2	29	30	28	-	-	-	-	-	-	-	-	
Average before modernization		*8*	*32*	*30*	*33*	*7*	-	-	-	-	-	-	-	
13	1993	-	-	-	-	-	-	-	-	-	-	-	-	Moder-nization
14	1994	-	-	-	-	-	-	-	-	-	-	-	-	
15	1995	29	58	71	48	24	-	-	-	-	-	-	-	After Modern-ization
16	1996	31	59	80	49	236	-	-	-	-	-	-	-	
17	1997	32	65	83	46	28	-	-	-	-	-	-	-	
18	1998	33	67	86	45	29	-	-	-	-	-	-	-	
19	1999	35	63	75	46	24	-	-	-	-	-	-	-	
20	2000	32	59	-	-	-	-	-	-	-	-	-	-	
Average after modernization		**32**	**62**	**79**	**47**	**26**	-	-	-	-	-	-	-	

TABLE No: 17(b) Annexure 4 Monthly Drawl (Ha.-m) of Water At Middle of Distv. No. 12

Sl. No.	Year	Month												Remarks
		June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1981	-	25	30	32	10	-	-	-	-	-	-	-	Before Modernization
2	1982	5	13	14	9	1	-	-	-	-	-	-	-	
3	1983	16	26	27	32	4	-	-	-	-	-	-	-	
4	1984	10	26	24	27	7	-	-	-	-	-	-	-	
5	1985	-	85	27	23	6	-	-	-	-	-	-	-	
6	1986	-	32	12	33	8	-	-	-	-	-	-	-	
7	1987	11	18	15	12	6	-	-	-	-	-	-	-	
8	1988	7	29	17	34	8	-	-	-	-	-	-	-	
9	1989	12	36	30	34	11	-	-	-	-	-	-	-	
10	1990	4	30	36	35	6	-	-	-	-	-	-	-	
11	1991	6	28	24	29	5	-	-	-	-	-	-	-	
12	1992	1	26	20	24	-	-	-	-	-	-	-	-	
Average before modernization		*6*	*27*	*23*	*27*	*6*	-	-	-	-	-	-	-	
13	1993	-	-	-	-	-	-	-	-	-	-	-	-	Modern-ization
14	1994	-	-	-	-	-	-	-	-	-	-	-	-	
15	1995	25	45	59	39	20	-	-	-	-	-	-	-	After Moder-nization
16	1996	26	47	66	40	21	-	-	-	-	-	-	-	
17	1997	27	52	67	38	23	-	-	-	-	-	-	-	
18	1998	27	54	69	38	23	-	-	-	-	-	-	-	
19	1999	29	52	59	40	18	-	-	-	-	-	-	-	
20	2000	28	50				-	-	-	-	-	-	-	
Average after modernization		**27**	**50**	**64**	**39**	**21**	-	-	-	-	-	-	-	

TABLE No: 17(c) Annexure 4 Monthly Drawl (Ha.-m) of Water At Tail of Disty. No. 12

Sl. No.	Year	Month												Remarks
		June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1981	-	9	14	12	4	-	-	-	-	-	-	-	Before Modernization
2	1982	2	5	7	4	-	-	-	-	-	-	-	-	
3	1983	6	10	12	13	1	-	-	-	-	-	-	-	
4	1984	4	10	11	11	2	-	-	-	-	-	-	-	
5	1985	-	14	12	10	2	-	-	-	-	-	-	-	
6	1986	-	13	5	15	3	-	-	-	-	-	-	-	
7	1987	4	8	6	5	2	-	-	-	-	-	-	-	
8	1988	2	12	7	16	2	-	-	-	-	-	-	-	
9	1989	4	15	12	16	3	-	-	-	-	-	-	-	
10	1990	1	13	14	17	2	-	-	-	-	-	-	-	
11	1991	2	13	9	14	3	-	-	-	-	-	-	-	
12	1992	-	10	11	11	-	-	-	-	-	-	-	-	
Average before modernization		*2*	*11*	*10*	*12*	*2*	-	-	-	-	-	-	-	
13	1993	-	-	-	-	-	-	-	-	-	-	-	-	Mode-rnization
14	1994	-	-	-	-	-	-	-	-	-	-	-	-	
15	1995	12	18	28	16	10	-	-	-	-	-	-	-	After Moder-nization
16	1996	12	20	30	17	10	-	-	-	-	-	-	-	
17	1997	12	22	30	17	11	-	-	-	-	-	-	-	
18	1998	12	24	30	17	11	-	-	-	-	-	-	-	
19	1999	12	23	27	18	8	-	-	-	-	-	-	-	
20	2000	12	25				-	-	-	-	-	-	-	
Average after Modernization		**12**	**22**	**29**	**17**	**10**	-	-	-	-	-	-	-	

TABLE No: 18(a) Annexure 4 Monthly Drawl (Ha.-m) of Water at Head of Disty. No 13

Sl. No.	Year	Month												Remarks
		June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1981	-	139	147	134	49	-	-	-	-	-	-	-	Berore Modernization
2	1982	33	150	132	71	48	-	-	-	-	-	-	-	
3	1983	44	261	265	145	82	-	-	-	-	-	-	-	
4	1984	48	162	134	134	52	-	-	-	-	-	-	-	
5	1985	-	155	97	75	55	-	-	-	-	-	-	-	
6	1986	-	119	103	145	32	-	-	-	-	-	-	-	
7	1987	51	115	79	95	43	-	-	-	-	-	-	-	
8	1988	53	226	117	208	20	-	-	-	-	-	-	-	
9	1989	74	149	93	195	76	-	-	-	-	-	-	-	
10	1990	29	165	194	164	45	-	-	-	-	-	-	-	
11	1991	15	153	137	143	27	-	-	-	-	-	-	-	
12	1992	-	112	108	132	-	-	-	-	-	-	-	-	
Average before modernization		*29*	*159*	*134*	*137*	*44*	-	-	-	-	-	-	-	
13	1993	-	-	-	-	-	-	-	-	-	-	-	-	Moder-nization
14	1994	-	-	-	-	-	-	-	-	-	-	-	-	
15	1995	131	275	328	196	83	-	-	-	-	-	-	-	After Mode-mizati-on
16	1996	135	285	365	192	86	-	-	-	-	-	-	-	
17	1997	148	300	337	182	91	-	-	-	-	-	-	-	
18	1998	159	296	356	189	81	-	-	-	-	-	-	-	
19	1999	153	278	342	185	84	-	-	-	-	-	-	-	
20	2000	146	304	-	-	-	-	-	-	-	-	-	-	
Average after modernization		**145**	**290**	**346**	**189**	**85**	-	-	-	-	-	-	-	

TABLE No: 18(b) Annexure 4 Monthly Drawl (Ha-m) of Water At Middle of Disty. No 13

Sl. No.	Year	Month												Remarks
		June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	1981	-	64	82	66	29	-	-	-	-	-	-	-	Berore Modernization
2	1982	17	71	73	36	28	-	-	-	-	-	-	-	
3	1983	22	125	143	74	48	-	-	-	-	-	-	-	
4	1984	24	79	71	17	30	-	-	-	-	-	-	-	
5	1985	-	78	50	40	31	-	-	-	-	-	-	-	
6	1986	-	61	52	78	18	-	-	-	-	-	-	-	
7	1987	24	60	40	52	23	-	-	-	-	-	-	-	
8	1988	24	120	57	116	11	-	-	-	-	-	-	-	
9	1989	33	80	44	111	40	-	-	-	-	-	-	-	
10	1990	13	91	91	95	23	-	-	-	-	-	-	-	
11	1991	11	86	63	84	7	-	-	-	-	-	-	-	
12	1992	-	57	50	66	-	-	-	-	-	-	-	-	
Average before modernization		**14**	**81**	**68**	**74**	**24**	-	-	-	-	-	-	-	
13	1993	-	-	-	-	-	-	-	-	-	-	-	-	Modern-ization
14	1994	-	-	-	-	-	-	-	-	-	-	-	-	
15	1995	80	149	190	112	48	-	-	-	-	-	-	-	After Modernization
16	1996	81	157	208	111	49	-	-	-	-	-	-	-	
17	1997	87	168	189	107	51	-	-	-	-	-	-	-	
18	1998	92	169	196	113	45	-	-	-	-	-	-	-	
19	1999	87	161	192	112	47	-	-	-	-	-	-	-	
20	2000	89	186				-	-	-	-	-	-	-	
Average after modernization		**86**	**165**	**195**	**111**	**48**	-	-	-	-	-	-	-	

TABLE No: 18(c) Annexure 4 Monthly Drawl (Ha-m) of Water At Tail of Disty. No 13

Sl. No.	Year	Month												Remarks
		June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	1981	-	47	65	52	24	-	-	-	-	-	-	-	Berore Modernization
2	1982	13	53	57	29	23	-	-	-	-	-	-	-	
3	1983	16	94	110	60	39	-	-	-	-	-	-	-	
4	1984	18	60	54	57	24	-	-	-	-	-	-	-	
5	1985	-	60	38	33	25	-	-	-	-	-	-	-	
6	1986	-	48	38	66	14	-	-	-	-	-	-	-	
7	1987	17	47	29	44	18	-	-	-	-	-	-	-	
8	1988	17	96	41	100	8	-	-	-	-	-	-	-	
9	1989	22	65	31	97	30	-	-	-	-	-	-	-	
10	1990	9	75	64	84	17	-	-	-	-	-	-	-	
11	1991	8	71	43	75	6	-	-	-	-	-	-	-	
12	1992	-	52	30	59	-	-	-	-	-	-	-	-	
Average before modernization		*10*	*64*	*50*	*63*	*19*	-	-	-	-	-	-	-	
13	1993	-	-	-	-	-	-	-	-	-	-	-	-	Modern-izatio
14	1994	-	-	-	-	-	-	-	-	-	-	-	-	
15	1995	70	112	162	90	42	-	-	-	-	-	-	-	After Moder-niza-tion
16	1996	70	119	175	90	42	-	-	-	-	-	-	-	
17	1997	75	129	157	88	43	-	-	-	-	-	-	-	
18	1998	78	132	161	94	38	-	-	-	-	-	-	-	
19	1999	73	127	155	93	40	-	-	-	-	-	-	-	
20	2000	60	173				-	-	-	-	-	-	-	
Average after modernization		**71**	**132**	**162**	**91**	**41**	-	-	-	-	-	-	-	

TABLE No: 19(a) Annexure 4 **Monthly Drawl (Ha-m) of Water at Head of Disty. No 14**

Sl. No.	Year	Month												Remarks
		June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	1981	-	121	105	103	51	-	-	-	-	-	-	-	Berore Modernization
2	1982	40	115	89	58	39	-	-	-	-	-	-	-	
3	1983	41	223	215	184	87	-	-	-	-	-	-	-	
4	1984	30	159	129	150	63	-	-	-	-	-	-	-	
5	1985	-	84	102	144	60	-	-	-	-	-	-	-	
6	1986	-	154	97	204	80	-	-	-	-	-	-	-	
7	1987	18	130	43	69	66	-	-	-	-	-	-	-	
8	1988	18	264	106	218	57	-	-	-	-	-	-	-	
9	1989	51	181	214	207	76	-	-	-	-	-	-	-	
10	1990	10	189	204	167	47	-	-	-	-	-	-	-	
11	1991	8	102	131	98	29	-	-	-	-	-	-	-	
12	1992	7	71	82	63	17	-	-	-	-	-	-	-	
Average before modernization		*19*	*149*	*126*	*139*	*56*	-	-	-	-	-	-	-	
13	1993	-	-	-	-	-	-	-	-	-	-	-	-	Moder-nization
14	1994	-	-	-	-	-	-	-	-	-	-	-	-	
15	1995	133	267	332	196	108	-	-	-	-	-	-	-	After Mode-rniza-tion
16	1996	130	274	312	190	112	-	-	-	-	-	-	-	
17	1997	131	277	324	176	103	-	-	-	-	-	-	-	
18	1998	138	264	340	183	107	-	-	-	-	-	-	-	
19	1999	136	258	320	187	109	-	-	-	-	-	-	-	
20	2000	128	254	-	-	-	-	-	-	-	-	-	-	
Average after modernization		**133**	**266**	**326**	**186**	**108**	-	-	-	-	-	-	-	

TABLE No: 19(b) Annexure 4 **Monthly Drawl (Ha-m) of Water at Middle of Disty. No 14**

Sl. No.	Year	Month												Remarks
		June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1981	-	86	89	77	44	-	-	-	-	-	-	-	....Before Modernization
2	1982	32	83	74	44	34	-	-	-	-	-	-	-	
3	1983	32	163	178	142	74	-	-	-	-	-	-	-	
4	1984	23	118	106	117	53	-	-	-	-	-	-	-	
5	1985	-	63	83	114	50	-	-	-	-	-	-	-	
6	1986	-	117	78	168	66	-	-	-	-	-	-	-	
7	1987	13	100	34	56	53	-	-	-	-	-	-	-	
8	1988	13	206	83	179	46	-	-	-	-	-	-	-	
9	1989	37	143	165	172	60	-	-	-	-	-	-	-	
10	1990	7	151	155	150	37	-	-	-	-	-	-	-	
11	1991	6	83	98	83	22	-	-	-	-	-	-	-	
12	1992	5	67	57	54	13	-	-	-	-	-	-	-	
Average before modernization		14	115	100	113	46	-	-	-	-	-	-	-	
13	1993	-	-	-	-	-	-	-	-	-	-	-	-	Moder-nization
14	1994	-	-	-	-	-	-	-	-	-	-	-	-	
15	1995	114	208	282	161	90	-	-	-	-	-	-	-	After Moder-nization
16	1996	111	216	262	158	92	-	-	-	-	-	-	-	
17	1997	110	222	269	148	83	-	-	-	-	-	-	-	
18	1998	115	214	279	156	86	-	-	-	-	-	-	-	
19	1999	112	212	253	157	84	-	-	-	-	-	-	-	
20	2000	110	224				-	-	-	-	-	-	-	
Average after modernization		**112**	**216**	**269**	**156**	**87**	-	-	-	-	-	-	-	

TABLE No: 19(c) Annexure 4 Monthly Drawl (Ha-m) of Water at Tail of Distv. No 14

Sl. No.	Year	Month												Remarks
		June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1981	-	50	59	49	30	-	-	-	-	-	-	-	Before Modernization
2	1982	18	49	48	29	23	-	-	-	-	-	-	-	
3	1983	17	98	114	94	49	-	-	-	-	-	-	-	
4	1984	12	72	67	78	34	-	-	-	-	-	-	-	
5	1985	-	39	51	78	32	-	-	-	-	-	-	-	
6	1986	-	74	48	116	42	-	-	-	-	-	-	-	
7	1987	7	64	20	39	33	-	-	-	-	-	-	-	
8	1988	6	134	49	127	28	-	-	-	-	-	-	-	
9	1989	18	94	96	124	36	-	-	-	-	-	-	-	
10	1990	3	101	88	110	22	-	-	-	-	-	-	-	
11	1991	3	56	55	61	13	-	-	-	-	-	-	-	
12	1992	-	33	37	43	6	-	-	-	-	-	-	-	
Average before modernization		*7*	*72*	*61*	*79*	*29*	-	-	-	-	-	-	-	
13	1993	-	-	-	-	-	-	-	-	-	-	-	-	Modernization
14	1994	-	-	-	-	-	-	-	-	-	-	-	-	
15	1995	84	137	206	109	67	-	-	-	-	-	-	-	After Modernization
16	1996	81	145	189	109	67	-	-	-	-	-	-	-	
17	1997	79	151	191	104	60	-	-	-	-	-	-	-	
18	1998	82	148	195	111	61	-	-	-	-	-	-	-	
19	1999	78	148	174	112	60	-	-	-	-	-	-	-	
20	2000	82	165				-	-	-	-	-	-	-	
Average after modernization		**81**	**149**	**191**	**109**	**63**	-	-	-	-	-	-	-	

ANNEXURE: 4

TABLE NO. 20(a) : RELATIVE WATER SUPPLY IN DIFFERENT DISTRIBUTARIES BEFORE MODERNIZATION (JUNE TO NOV.)

Serial No.	Name of Canal	Description	June			July			August			September			October			November			Remarks (June ~ November)		
			Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach
1	Distributory No. 2	Water Supply (Drawl) in Ha-m	86	63	28	215	159	76	433	334	160	357	269	133	300	234	87	-	-	-	1391	1059	484
		Cumulative water demand (Requirement) in Ha-m	306	252	132	537	443	231	672	556	290	433	358	187	341	282	147	-	-	-	2289	1891	987
		Relative water supply	0.28	0.25	0.21	0.40	0.36	0.33	0.64	0.60	0.55	0.82	0.75	0.71	0.88	0.83	0.59	-	-	-	0.61	0.56	0.49
2	Distributory No.11	Water Supply (Drawal) in Ha-m	108	66	17	366	198	52	332	196	52	318	210	53	75	40	9	-	-	-	1199	710	183
		Cumulative water demand (Requirement) in Ha-m	348	244	68	664	466	130	841	589	164	566	397	110	475	333	93	-	-	-	2894	2029	565
		Relative water supply	0.31	0.27	0.25	0.55	0.42	0.40	0.39	0.33	0.32	0.56	0.53	0.48	0.16	0.12	0.10	-	-	-	0.41	0.35	0.32
3	Distributory No. 12	Water Supply (Drawal) in Ha-m	8	6	2	32	27	11	30	23	10	33	27	12	7	6	2	-	-	-	110	89	37
		Cumulative water demand (Requirement) in Ha-m	41	35	17	79	68	33	101	87	42	56	48	23	34	29	14	-	-	-	311	267	129

		Relative water supply	0.20	0.16	0.13	0.41	0.39	0.34	0.30	0.26	0.23	0.59	0.56	0.51	0.21	0.19	0.16	-	-	-	0.35	0.33	0.29
4	Distributory No. 13	Water Supply (Drawal) in Ha-m	29	14	10	159	81	64	134	68	50	137	74	63	44	24	19	-	-	-	503	261	206
		Cumulative water demand (Requirement) in Ha-m	187	113	99	366	220	194	468	282	249	231	139	123	104	62	55	-	-	-	1356	816	720
		Relative water supply	0.16	0.12	0.10	0.43	0.37	0.33	0.29	0.24	0.20	0.59	0.53	0.51	0.42	0.39	0.35	-	-	-	0.37	0.32	0.29
5	Distributory No. 14	Water Supply (Drawal) in Ha-m	19	14	7	149	115	72	126	100	61	139	113	79	56	46	29	-	-	-	489	388	248
		Cumulative water demand (Requirement) in Ha-m	164	144	106	322	281	207	410	358	265	223	195	144	132	115	85	-	-	-	1251	1093	807
		Relative water supply	0.12	0.10	0.07	0.46	0.41	0.35	0.31	0.28	0.23	0.62	0.58	0.55	0.42	0.40	0.34	-	-	-	0.39	0.35	0.31

ANNEXURE: 4

TABLE NO. 20(b) : RELATIVE WATER SUPPLY IN DIFFERENT DISTRIBUTARIES BEFORE MODERNIZATION (DEC. TO MAY)

Serial No.	Name of Canal	Description	December			January			February			March			April			May			Remarks (December ~ May)		
			Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach
1	Distributory No. 2	Water Supply (Drawl) in Ha-m	10	7	3	85	65	25	31	24	11	28	22	11	34	27	13	38	19	7	226	164	70
		Cumulative water demand (Requirement) in Ha-m	121	100	52	108	90	47	73	60	31	55	45	23	44	36	19	51	42	22	452	373	194
		Relative water supply	0.08	0.07	0.06	0.79	0.72	0.53	0.42	0.40	0.35	0.51	0.49	0.48	0.77	0.75	0.68	0.75	0.45	0.32	0.50	0.44	0.36
2	Distributory No.11	Water Supply (Drawl) in Ha-m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Cumulative water demand (Requirement) in Ha-m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Relative water supply	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	Distributory No. 12	Water Supply (Drawl) in Ha-m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Cumulative water demand (Requirement) in Ha-m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Relative water supply	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

4	Distributory No. 13	Water Supply (Drawl) in Ha-m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Cumulative water demand (Requirement) in Ha-m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Relative water supply	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	Distributory No. 14	Water Supply (Drawl) in Ha-m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Cumulative water demand (Requirement) in Ha-m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Relative water supply	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

ANNEXURE: 4

TABLE NO. 21(a) : RELATIVE WATER SUPPLY IN DIFFERENT DISTRIBUTARIES AFTER MODERNIZATION (JUNE TO NOV.)

Serial No.	Name of Canal	Description	June			July			August			September			October			November			Remarks (June ~ November)		
			Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach
1	Distributory No. 2	Water Supply (Drawl) in Ha-m	234	184	91	425	332	166	557	439	215	368	283	137	306	240	118	-	-	-	1890	1478	727
		Cumulative water demand (Requirement) in Ha-m	306	252	132	537	443	231	672	556	290	433	358	187	341	282	147	-	-	-	2289	1891	987
		Relative water supply	0.76	0.73	0.69	0.79	0.75	0.72	0.83	0.79	0.74	0.85	0.79	0.73	0.90	0.85	0.80	-	-	-	0.83	0.78	0.74
2	Distributory No.11	Water Supply (Drawl) in Ha-m	274	183	50	541	363	99	681	442	121	466	314	83	365	246	66	-	-	-	2327	1548	419
		Cumulative water demand (Requirement) in Ha-m	348	244	68	664	466	130	841	589	164	566	397	110	475	333	93	-	-	-	2894	2029	565
		Relative water supply	0.79	0.75	0.73	0.81	0.78	0.76	0.81	0.75	0.74	0.82	0.79	0.75	0.77	0.74	0.71	-	-	-	0.80	0.76	0.74
3	Distributory No. 12	Water Supply (Drawl) in Ha-m	32	27	12	62	50	22	79	64	29	47	39	17	26	21	10	-	-	-	246	201	90
		Cumulative water demand (Requirement) in Ha-m	41	35	17	79	68	33	101	87	42	56	48	23	34	29	14	-	-	-	311	267	129
		Relative water supply	0.78	0.76	0.72	0.78	0.74	0.68	0.78	0.74	0.69	0.84	0.82	0.76	0.76	0.72	0.69	-	-	-	0.79	0.75	0.70

4	Distributory No. 13	Water Supply (Drawl) in Ha-m	145	86	71	290	165	132	346	195	162	189	111	91	85	48	41	-	-	-	1055	605	497
		Cumulative water demand (Requirement) in Ha-m	187	113	99	366	220	194	468	282	249	231	139	123	104	62	55	-	-	-	1356	816	720
		Relative water supply	0.78	0.76	0.72	0.79	0.75	0.68	0.74	0.69	0.65	0.82	0.80	0.74	0.82	0.78	0.75	-	-	-	0.78	0.74	0.69
5	Distributory No. 14	Water Supply (Drawl) in Ha-m	133	112	81	266	216	149	326	269	191	186	156	109	108	87	63	-	-	-	1019	840	593
		Cumulative water demand (Requirement) in Ha-m	164	144	106	322	281	207	410	358	265	223	195	144	132	115	85	-	-	-	1251	1093	807
		Relative water supply	0.81	0.78	0.76	0.83	0.77	0.72	0.80	0.75	0.72	0.83	0.80	0.76	0.82	0.76	0.74	-	-	-	0.81	0.77	0.73

ANNEXURE: 4

TABLE NO. 21(b) : RELATIVE WATER SUPPLY IN DIFFERENT DISTRIBUTARIES AFTER MODERNIZATION (DEC. TO MAY)

Sl No.	Name of Canal	Description	December			January			February			March			April			May			Remarks (December ~ May)		
			Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach
1	Distributory No. 2	Water Supply (Drawl) in Ha-m	93	76	39	86	66	30	53	43	22	45	36	18	35	28	14	39	31	16	351	280	139
		Cumulative water demand (Requirement) in Ha-m	121	100	52	108	90	47	73	60	31	55	45	23	44	36	19	51	42	22	452	373	194
		Relative water supply	0.84	0.76	0.75	0.80	0.73	0.63	0.73	0.72	0.71	0.82	0.80	0.78	0.80	0.78	0.74	0.76	0.74	0.73	0.78	0.75	0.71
2	Distributory No.11	Water Supply (Drawl) in Ha-m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Cumulative water demand (Requirement) in Ha-m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Relative water supply	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	Distributory No. 12	Water Supply (Drawl) in Ha-m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Cumulative water demand (Requirement) in Ha-m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Relative water supply	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

4	Distributory No. 13	Water Supply (Drawl) in Ha-m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Cumulative water demand (Requirement) in Ha-m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Relative water supply	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	Distributory No. 14	Water Supply (Drawl) in Ha-m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Cumulative water demand (Requirement) in Ha-m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Relative water supply	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Annexure: 4

Table No. 22(a) **Relative water supply (season-wise) Before Modernization**

Serial No.	Name canal	Location along distributary						Remarks i.e average
		Head Reach		Middle Reach		Tail Reach		
		June to November	December to May	June to November	December to May	June to November	Decemeber to May	
1	Distrbutary No.2	0.61	0.50	0.56	0.44	0.49	0.36	*0.49 i.e (Highest)*
2	Distrbutary No.11	0.41	-	0.35	-	0.32	-	*0.36*
3	Distrbutary No.12	0.35	-	0.33	-	0.29	-	*0.32 (Lowest)*
4	Distrbutary No.13	0.37	-	0.32	-	0.29	-	*0.33*
5	Distrbutary No.14	0.39	-	0.35	-	0.31	-	*0.35*
Average		**0.43**		**0.38**		**0.34**		**0.37**

Annexure: 4

Table No. 22(b) **Relative water supply (season-wise) After Modernization**

Serial No.	Name canal	Location along distributary						Remarks i.e average
		Head Reach		Middle Reach		Tail Reach		
		June to November	December to May	June to November	December to May	June to November	Decemeber to May	
1	Distrbutary No.2	0.83	0.78	0.78	0.75	0.74	0.71	*0.77 i.e (Highest)*
2	Distrbutary No.11	0.80	-	0.76	-	0.74	-	*0.76*
3	Distrbutary No.12	0.79	-	0.75	-	0.70	-	*0.75*
4	Distrbutary No.13	0.78	-	0.74	-	0.69	-	*0.74 (Lowest)*
5	Distrbutary No.14	0.81	-	0.77	-	0.73	-	*0.77*
Average		**0.80**		**0.76**		**0.72**		**0.758**

ANNEXURE: 4

PERIOD: JUNE TO NOVEMBER

TABLE NO: 23(a) : WATER DELIVERY PERFORMANCE IN TERMS OF RELATIVE PRODUCTIVITY POTENTIAL (RPP) (BEFORE MODERNISATION)

Serial No.	Name of canal	Description	Unit	LOCATION ALONG THE DISTRIBUTARY												REMARKS i.e. AVERAGE
				HEAD REACH				MIDDLE REACH				TAIL REACH				
				Early Paddy	Medium Paddy	HYV Paddy	Total	Early Paddy	Medium Paddy	HYV Paddy	Total	Early Paddy	Medium Paddy	HYV Paddy	Total	
1	Distributory No. 2	Crop Production	10^4kg	19.53	29.29	34.18	83.00	32.07	48.10	56.11	136.28	25.05	37.58	43.85	106.48	Early Paddy =76.65 x 10^4 kg = 766.50 MT Medium Paddy = 114.97 x 10^4 kg =1149.70 MT HYV Paddy =134.14 x 10^4 kg =1341.40 MT
		Water Supply	10^4 m^3	98.73	111.96	121.31	332.00	168.11	191.74	215.15	575.00	148.77	152.55	182.68	484.00	
		Relative Productivity Potential	Kg/m^3	0.198	0.262	0.282	0.25	0.191	0.251	0.261	0.24	0.168	0.246	0.24	0.22	Sub-total =3257.60 MT
2	Distributory No. 11	Crop Production	10^4kg	40.73	-	71.27	112.00	42.16	-	73.78	115.94	13.97	-	24.46	38.43	Early Paddy =96.86 x 10^4 kg = 968.60 MT HYV Paddy =169.51 x 10^4 kg = 1695.10 MT
		Water Supply	10^4 m^3	215.49	-	273.51	489.00	231.65	-	295.35	527.00	83.18	-	99.82	183.00	
		Relative Productivity Potential	Kg/m^3	0.189	-	0.261	0.23	0.182	-	0.250	0.22	0.168	-	0.245	0.21	Sub-total =2663.70 MT
3	Distributory No. 12	Crop Production	10^4kg	1.68	-	2.94	4.62	3.78	-	6.62	10.40	2.56	-	4.47	7.03	Early Paddy =8.02 x 10^4 kg = 80.20 MT HYV Paddy =14.03 x 10^4 kg = 140.30 MT
		Water Supply	10^4 m^3	8.94	-	12.06	21.00	22.25	-	29.75	52.00	15.49	-	21.51	37.00	
		Relative Productivity Potential	Kg/m^3	0.188	-	0.244	0.22	0.170	-	0.223	0.20	0.165	-	0.208	0.19	Sub-total =220.50 MT
4	Distributory No. 13	Crop Production	10^4kg	17.60	-	30.80	48.40	3.60	-	6.30	9.90	12.73	-	22.29	35.02	Early Paddy =33.93 x 10^4 kg = 339.30 MT HYV Paddy =59.39 x 10^4 kg = 593.90 MT
		Water Supply	10^4 m^3	107.98	-	134.02	242.00	24.49	-	30.51	55.00	92.28	-	113.72	206.00	
		Relative Productivity Potential	Kg/m^3	0.163	-	0.230	0.20	0.147	-	0.206	0.18	0.138	-	0.196	0.17	Sub-total =933.20 MT

5	Distributory No. 14	Crop Production	10^4 kg	8.81	-	15.43	24.24	10.69	-	18.71	29.40	18.04	-	31.56	49.60	Early Paddy =37.54 x 10^4 kg = 375.40 MT HYV Paddy =65.7 x 10^4 kg = 657.00 MT Sub -total =1032.40 MT
		Water Supply	10^4 m^3	44.07	-	56.93	101.00	62.52	-	77.48	140.00	110.65	-	137.35	248.00	
		Relative Productivity Potential	Kg/m^3	0.200	-	0.271	0.24	0.171	-	0.241	0.21	0.163	-	0.23	0.20	
Average							0.228				0.21				0.198	Grand Total Early Paddy = 25.30.00 MT Medium Paddy = 1149.70 MT HVY Paddy = 4427.70 MT Σ = 8107.40 MT

ANNEXURE: 4

TABLE NO: 23(b)
PERIOD: DECEMBER TO MAY
WATER DELIVERY PERFORMANCE IN TERMS OF RELATIVE PRODUCTIVITY POTENTIAL (RPP)
(BEFORE MODERNISATION)

Serial No.	Name of canal	Description	Unit	LOCATION ALONG THE DISTRIBUTARY												REMARKS i.e. AVERAGE
				HEAD REACH				MIDDLE REACH				TAIL REACH				
				Sugar Cane	Ground - Nut	Vegetables	Total	Sugar Cane	Ground - Nut	Vegetables	Total	Sugar Cane	Ground - Nut	Vegetables	Total	
1	Distributory No. 2	Crop Production	10^4kg	16.67	6.33	7.00	30.00	23.88	8.19	6.93	39.00	16.11	4.95	2.94	24.00	Sugarcane = 56.66 x 10^4 kg = 566.6 MT Groundnut = 19.47 x 10^4 kg = 194.7 MT Vegetables = 16.87 x 10^4 kg = 168.7 MT
		Water Supply	10^4 m^3	36.24	21.21	4.55	62.00	57.11	32.30	4.59	94.00	43.22	24.75	2.03	70.00	
		Relative Productivity Potential	Kg/m^3	0.46	0.30	1.54	0.48	0.42	0.25	1.51	0.41	0.37	0.20	1.45	0.34	Total = 930 MT
2	Distributory No. 11	Crop Production	10^4kg	-	-	-	-	-	-	-	-	-	-	-	-	
		Water Supply	10^4 m^3	-	-	-	-	-	-	-	-	-	-	-	-	
		Relative Productivity Potential	Kg/m^3	-	-	-	-	-	-	-	-	-	-	-	-	
3	Distributory No. 12	Crop Production	10^4kg	-	-	-	-	-	-	-	-	-	-	-	-	
		Water Supply	10^4 m^3	-	-	-	-	-	-	-	-	-	-	-	-	
		Relative Productivity Potential	Kg/m^3	-	-	-	-	-	-	-	-	-	-	-	-	
4	Distributory No. 13	Crop Production	10^4kg	-	-	-	-	-	-	-	-	-	-	-	-	
		Water Supply	10^4 m^3	-	-	-	-	-	-	-	-	-	-	-	-	
		Relative Productivity Potential	Kg/m^3	-	-	-	-	-	-	-	-	-	-	-	-	

5	Distributory No. 14	Crop Production	10^4 kg	-	-	-	-	-	-	-	-	-	-	-	-	
		Water Supply	10^4 m^3	-	-	-	-	-	-	-	-	-	-	-	-	
		Relative Productivity Potential	Kg/m^3	-	-	-	-	-	-	-	-	-	-	-	-	
Average							0.48				0.41				0.34	Grand Total Sugarcane = 566.6 MT Groundnut = 194.7 MT Vegetables = 168.7 MT 930.0 MT

ANNEXURE: 4

TABLE NO: 24(a)
PERIOD: JUNE TO NOVEMBER
WATER DELIVERY PERFORMANCE IN TERMS OF RELATIVE PRODUCTIVITY POTENTIAL (RPP)
(AFTER MODERNISATION)

Serial No.	Name of canal	Description	Unit	LOCATION ALONG THE DISTRIBUTARY												REMARKS i.e. AVERAGE
				HEAD REACH				MIDDLE REACH				TAIL REACH				
				Early Paddy	Medium Paddy	HYV Paddy	Total	Early Paddy	Medium Paddy	HYV Paddy	Total	Early Paddy	Medium Paddy	HYV Paddy	Total	
1	Distributory No. 2	Crop Production	10^4kg	36.12	44.55	51.17	131.84	60.67	80.46	90.40	23153	53.10	70.80	79.66	203.56	Early Paddy =149.89 x 10^4 kg = 1498.90 MT Medium Paddy = 195.81 x 10^4 kg =1958.10 MT HYV Paddy =221.23 x 10^4 kg =2212.30 MT Sub -total =5669.30 MT
		Water Supply	10^4 m^3	118.16	142.78	151.06	412.00	216.67	26039	273.94	751.00	204.97	248.20	273.83	727.00	
		Relative Productivity Potential	Kg/m^3	0.306	0.312	0.339	0.32	0.280	0.309	0.33	0.31	0.259	0.285	0.291	0.28	
2	Distributory No. 11	Crop Production	10^4kg	109.06	-	163.59	272.65	162.19	-	210.38	372.57	50.28	-	75.42	125.70	Early Paddy =321.53 x 10^4 kg = 3215.30 MT HYV Paddy =449.391x 10^4 kg = 4493.90 MT Sub -total =7709.20 MT
		Water Supply	10^4 m^3	293.17	-	485.83	779.00	477.66	-	651.34	1129.00	170.44	-	248.56	419.00	
		Relative Productivity Potential	Kg/m^3	0.372	-	0.337	0.35	0.34	-	0.323	0.33	0.295	-	0.303	0.30	
3	Distributory No. 12	Crop Production	10^4kg	5.94	-	8.91	14.85	14.21	-	21.31	35.52	10.44	-	15.66	26.10	Early Paddy =30.59 x 10^4 kg = 305.90 MT HYV Paddy =45.88 x 10^4 kg = 458.8 MT Sub -total =764.70 MT
		Water Supply	10^4 m^3	19.80	-	25.20	45.00	49.85	-	61.15	111.00	37.83	-	52.17	90.00	
		Relative Productivity Potential	Kg/m^3	0.300	-	0.354	0.33	0.285	-	0.348	0.32	0.276	-	0.300	0.29	
4	Distributory No. 13	Crop Production	10^4kg	57.60	-	86.40	144.00	12.53	-	18.79	31.32	53.68	-	80.51	134.19	Early Paddy =123.81 x 10^4 kg = 1238.10 MT HYV Paddy =185.70 x 10^4 kg = 1857.00 MT Sub -total =3095.10 MT
		Water Supply	10^4 m^3	195.25	-	254.75	450.00	43.36	-	64.64	108.00	188.35	-	308.65	497.00	
		Relative Productivity Potential	Kg/m^3	0.295	-	0.339	0.32	0.289	-	0.291	0.29	0.285	-	0.261	0.27	

5	Distributory No. 14	Crop Production	10^4 kg	24.34	-	36.52	60.86	30.63	-	45.94	76.57	61.67	-	92.51	154.18	Early Paddy =116.64 x 10^4 kg = 1166.40 MT HYV Paddy =174.97 x 10^4 kg = 1749.70 MT
		Water Supply	10^4 m^3	59.23	-	119.77	179.00	87.26	-	159.74	247.00	251.72	-	341.28	593.00	Sub -total =2916.10 MT
		Relative Productivity Potential	Kg/m^3	0.411	-	0.305	0.34	0.351	-	0.288	0.31	0.245	-	0.271	0.26	
Average							0.332				0.312				0.28	Grand Total Early Paddy = 7424.60 MT Medium Paddy = 1958.10 MT HYV Paddy = 10.717.70 MT Σ = 20.154.40 MT

ANNEXURE: 4

TABLE NO: 24(b)
PERIOD: DECEMBER TO MAY
WATER DELIVERY PERFORMANCE IN TERMS OF RELATIVE PRODUCTIVITY POTENTIAL (RPP)
(AFTER MODERNISATION)

Serial No.	Name of canal	Description	Unit	LOCATION ALONG THE DISTRIBUTARY												REMARKS i.e. AVERAGE
				HEAD REACH				MIDDLE REACH				TAIL REACH				
				Sugar Cane	Ground - Nut	Vegetables	Total	Sugar Cane	Ground - Nut	Vegetables	Total	Sugar Cane	Ground - Nut	Vegetables	Total	
1	Distributory No. 2	Crop Production	10^4 kg	33.00	14.00	7.00	54.00	29.00	52.00	22.00	103.00	52.51	8.40	33.61	94.52	Sugarcane = 114.51 x 10^4 kg = 1145.10 MT Groundnut = 74.40 x 10^4 kg = 744.0 MT Vegetables = 62.61 x 10^4 kg = 626.10 MT
		Water Supply	10^4 m^3	45.00	23.14	2.86	71.00	40.28	91.59	9.13	141.00	92.15	32.43	14.42	139.00	
		Relative Productivity Potential	Kg/m^3	0.73	0.61	2.45	0.76	0.72	0.57	2.41	0.73	0.57	0.26	2.33	0.68	Total = 2515.20 MT
2	Distributory No. 11	Crop Production	10^4 kg	-	-	-	-	-	-	-	-	-	-	-	-	
		Water Supply	10^4 m^3	-	-	-	-	-	-	-	-	-	-	-	-	
		Relative Productivity Potential	Kg/m^3	-	-	-	-	-	-	-	-	-	-	-	-	
3	Distributory No. 12	Crop Production	10^4 kg	-	-	-	-	-	-	-	-	-	-	-	-	
		Water Supply	10^4 m^3	-	-	-	-	-	-	-	-	-	-	-	-	
		Relative Productivity Potential	Kg/m^3	-	-	-	-	-	-	-	-	-	-	-	-	
4	Distributory No. 13	Crop Production	10^4 kg	-	-	-	-	-	-	-	-	-	-	-	-	
		Water Supply	10^4 m^3	-	-	-	-	-	-	-	-	-	-	-	-	
		Relative Productivity Potential	Kg/m^3	-	-	-	-	-	-	-	-	-	-	-	-	

5	Distributory No. 14	Crop Production	10^4 kg	-	-	-	-	-	-	-	-	-	-	-	-	
		Water Supply	10^4 m^3	-	-	-	-	-	-	-	-	-	-	-	-	
		Relative Productivity Potential	Kg/m^3	-	-	-	-	-	-	-	-	-	-	-	-	
Average				-	-	-	0.76	-	-	-	0.73	-	-	-	0.68	Grand Total Sugarcane = 1145.10 MT Groundnut = 744.00 MT Vegetables = 626.10MT 2515.20MT

Abstract of Water Delivery Performance In terms of Relative Production Potential (Before Moderanisation)

Annexure : 4 **Table No : 25 (a)**

Serial No.	Name canal	Location along the distributary						Remarks i.e average
		Head Reach		Middle Reach		Tail Reach		
		June to November	December to May	June to November	December to May	June to November	Decemeber to May	
1	Distrbutary No.2	0.25	0.48	0.24	0.41	0.22	0.34	*0.323*
2	Distrbutary No.11	0.23	-	0.22	-	0.21	-	*0.22*
3	Distrbutary No.12	0.22	-	0.20	-	0.19	-	*0.203*
4	Distrbutary No.13	0.20	-	0.18	-	0.17	-	*0.183*
5	Distrbutary No.14	0.24	-	0.21	-	0.20	-	*0.108*
Average		**0.228**		**0.21**		**0.198**		**0.207**

Abstract of Water Delivery Performance In terms of Relative Production Potential (After) Moderanisation)

Annexure : 4

Table No : 25 (b)

Serial No.	Name canal	Location along the distributary						Remarks i.e average
		Head Reach		Middle Reach		Tail Reach		
		June to November	December to May	June to November	December to May	June to November	Decemeber to May	
1	Distrbutary No.2	0.32	0.76	0.31	0.73	0.28	0.68	*0.513*
2	Distrbutary No.11	0.35	-	0.33	-	0.30	-	*0.327*
3	Distrbutary No.12	0.33	-	0.32	-	0.29	-	*0.313*
4	Distrbutary No.13	0.32	-	0.29	-	0.27	-	*0.293*
5	Distrbutary No.14	0.34	-	0.31	-	0.26	-	*0.303*
Average		**0.332**		**0.312**		**0.280**		**0.350**

Annexure: 4

Inter- Quartile Ratio (Before Modernization)

Table No. 26(a)

Serial No.	Name of the Distributary	Design discharge (CUMECS)	Volumes (Ha-m) Delivered to the most favored upper 25% of Cca		Volumes Ha-m) Delivered to the least favoured lowest 25% of CCA		Inter quartile Ratio		Remarks i.e average
			June to November	December to May	June to November	December to May	June to November	December to May	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8=4/6**	**9=5/7**	**10=(8+9/2)**
1	Distributary No. 2	2.79	440.07	79.67	281.55	40.72	1.563	1.956	*1.760*
2	Distributary No. 11	4.60	4.09.404	-	90.40	-	4.529	-	*2.265*
3	Distributary No. 12	0.42	45.284	-	25.309	-	1.789	-	*2.895*
4	Distributary No. 13	1.86	151.655	-	97.108	-	1.562	-	*0.781*
5	Distributary No. 14	1.89	176.88	-	96.066	-	1.841	-	*0.921*
Average							**2.257**	**0.3912**	**1.324**

$$\textbf{Equity factor} = \frac{1}{\textbf{Inter-Quartile Ratio}} = \frac{1}{1.324} = 0.755\text{(Fair)}$$

Annexure: 4

Inter-Quartile Ratio (After Modernization)

Table No. 26(b)

Serial No.	Name of the Distributary	Design discharge (CUMECS)	Volumes (Ha-m) Delivered to the most favored upper 25% of Cca		Volumes Ha-m) Delivered to the least favoured lowest 25% of CCA		Inter quartile Ratio		Remarks i.e average
			June to November	December to May	June to November	December to May	June to November	December to May	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8=4/6**	**9=5/7**	**10=(8+9)/2**
1	Distributary No. 2	2.79	553.15	97.50	422.913	80.86	1.308	1..206	1..257
2	Distributary No. 11	4.60	652.199	-	2.06.987	-	3.151	-	1..576
3	Distributary No. 12	0.420	96.837	-	61.563	-	1.573	-	0.787
4	Distributary No. 13	1.86	338.405	-	234.284	-	1.444	-	0.722
5	Distributary No. 14	1.89	312.874	-	229.706	-	1.362	-	0.681
Average							**1.768**	**0.241**	**1.005**

$$\textbf{Equity factor} = \frac{1}{\textbf{Inter - Quartile Ratio}} = \frac{1}{1.005} = \textbf{0.995(Good)}$$

ANNEXURE: 4
Table no: 27(a)
Crop: Rice (Paddy)
Effective Rooting Depth (Meter): 0.60

RELATIVE GROUND WATER DEPTH (RGWD)

$$= \frac{\text{ACTUAL DEPTH OF GROUND WATER}}{\text{CRITICAL DEPTH OF GROUND WATER (OR) EFFECTIVE ROOTING DEPTH}}$$

YEAR: 1999

Serial Number	Name of the Distributary	LOCATION IN THE COMMAND																		Remarks
		HEAD REACH						MIDDLE REACH						TAIL REACH						
		Pre-monsoon period		Monsoon period		Post Monsoon Period		Pre-monsoon period		Monsoon period		Post Monsoon Period		Pre-monsoon period		Monsoon period		Post Monsoon Period		
		Depth of ground Water (meter)	RGWD	Depth of ground water (meter)	RGWD	Depth of ground water (meter)	RGWD	Depth of ground water (meter)	RGWD	Depth of ground water (meter)	RGWD	Depth of ground water (meter)	RGWD	Depth of ground water (meter)	RGWD	Depth of ground water (meter)	RGWD	Depth of ground water (meter)	RGWD	
1	Distri butary No 2	4.67	7.783 (o.k.)	1.26	2.10 (o.k.)	2.69	4.483 (o.k.)	4.83	8.05 (o.k.)	1.33	2.217(o.k.)	2.79	4.65 (o.k.)	4.85	8.083(o.k.)	1.34	2.233(o.k.)	2.78	4.633(o.k.)	No waterlogging. Best sustainability

3	2
Distri butary No12	Dsisti Butary No.11
6.00	7.00
10.00 (o.k.)	11.667(o.k.)
0.30	0.50
0.500 i.e. water logged	0.833 i.e. water logged
3.00	3.70
5.00 (o.k.)	6.167 (o.k.)
7.20	7.10
12.00 (o.k.)	11.833 (o.k.)
0.50	0.42
0.833 i.e. water logged	0.70 i.e. water logged
3.20	3.60
5.333 (o.k.)	6.00 (o.k.)
6.80	6.90
11.333 (o.k.)	11.50 (o.k.)
0.60	0.40
1.00 i.e. just water logged	0.667 i.e. water logged
3.10	3.20
5.167(o.k.)	5.333 (o.k.)
Problem in monsoon period only	Problem in monsoon period only

Average sustainability:	5	4
	Distri butary No 14	Distri butary No 13
	8.00	6.10
10.59	13.333 (o.k.)	10.167 (o.k.)
	0.20	0.30
0.8532	0.333 i.e. water logged	0.500 i.e. water logged
	2.70	2.80
4.9634	4.50 (o.k.)	4.667 (o.k.)
	7.50	6.60
11.0766	12.50 (o.k.)	11.00 (o.k.)
	0.25	0.25
0.9168	0.417 i.e. water logged	0.417 i.e. waterlogged
	3.10	2.50
5.0634	5.167 (o.k.)	4.167 (o.k.)
	7.20	6.80
10.8498	12.00 (o.k.)	11.333 (o.k.)
	0.30	0.35
1.0166	0.500 i.e. water logged	0.583 i.e. water logged
	2.90	3.10
5.0266	4.833(o.k.)	5.167 (o.k.)
5.595	Problem in monsoon period	Problem in monsoon period

ANNEXURE: 4
Table No: 27(b)
Crop: Sugarcane
Effective Rooting Depth (Meter): 0.90
RELATIVE GROUND WATER DEPTH (RGWD)

$$= \frac{\text{ACTUAL DEPTH OF GROUND WATER}}{\text{CRITICAL DEPTH OF GROUND WATER (OR) EFFECTIVE ROOTING DEPTH}}$$

YEAR: 1999

Serial Number	Name of the Distributary	LOCATION IN THE COMMAND																	
		HEAD REACH						MIDDLE REACH						TAIL REACH					
		Pre-monsoon period		Monsoon period		Post Monsoon Period		Pre-monsoon period		Monsoon period		Post Monsoon Period		Pre-monsoon period		Monsoon period		Post Monsoon Period	
		Depth of ground water (meter)	RGWD	Depth of ground water (meter)	RGWD	Depth of ground water (meter)	RGWD	Depth of ground water (meter)	RGWD	Depth of ground water (meter)	RGWD	Depth of ground water (meter)	RGWD	Depth of ground water (meter)	RGWD	Depth of ground water (meter)	RGWD	Depth of ground water (meter)	RGWD

3	2	1
Distributary No12	Distributary No.11	Distributary No 2
6.00	7.00	4.67
-	-	5.189 (o.k.)
0.30	0.50	1.26
-	-	1.40 (o.k.)
3.00	3.70	2.69
-	-	2.989 (o.k.)
7.20	7.10	4.83
-	-	5.367 (o.k.)
0.50	0.42	1.33
-	-	1.478 (o.k.)
3.20	3.60	2.79
-	-	3.10 (o.k.)
6.80	6.90	4.85
-	-	5.389 (o.k.)
0.60	0.40	1.34
-	-	1.489 (o.k.)
3.10	3.20	2.78
-	-	3.089 (o.k.)

5	4
Distributary No 14	Distributary No 13
8.00	6.10
-	-
0.20	0.30
-	-
2.70	2.80
-	-
7.50	6.60
-	-
0.25	0.25
-	-
3.10	2.50
-	-
7.20	6.80
-	-
0.30	0.35
-	-
2.90	3.10
-	-

ANNEXURE: 4
Table No: 27(c)
Crop: Groundnut
Effective Rooting Depth (Metre): 0.75
RELATIVE GROUND WATER DEPTH (RGWD)

$$= \frac{\text{ACTUAL DEPTH OF GROUND WATER}}{\text{CRITICAL DEPTH OF GROUND WATER (OR) EFFECTIVE ROOTING DEPTH}}$$

YEAR:1999~2000

Serial Number	Name of the Distributary	LOCATION IN THE COMMAND																	
		HEAD REACH						MIDDLE REACH						TAIL REACH					
		Premonsoon period		Monsoon period		Post Monsoon Period		Premonsoon period		Monsoon period		Post Monsoon Period		Premonsoon period		Monsoon period		Post Monsoon Period	
		Depth of ground water (metre)	RGWD	Depth of ground water (metre)	RGWD	Depth of ground water (metre)	RGWD	Depth of ground water (metre)	RGWD	Depth of ground water (metre)	RGWD	Depth of ground water (metre)	RGWD	Depth of ground water (metre)	RGWD	Depth of ground water (metre)	RGWD	Depth of ground water (metre)	RGWD

3	2	1
Distributary No12	Distributary No.11	Distributary No.2
6.00	7.00	4.67
-	-	6.227 (o.k)
0.30	0.50	1.26
-	-	1.68 (o.k)
3.00	3.70	2.69
-	-	3.587 (o.k)
7.20	7.10	4.83
-	-	6.44 (o.k)
0.50	0.42	1.33
-	-	1.773 (o.k)
3.20	3.60	2.79
-	-	3.72 (o.k)
6.80	6.90	4.85
-	-	6.467 (o.k)
0.60	0.40	1.34
-	-	1.787 (o.k)
3.10	3.20	2.78
-	-	3.701 (o.k)

4	Distributary No 13	6.10	-	0.30	-	2.80	-	6.60	-	0.25	-	2.50	-	6.80	-	0.35	-	3.10	-
5	Distributary No 14	8.00	-	0.20	-	2.70	-	7.50	-	0.25	-	3.10	-	7.20	-	0.30	-	2.90	-

ANNEXURE: 4

Table No: 27 (d)

Crop: Vegetables

Effective Rooting Depth (Meter): 0.40

RELATIVE GROUND WATER DEPTH (RGWD)

$$= \frac{\text{ACTUAL DEPTH OF GROUND WATER}}{\text{CRITICAL DEPTH OF GROUND WATER (OR) EFFECTIVE ROOTING DEPTH}}$$

YEAR: 1999~200

Serial Number	Name of the Distributary	LOCATION IN THE COMMAND																	
		HEAD REACH						MIDDLE REACH						TAIL REACH					
		Pre-monsoon period		Monsoon period		Post Monsoon Period		Pre-monsoon period		Monsoon period		Post Monsoon Period		Pre-monsoon period		Monsoon period		Post Monsoon Period	
		Depth of ground water (metre)	RGWD	Depth of ground water (metre)	RGWD	Depth of ground water (metre)	RGWD	Depth of ground water (metre)	RGWD	Depth of ground water (metre)	RGWD	Depth of ground water (metre)	RGWD	Depth of ground water (metre)	RGWD	Depth of ground water (metre)	RGWD	Depth of ground water (metre)	RGWD

3	2	1
Distributary No12	Distributary No.11	Distributary No 2
6.00	7.00	4.67
-	-	11.675 (o.k)
0.30	0.50	1.26
-	-	3..15 (o.k)
3.00	3.70	2.69
-	-	6.725 (o.k)
7.20	7.10	4.83
-	-	12.075 (o.k)
0.50	0.42	1.33
-	-	3.325 (o.k)
3.20	3.60	2.79
-	-	6.975 (o.k)
6.80	6.90	4.85
-	-	12.125 (o.k)
0.60	0.40	1.34
-	-	3.35 (o.k)
3.10	3.20	2.78
-	-	6.95 (o.k)

4	Distributary No 13	6.10	-	0.30	-	2.80	-	6.60	-	0.25	-	2.50	-	6.80	-	0.35	-	3.10	-
5	Distributary No 14	8.00	-	0.20	-	2.70	-	7.50	-	0.25	-	3.10	-	7.20	-	0.30	-	2.90	-

ANNEXURE: 4
TABLE NO. 28

SUSTAINABILITY OF COMMAND AREA

YEAR	INITIAL TOTAL IRIGABLE AREA (Ha)	CURRENT IRRIGABLE AREA (Ha)	AGRICULTURAL LAND LOST (Ha)	SUSTANIABILITY OF IRRIGABLE AREA
1	2	3	4 = 2-3	5 = 3/2
1981	12,618	11,482	1136	0.910
1982	12,618	11,230	1388	0.890
1983	12,618	11,040	1578	0.875
1984	12,618	10,851	1767	0.860
1985	12,618	10,725	1893	0.850
1986	12,618	10,599	2019	0.840
1987	12,618	10,473	2145	0.830
1988	12,618	10,397	2221	0.824
1989	12,618	10,322	2296	0.818
1990	12,618	10,246	2372	0.812
1991	12,618	10,183	2435	0.807
1992	12,618	10,120	2498	0.802
1993	13,733	13,733	-	1.000
1994	13,733	13,733	-	1.000
1995	13,733	13,184	549	0.960
1996	13,733	13,115	618	0.955
1997	13,733	13,046	687	0.950
1998	13,733	12,991	742	0.946
1999	13,733	12,936	797	0.942

Average Sustainability before modernization = 0.843

Average Sustainability after modernization = 0.965

TABLE NO. 29

ANNEXURE: 4

ABSTRACT OF PERFORMANCE STANDARDS

Sl. No.	Measures or Standards	Before Modernization		After Modernization	
		Average Value	Performance Class	Average Value	Performance Class
1.	Equity i.e. water distribution	0.755 (table 26.a)	Fair (not equitable)	0.995 (table 26.b)	Good (equitable)
2.	Adequacy or water application	0.37 (table 22.a)	Poor (not appropriate)	0.758 (table 22.b)	Fair (appropriate)
3.	Timeliness or water delivery	0.207 (table 25.a)	Poor (not reliable)	0.350 (table 25.b)	Fair (reliable)
4.	Sustainability	0.843 (table 28)	Poor	0.965 (table 28)	Good
5.	Design of structures	-	Costly	-	Economic due to proportionate distributor
6.	Construction	-	Complicated due to gated outlet	-	Simple due to non-gated outlet
7.	Operation	-	Non-co-operative	-	Co-operative
8.	Wastage of water	35% ~ 50%	High	15% ~ 20%	Low
9.	Complete management	-	Lethargic & idle	-	Good & Prompt
10.	Communication	-	Non-accessible to some part of branch canal	-	Accessible
11.	Decision making	-	Slow	-	Quick
12.	Irrigation Service Fees (ISF) collection	-	Less	-	More
13.	Operation and maintenance share	-	Low	-	High
14.	Overall efficiency	-	Low	-	High

15.	Productivity	Av. 33.29 Quintal /ha	Low	Av. 45.47 Quintal/ha	High
16.	Cropping intensity	80% (Disty. No. 2) 60% (Other Disty.)	Low	129% (Disty. No. 2) 100% (Other Disty.)	High
17.	Ownership feeling	-	Inert	-	Good
18.	Willingness to pay	-	Avoid to pay (default)	-	Good
19.	Overall performance	-	Poor	-	Good
20.	Irrigation employment generation	411 per ha	Poor	576 per ha	Fair
21.	Per capita income	Rs 780 .00 (1992)	Poor	Rs. 1356.00 (1995)	Fair
22.	Irrigable area (Ha)	12,618	Fair	13,733	Good
23.	Economic internal rate of return	-	Poor	17%	Good

TABLE NO. 30.(a)
ANNEXURE: 4

PROPOSED PROJECT BENEFITS (1992-93)

Sl. No.		Name of the crop	Benefit without project				Benefit with project				Net benefits	
			Area (Ha)	Yield (Qntl /Ha)	Rate (Rs./Qntl) in (1992-93)	Amount (Rs. Lakh)	Area (Ha)	Yield (Qntl/Ha)	Rate (Rs./Qntl) in (1992-93)	Amount (Rs. Lakh)	Yield (Qntl/Ha)	Amount (Rs. Lakh)
1		2	3	4	5	6	7	8	9	10	11	12
1.	KHARIF	Early Paddy	4,155	20	220	182.82	4,155	30	220	274.23	41,550	91.41
2.	KHARIF	Medium Paddy	463	30	255	35.42	463	40	255	47.23	4,630	11.81
3.	KHARIF	H.Y.V. Paddy	8,915	35	285	889.27	8,915	45	285	1143.35	89,150	254.08
4.	KHARIF	Sugar-cane	200	75	150	22.50	200	125	150	37.50	10,000	15.00
			13,733			*1130.01*				*1502.31*		*372.30*
5.	RABI	Groundnut	500	10	800	40.00	500	20	800	80.00	5,000	40.00
6.	RABI	Vegetables	563	50	400	112.6	563	80	400	180.16	16,890	67.56
						152.60				260.16		107.56
Grand Total						**1282.61**				**1762.47**		**479.86**

TABLE NO. 30.(b)
ANNEXURE: 4

PROJECT BENEFITS (1999-2000)

Sl. No.		Name of the crop	Benefit without project				Benefit with project				Net benefits	
			Area (Ha)	Yield (Qntl /Ha)	Rate (Rs./Qntl) in (1992-93)	Amount (Rs. Lakh)	Area (Ha)	Yield (Qntl/Ha)	Rate (Rs./Qntl) in (1999-2000)	Amount (Rs. Lakh)	Yield (Qntl/Ha)	Amount (Rs. Lakh)
1		2	3	4	5	6	7	8	9	10	11	12
1.	KHARIF	Early Paddy	4,155	20	220	182.82	4,155	30	1200	1495.80	41,550	407.19
2.	KHARIF	Medium Paddy	463	30	255	35.42	463	40	1400	259.28	4,630	64.82
3.	KHARIF	H.Y.V. Paddy	8,915	35	285	889.27	8,915	45	1800	7221.15	89,150	1604.70
4.	KHARIF	Sugar-cane	200	75	150	22.50	200	125	400	100.00	10,000	40.00
			13,733			*1130.01*				*9076.23*		*2116.71*
5.	RABI	Groundnut	500	10	800	40.00	500	20	1550	155.00	5,000	77.50
6.	RABI	Vegetables	563	50	400	112.6	563	80	1100	495.44	16,890	185.79
						152.60				650.44		263.29
Grand Total						**1282.61**				**9726.67**		**2380.00**

TABLE NO. 31. (a)

ANNEXURE: 4

ETHNIC COMPOSITION AND THEIR LAND (Data from Tehasil Office)

Sl. No.	Ethnic Group	Percentage of Ethnic Group	Land holding Before Modernization (1992-93)	Land holding After Modernization (1999-2000)
1.	Brahmin	27.3	18.7	17.4
2.	Khhetriya	22.6	23.1	21.5
3.	Vaisya	36.2	38.8	36.1
4.	SC/ST	9.4	14.6	20.1
5.	Others	4.5	4.8	4.9
	Total	**100.0**	**100.0**	**100.0**

TABLE NO. 31. (b)

ANNEXURE: 4

LAND DISTRIBUTION (Data from Tehasil office)

Year: 1999-2000

Farm size	Average farm size	Percentage of farmer and category	Percentage of total farm land
Less than 1 ha	0.71	16.1 (small farmer)	5.66
1~2 ha	1.36	34.7 (marginal farmer)	32.75
2~5 ha	3.42	35.2 (medium farmer)	18.32
5~10 ha	7.49	11.4 (larger medium farmer)	29.77
10 ha and more	14.28	2.6 (large farmer)	13.5
Total		**100.0**	**100.00**

TABLE NO. 32

ANNEXURE: 4

OPERATION AND MAINTENANCE BUDGET AND EXPENDITURE

Fiscal year	Total budget (in rupees lakh)	Total expenditure (in rupees lakh)	Expenditure per Ha
1990-91	26.88	25.63	202.04
1991-92	32.50	32.50	257.83
1992-93	40.63	40.00	314.78
1993-94	-	-	-
1994-95	-	-	-
1995-96	125.00	113.13	826.44
1996-97	80.00	78.75	573.88
1997-98	90.00	88.13	643.50
1998-99	61.25	57.50	420.56
1999-2000	33.13	31.25	226.94

TABLE NO. 33. (a)

ANNEXURE: 4

IRRIGATION SERVICE FEE (ISF) COLLECTION

Fiscal year	Amount due in rupees	Amount Collected in Rupees		
		Current year	Last year	Percentage of collection
1	2	3	4	5 = 3/2
1990-91	6,56,343	1,96,903	-	30
1991-92	8,97,132	2,42,226	-	27
1992-93	8,93,775	1,87,693	-	21
1993-94	-	-	-	-
1994-95	-	-	-	-
1995-96	12,23,843	9,54,598	4,07,828	78
1996-97	12,23,843	9,05,644	4,86,674	74
1997-98	12,23,843	8,44,452	8,78,519	69
1998-99	12,23,843	9,26,828	4,70,571	76
1999-2000	12,23,843	8,93,405	4,19,095	73

TABLE NO. 33. (b)

ANNEXURE: 4

COMPARISON OF EXPENDITURE AND ISF COLLECTION

Fiscal year	Expenditure in rupees	Collection in rupees	Difference in rupees	Percentage of recovery
1	2	3	4	5
1990-91	25,63,000	1,96,903	23,66,097	7.68
1991-92	32,50,000	2,42,226	30,07,774	7.45
1992-93	40,00,000	1,87,693	38,12,307	4.69
1993-94	-	-	-	-
1994-95	-	-	-	-
1995-96	1,13,13,000	13,62,426	99,50,574	12.04
1996-97	78,75,000	13,92,318	64,82,682	17.68
1997-98	88,13,000	17,22,971	70,90,029	19.55
1998-99	57,50,000	13,97,399	43,52,601	24.30
1999-2000	31,25,000	8,93,405	13,12,500	42.00

TABLE (STATEMENT) NO. 34

ANNEXURE: 4

INFLATION RATE

Net benefit (1992-93) = 479.86 rupees lakh

Net benefit (1999-2000) = 2380.00 rupees lakh

i.e. after 7 years.

Let i = rate of inflation

$\therefore$ 479.86 $(1+i)^n$ = 2380.00

$\Rightarrow$ i = 0.257 = 25.7%

PRESENT BENEFIT - COST RATIO

1. Expenditure in 1992-93 = 2.50 rupees lakh

   $\therefore$ Present worth of expenditure (1999-2000) = 2.50 $(1+0.257)^7$ = 12.396 rupees lakh .... (a)

   Expenditure in 1993-94 = 186.48 rupees lakh

   $\therefore$ Present worth of expenditure = 186.48 ?$(1+0.257)^6$ = 735.603 rupees lakh ....(b)

   Expenditure in 1994-95 = 189.82 rupees lakh

   $\therefore$ Present worth of expenditure = 189.82 $(1+0.257)^5$ = 595.687 rupees lakh ....(c)

   $\therefore$ Present worth of total expenditure = (a) + (b) +(c) = 1343.686 rupees lakh

2. Annual cost of development

   (i) Interest @ 10% = 134.369 rupees lakh

   (ii) Depreciation @ 1% = 13.437 rupees lakh

   (iii) Average annual maintenance from 1995~2000 (As per actual) = 73.752 rupees lakh

   Total = 221.588 rupees lakh

3. Net present (1999-2000) benefit =2380.00 rupees lakh

Taking 15% total annual benefit = 357.00 rupees lakh

(As per actual)

4. Benefit –Cost ratio $= \dfrac{\text{Annual Project Benefit}}{\text{Annual Project Cost}} = \dfrac{357.00}{221.558} = 1.61$ (attractive)

TABLE NO. 35(a)

ANNEXURE:4

ABSTRACT OF AVERAGE DEMAND AND SUPPLY (BEFORE MODERNIZATION) IN DIFFERENT DISTRIBUTARIES

Sl. No.	Name of the distributaries	Design discharge (cumecs)	Demand in cumecs			Supply in cumecs			Remarks
			Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	
1	2	3	4	5	6	7	8	9	10
1.	Distributory No. 2	2.79	2.53	2.09	1.09	1.49	1.13	0.51	Both Kharif & Rabi supply (125.60≅125 day supply) Intensity of irrigation =37.31%
2.	Distributory No. 11	4.60	4.10	2.87	0.80	1.70	1.00	0.256	Only Kharif supply (81.6 ≅ 82 day supply) Intensity of irrigation = 82/153 =53.6%

3.	Distributory No. 12	0.42	0.38	0.33	0.16	0.134	0.108	0.046	Only Kharif supply (95.01 ≅ 95 day supply) Intensity of irrigation = 95/153 = 62%
4.	Distributory No. 13	1.86	1.62	0.97	0.53	0.600	0.311	0.153	Only Kharif supply (97.02 ≅97 day supply) Intensity of irrigation =97/153 = 63%
5.	Distributory No. 14	1.89	1.64	1.43	1.06	0.643	0.510	0.326	Only Kharif supply (88.02 ≅88 day supply) Intensity of irrigation =88/153 = 57.5%

TABLE NO. 35(b)

ANNEXURE:4

ABSTRACT OF AVERAGE DEMAND AND SUPPLY (AFTER MODERNIZATION) IN DIFFERENT DISTRIBUTARIES

Sl. No.	Name of the distributaries	Design discharge (cumecs)	Demand in cumecs			Supply in cumecs			Remarks
			Head Reach	Middle Reach	Tail Reach	Head Reach	Middle Reach	Tail Reach	
1	2	3	4	5	6	7	8	9	10
1.	Distributory No. 2	2.79	2.53	2.09	1.09	2.07	1.63	0.80	Both Kharif & Rabi supply (125.30≅125 day supply) Intensity of irrigation =37.31%
2.	Distributory No. 11	4.60	4.10	2.87	0.80	3.30	2.19	0.593	Only Kharif supply (81.6 ≅ 82 day supply) Intensity of irrigation = 82/153 =53.6%

3.	Distributory No. 12	0.42	0.38	0.33	0.16	0.30	0.25	0.111	Only Kharif supply (94.90 ≅ 95 day supply) Intensity of irrigation = 95/153 = 62%
4.	Distributory No. 13	1.86	1.62	0.97	0.53	1.26	0.72	0.365	Only Kharif supply (96.90 ≅97 day supply) Intensity of irrigation =97/153 = 63%
5.	Distributory No. 14	1.89	1.64	1.43	1.06	1.34	1.10	0.78	Only Kharif supply (88.02 ≅88 day supply) Intensity of irrigation =88/153 = 57.5%

TABLE N0.36(a)

ANNEXURE :4

SEEPAGE LOSS DUE TO CONVEYANCE (AFTER MODERNIZATION) IN DISTRIBUTARIES

SL.N0.	NAME OF THE DISTRIBUTARY	DISCHARGE IN CUMECS (Q) i.e. SUPPLY			MILLION SQUARE METER OF WETTED PERIMETER			SEEPAGE LOSS IN CUMECS PER MILLION SQ. METER (Δ Q)			AVERAGE
		HEAD	MIDDLE	TAIL	HEAD	MIDDLE	TAIL	HEAD	MIDDLE	TAIL	
1.	DISTRIBUTARY N0.2	2.07	1.63	0.80	0.04	0.068	0.066	1.657	1.842	1.831	1.777
2.	DISTRIBUTARY N0.11	3.30	2.19	0.593	0.057	0.078	0.034	1.933	2.054	1.742	1.910
3.	DISTRIBUTARY N0.12	0.300	0.25	0.111	0.004	0.010	0.008	1.153	1.367	1.317	1.279
4.	DISTRIBUTARY N0.13	1.26	0.72	0.365	0.032	0.022	0.023	1.714	1.599	1.606	1.640
5.	DISTRIBUTARY N0.14	1.34	1.10	0.78	0.016	0.020	0.043	1.498	1.571	1.823	1.631
TOTAL											**8.237**

TABLE N0.36(b)

ANNEXURE :4

COST TO PREVENT SEEPAGE IN SUSCEPTIBLE ZONE

Sl. No.	Name of the distributary	Wetted perimeter (Sq. Metre) in Zone Susceptible to Seepage			Cost for Lining (Rs Lakh)			Total cost in Rs. Lakh
		Head	Middle	Tail	Head	Middle	Tail	
1.	Distributary No.2	39,831	67,589	65,538	35.85	60.83	58.98	155.66
2.	Distributary No.11	57,424	77,751	34,041	51.68	69.98	30.64	152.30
3.	Distributary No.12	4,337	10,168	8,428	2.39	5.59	4.64	12.62
4.	Distributary No.13	31,505	22,201	22,727	25.20	17.76	18.18	61.14
5.	Distributary No.14	16,021	20,369	42,787	12.82	16.30	34.23	63.35
Total		**5,20,717 = 5,27 million square meter**						**445.07**

TABLE N0.37

ANNEXURE :4

EXTRA REQUIREMENT AFTER MODERNIZATION (Ha.-m)

Sl. No.	Name of the distributary	Demand in Ha-m.			Canal supply in Ha-m			Requirement meet from million well scheme			Requirement to be mat from private tube-well		
		Head	Middle	Tail	Head	Middle	Tail	Head	Middle	Tail	Head	Middle	Tail
1.	Distributary No. 2	2741	2264	1181	2241	1758	866	432	438	273	68	68	42
2.	Distributary No. 11	2894	2029	565	2327	1548	419	490	416	126	77	65	20
3.	Distributary No.12	311	267	129	246	201	90	59	57	34	6	9	5
4.	Distributary No.13	1356	816	720	1055	605	497	261	183	193	40	28	30
5.	Distributary No.14	1251	1093	807	1019	840	593	200	218	185	32	35	29

TABLE N0.38
ANNEXURE : 4

DETAILS OF PRIVATE TUBE-WELL IRRIGATION

Sl. No.	Name of the Distributary	Reach	No. of motor	Discharge rate (m^3/hr)	Working hour (hr/day)	Working days (day)	Head including depression (m)	H.P. of motor	Hiring cost in Rs. (Rs. 10 per hour for 5 HP and Rs. 15/- per hour for 8 HP)
1.	Distributary No. 2	Head	3	143.09	16	99	6.16	5	3 x 10 x 16 x 99 = 47,520/-
		Middle	3	143.09	16	99	6.13	5	3 x 10 x 16 x 99 = 47,520/-
		Tail	2	142.66	16	92	6.16	5	2x 10 x 16 x 92 = 29,440/-
2.	Distributary No. 11	Head	4	146.72	16	82	9.59	8	4 x 15 x 16 x 82 = 78,720/-
		Middle	4	141.06	16	72	9.94	8	4 x 15 x 16 x 72 = 69,120/-
		Tail	1	152.49	16	82	9.18	8	4 x 15 x 16 x 82 = 78,720/-
3.	Distributary No.12	Head	1	144.23	16	26	9.72	8	1 x 15 x 16 x 26 = 6,240/-
		Middle	1	144.23	16	39	9.72	8	1 x 15 x 16 x 39 = 9,360/-
		Tail	1	142.05	16	22	9.86	8	1 x 15 x 16 x 22 = 5,280/-
4.	Distributary No. 13	Head	2	143.68	16	87	9.76	8	2 x 15 x 16 x 87 = 41,760/-
		Middle	2	145.83	16	60	9.64	8	2 x 15 x 16 x 60 = 28,800/-
		Tail	2	146.48	16	64	9.52	8	2 x 15 x 16 x 64 = 30,720/-
5.	Distributary No. 14	Head	2	144.93	16	69	9.68	8	2 x 15 x 16 x 69 = 33,120/-
		Middle	2	145.83	16	75	9.60	8	2 x 15 x 16 x 75 = 36,000/-
		Tail	2	143.85	16	63	9.79	8	2 x 15 x 16 x 63 = 30,240/-
								Total	**5,72,560/- (for 482 ha-land)**

TABLE N0.39

ANNEXURE : 4

LAND IRRIGATED BY DIFFERENT TYPE OF IRRIGATION

Sl. No.	Name of the disributary	Reach	Canal Irrigation (Ha) after modernization	Million well irrigation (Ha)	Private tube-well irrigation (in hiring) experimentally
1.	Distributary No. 2	Head	513	134	21
		Middle	1084	375	58
		Tail	1086	486	75
2.	Distributary No. 11	Head	1124	237	37
		Middle	1807	486	76
		Tail	678	204	32
3.	Distributary No. 12	Head	62	14	2
		Middle	181	51	8
		Tail	157	59	9
4.	Distributary No. 13	Head	769	190	29
		Middle	130	40	6
		Tail	907	352	55
5.	Distributary No. 11	Head	226	44	55
		Middle	387	100	16
		Tail	1043	325	51
		Total	**10,154**	3,097	482

TABLE N0.40

ANNEXURE : 4

COST ECONOMY FOR DIFFERENT TYPES OF IRRIGATION FOR 100% SUSCEPTIBILITY

Sl. No.	Type of irrigation	Expenditure incurred (Rs.)	Land irrigated (ha.)	Cost in (Rupees per ha.)	Percentage of land irrigated (%)	Remarks
1.	Canal irrigation (after modernization)	3,78,80,000/- (1992-93, 93-94, 94-95)	10,154	3,730.55	73.94	-
2.	Open well irrigation (Million well scheme by DRDA grant) 316 nos. @ Rs. 15,000/- per no.	47,40,000/- (1993-94, 94-95)	3,097	1530.51	22.55	-
3.	Hiring pump from private tube-well owner @ Rs. 10/- per hour (for 5 HP motor) and Rs. 15/- per hour (for 8 HP motor)	5,72,560/- (2000)	482	1187.88	3.51 (experimental)	100% assured water-logging prevention
4.	Lining to prevent canal seepage	4,45,07,000 (2000)	1919	23,192.00	18.90	15.15 times costlier than open well irrigation with 96.5% (expected) water-logging prevention. (from a field survey work)

LIST OF FIGURES

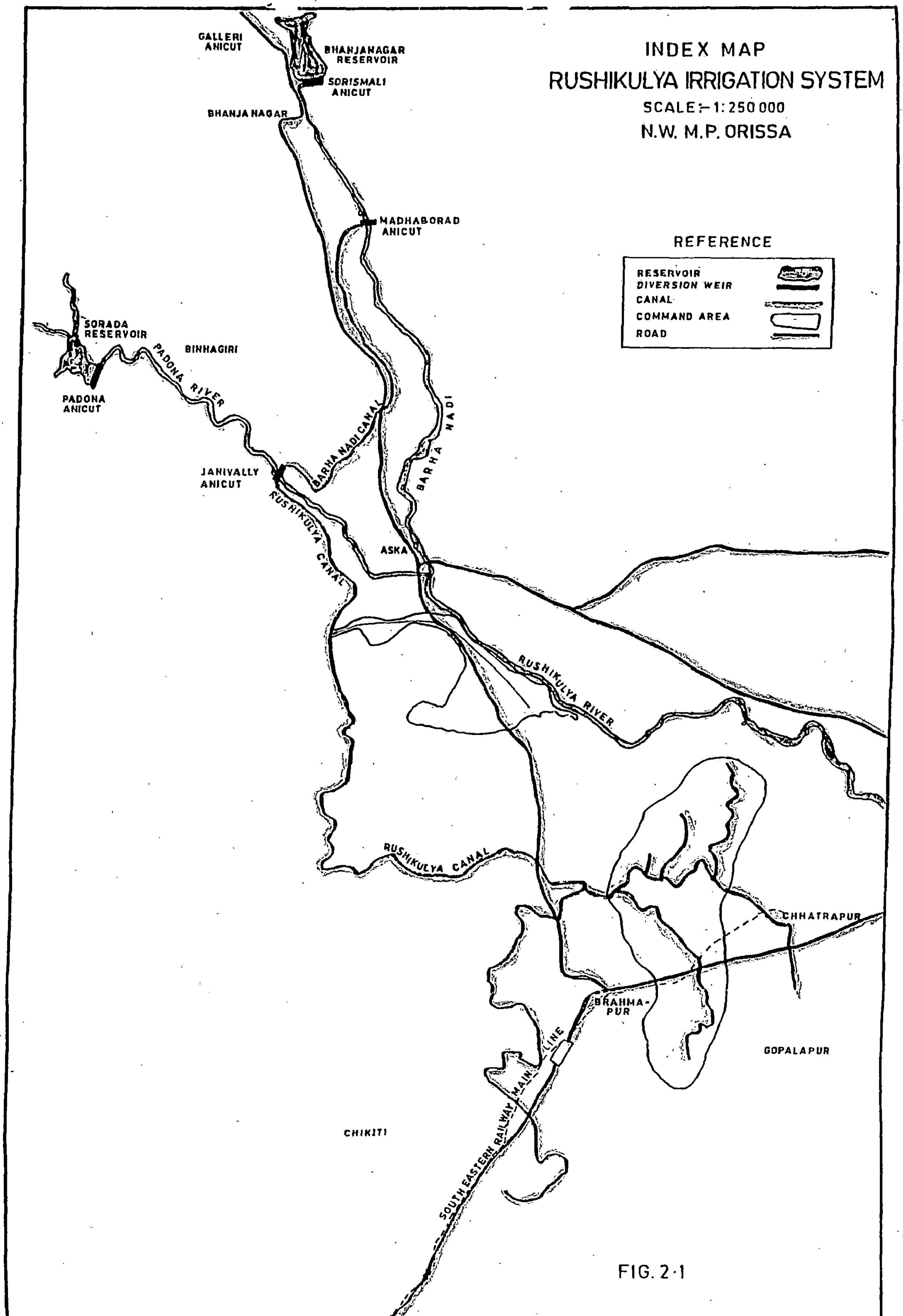

INDEX MAP
RUSHIKULYA IRRIGATION SYSTEM
SCALE:-1:250 000
N.W. M.P. ORISSA
REFERENCE
RESERVOIR
DIVERSION WEIR
CANAL
COMMAND AREA
ROAD
GALLERI ANICUT
BHANJANAGAR RESERVOIR
SORISMALI ANICUT
BHANJA NAGAR
MADHABORAD ANICUT
SORADA RESERVOIR
BINHAGIRI
PADONA RIVER
PADONA ANICUT
BARHA NADI CANAL
BARHA NADI
JANIVALLY ANICUT
RUSHIKULYA CANAL
ASKA
RUSHIKULYA RIVER
RUSHIKULYA CANAL
CHHATRAPUR
BRAHMA-PUR
GOPALAPUR
MAIN LINE
SOUTH EASTERN RAILWAY
CHIKITI

FIG. 2·1

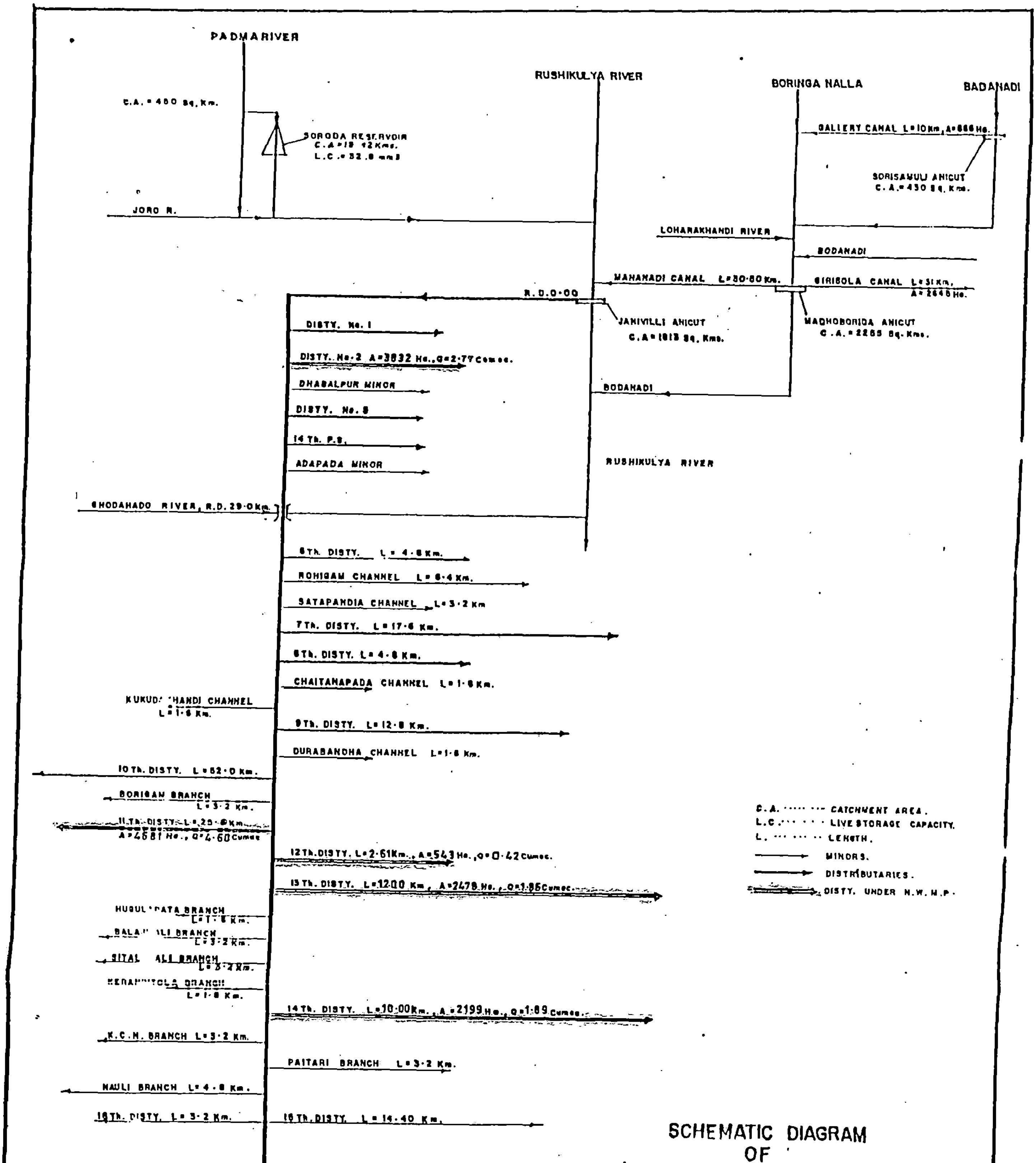


FIG. 2.2 SCHEMATIC DIAGRAM OF RUSHIKULYA IRRIGATION PROJECT

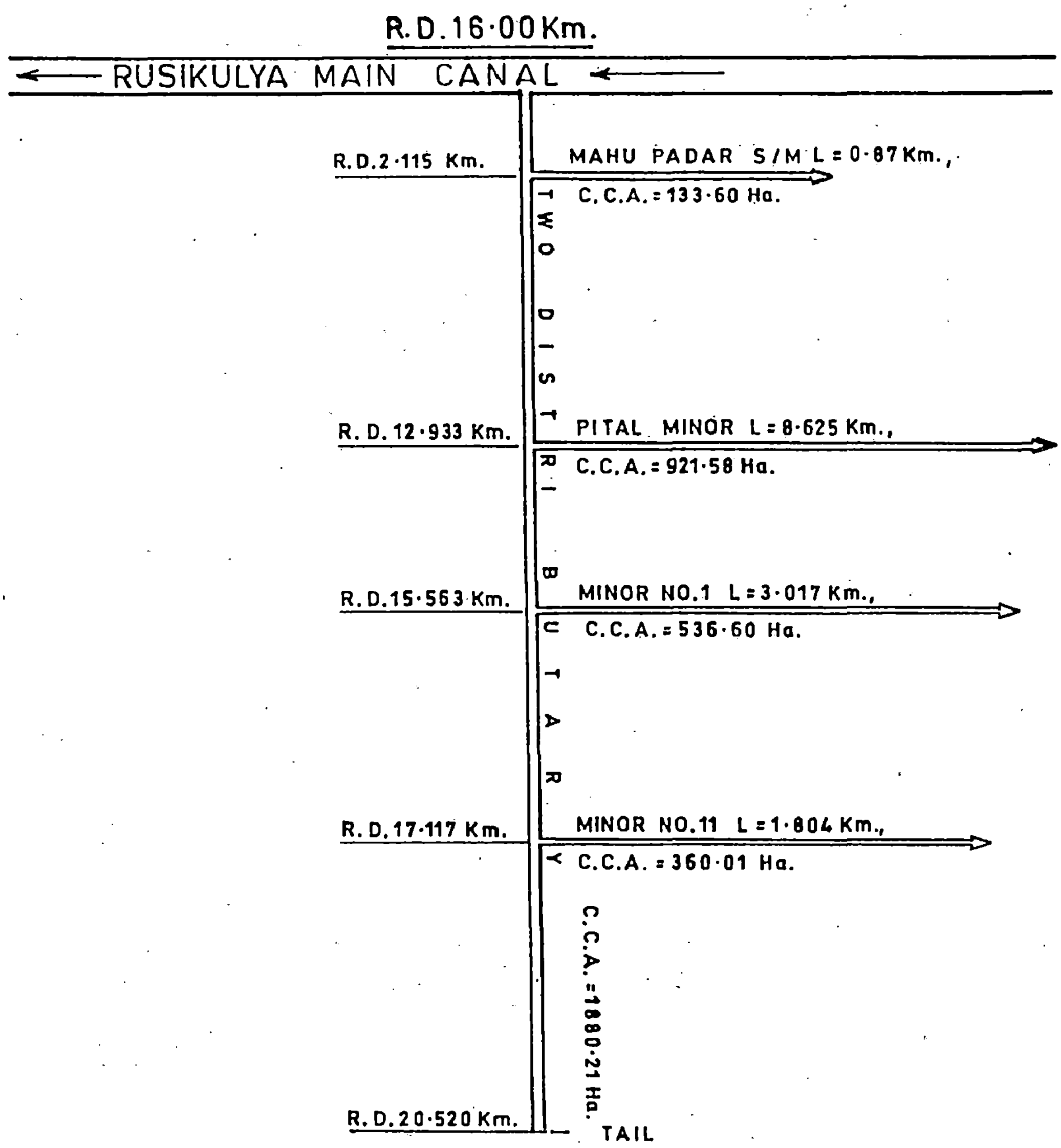


FIG. 2·3

SCHEMATIC DIAGRAM
OF
NO. 2 DISTRIBUTARY
(RUSIKULYA IRRIGATION SYSTEM)

LONGITUDINAL SECTION
OF
DISTRIBUTARY No.2
OF RUSHIKULYA CANAL
SCALE V= 1Cm= 2m. H= 1Cm=500m.

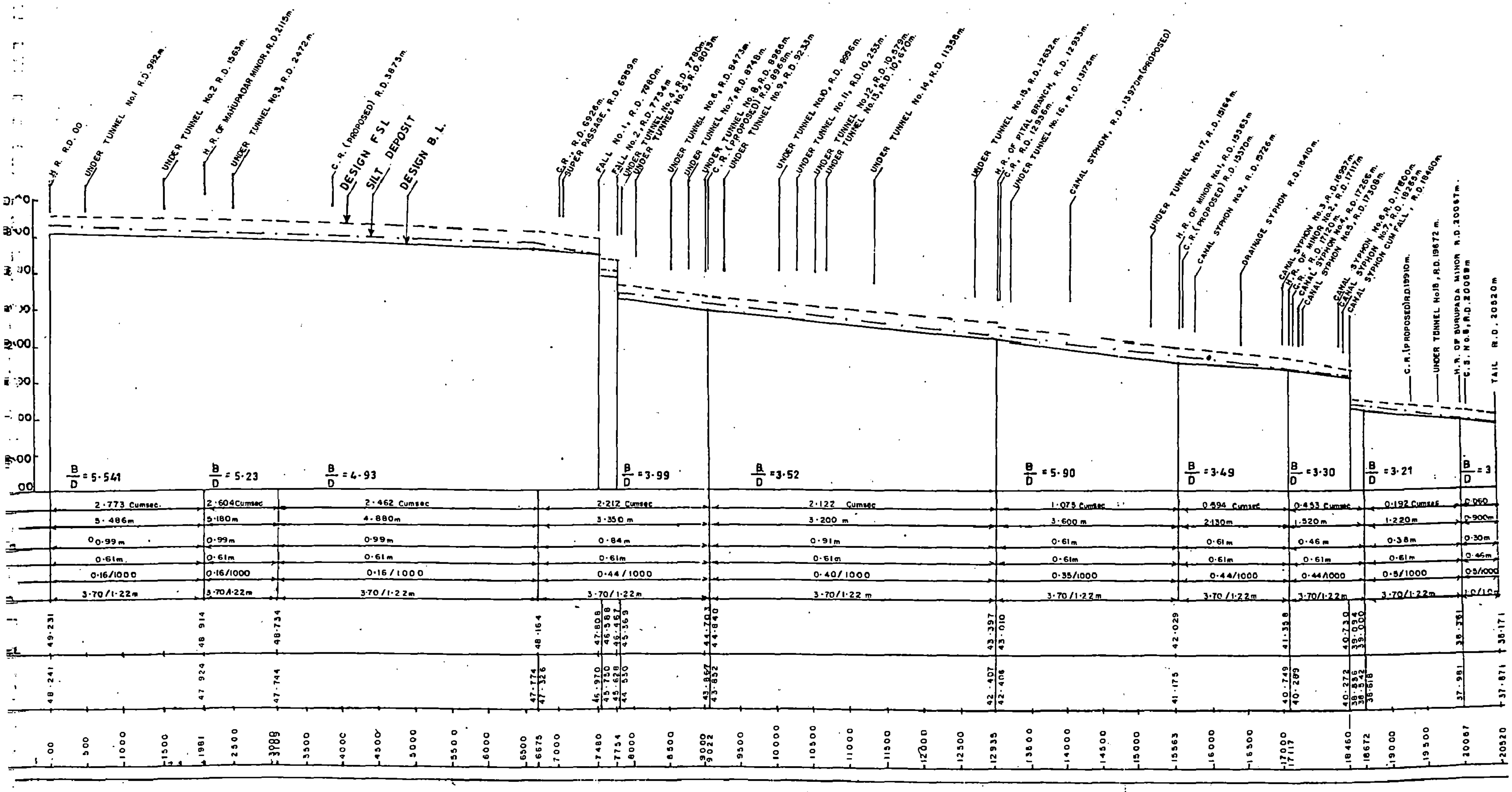


FIG. 2·4

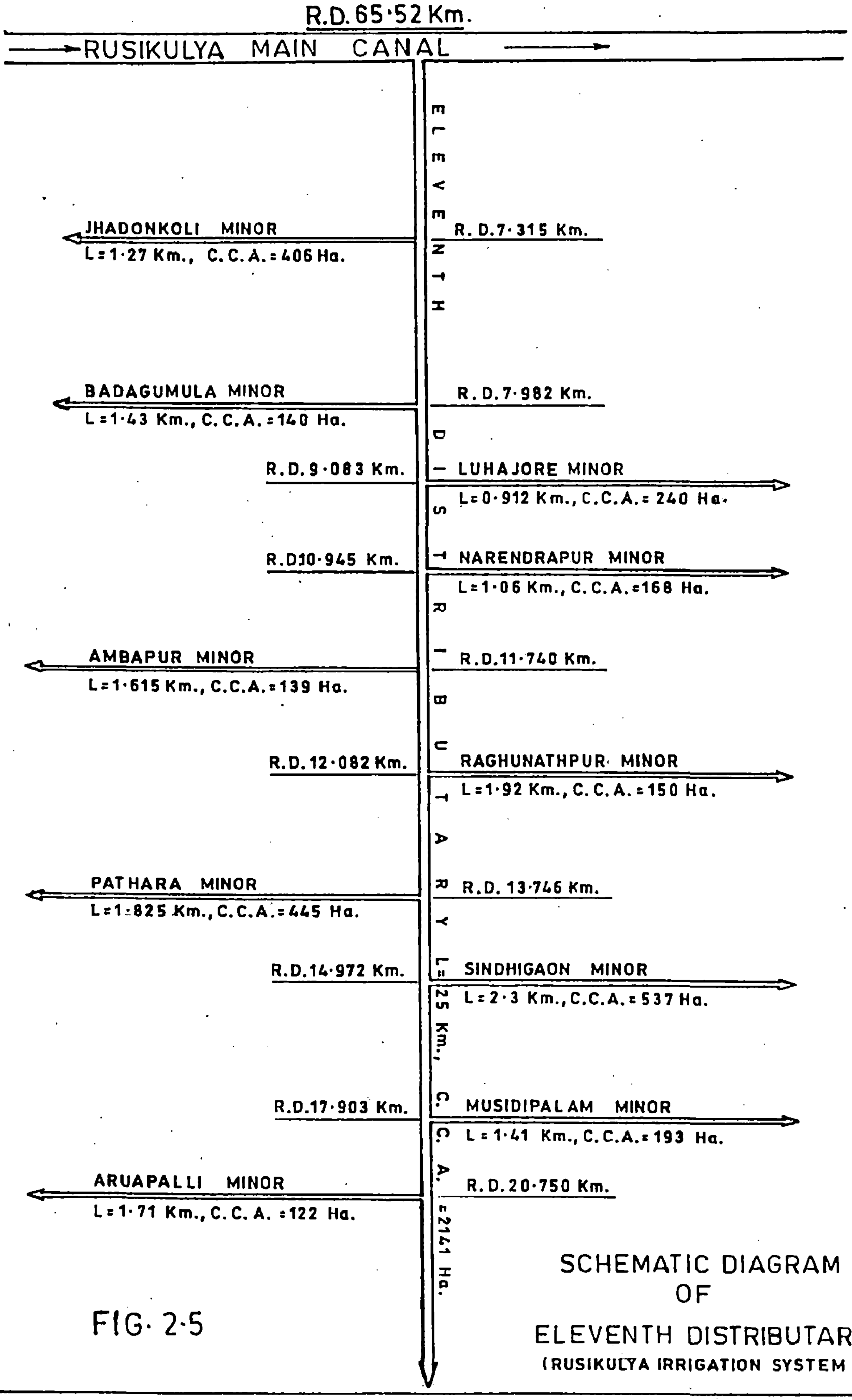


FIG. 2·5

SCHEMATIC DIAGRAM OF ELEVENTH DISTRIBUTARY (RUSIKULYA IRRIGATION SYSTEM)

LONGITUDINAL SECTION OF 11 Th. DISTRIBUTARY.

SCALE: Ver. 1Cm.=2 M. / Hor. 1Cm=1000M.

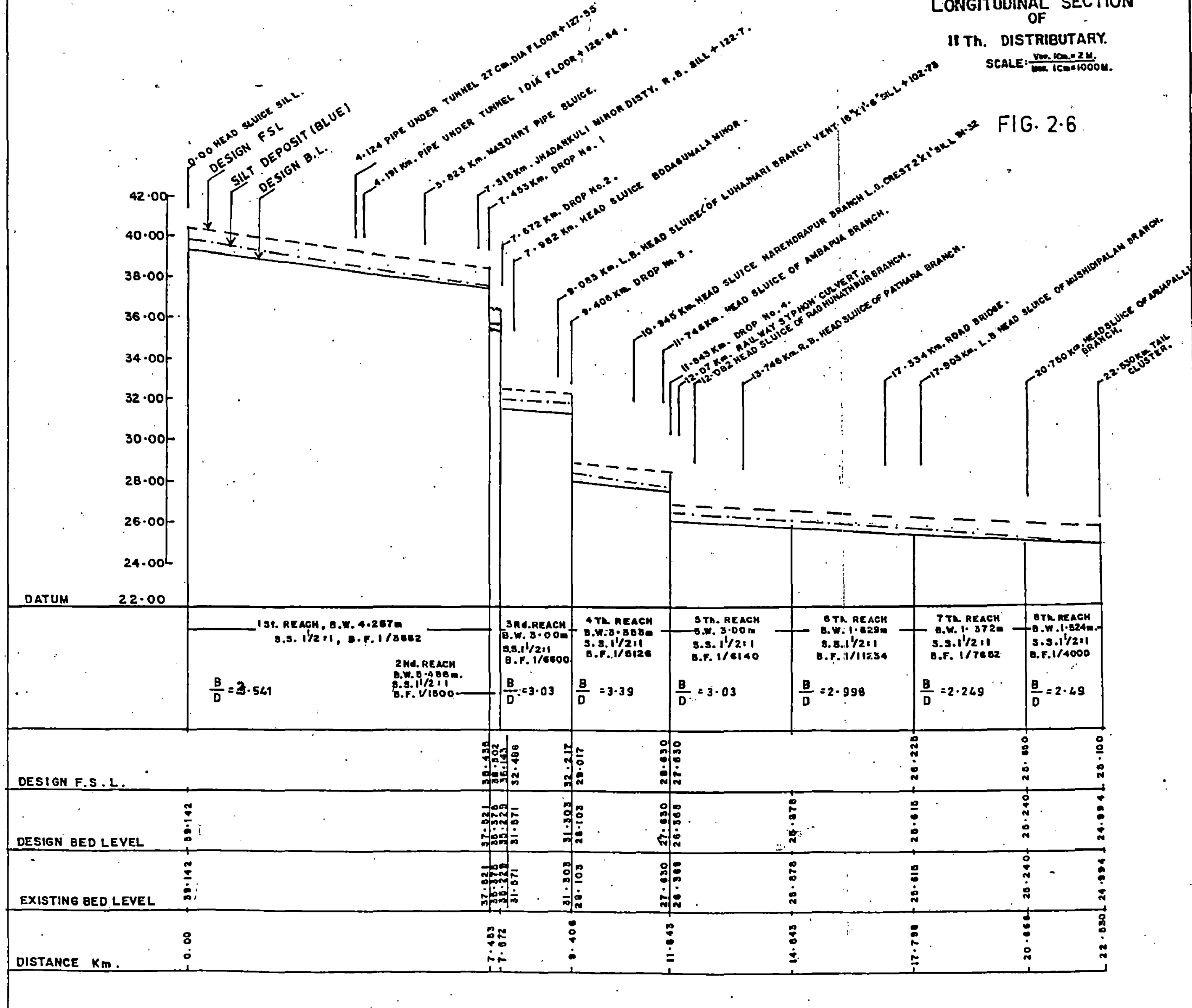


FIG. 2·6

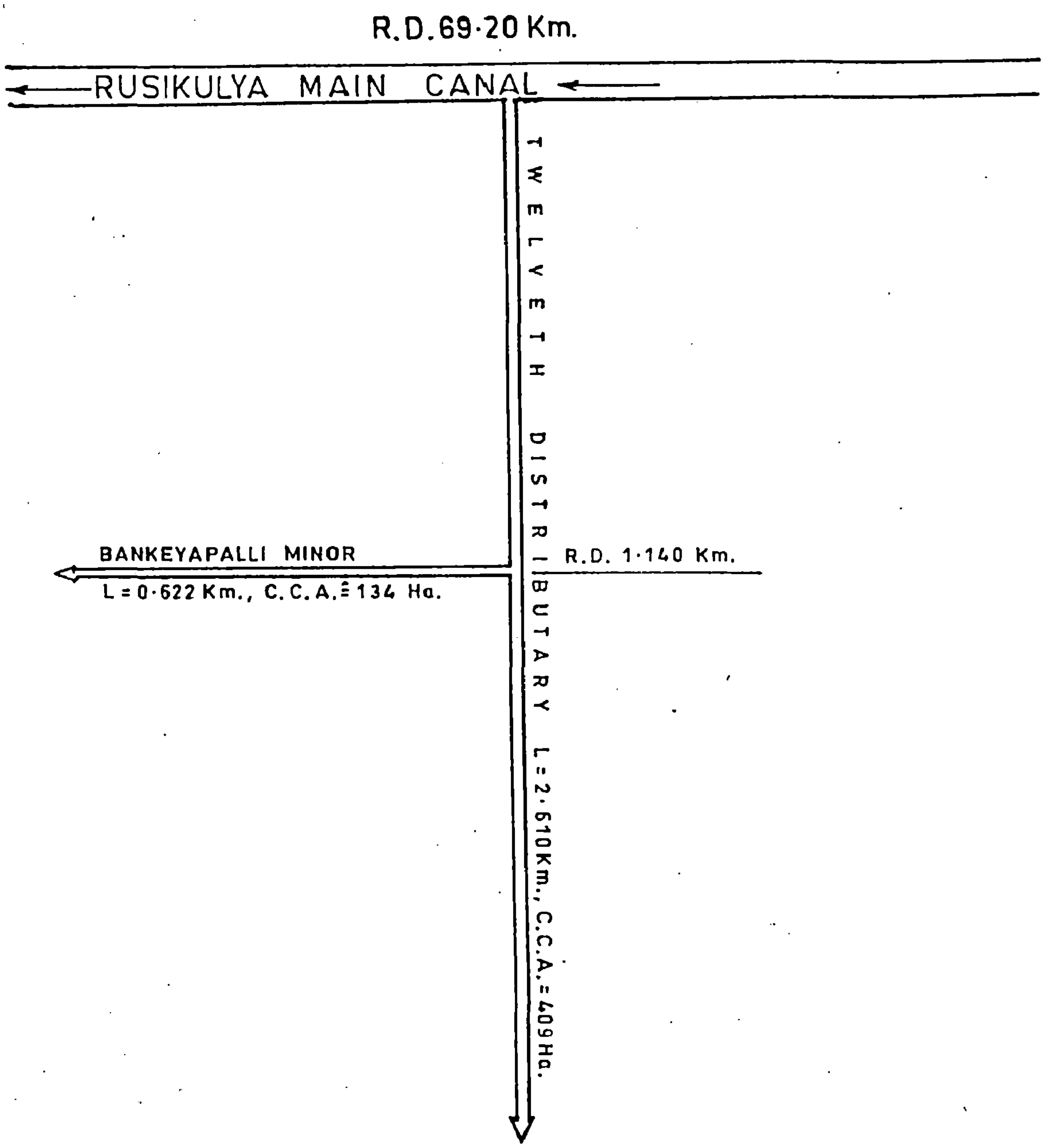
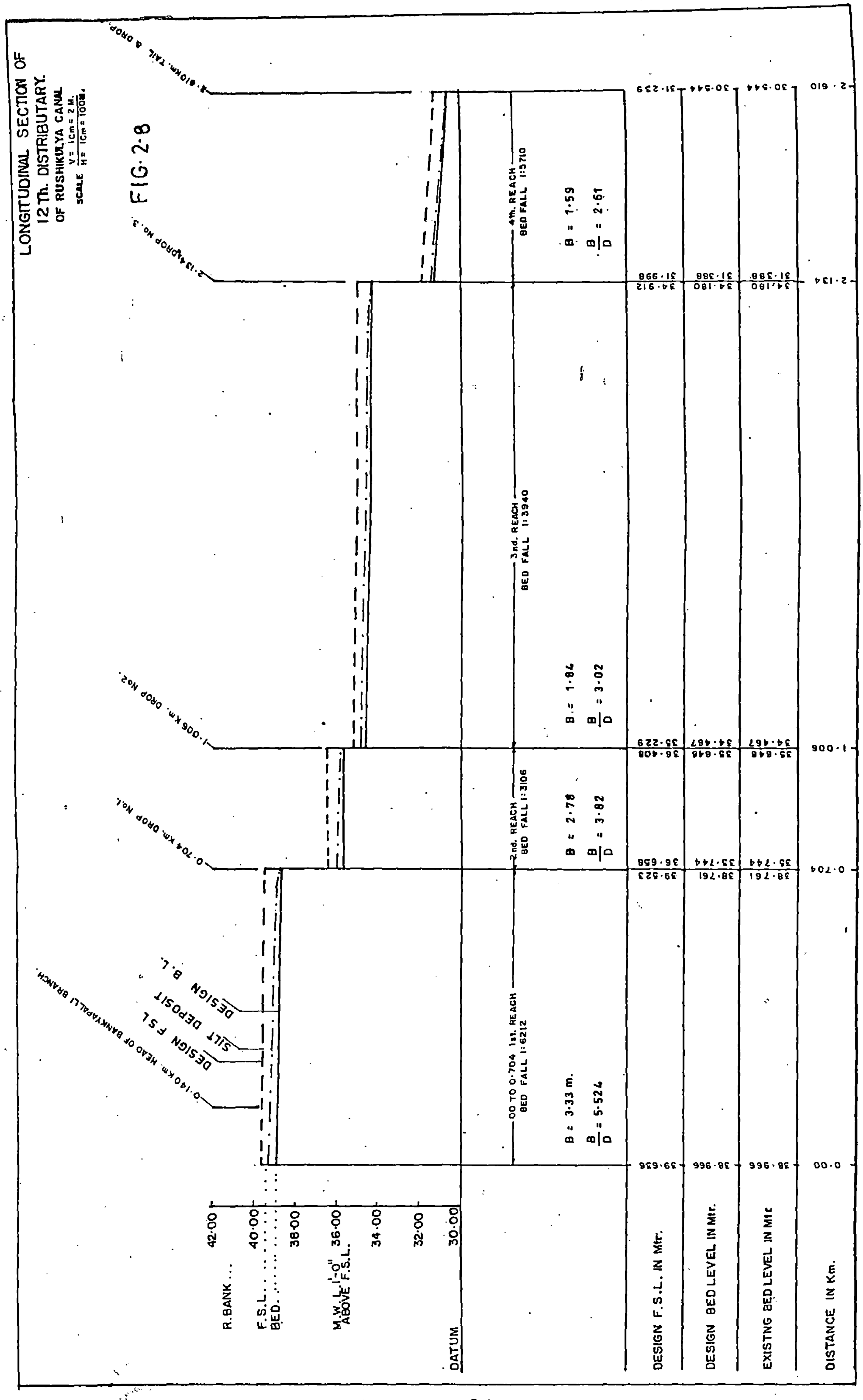
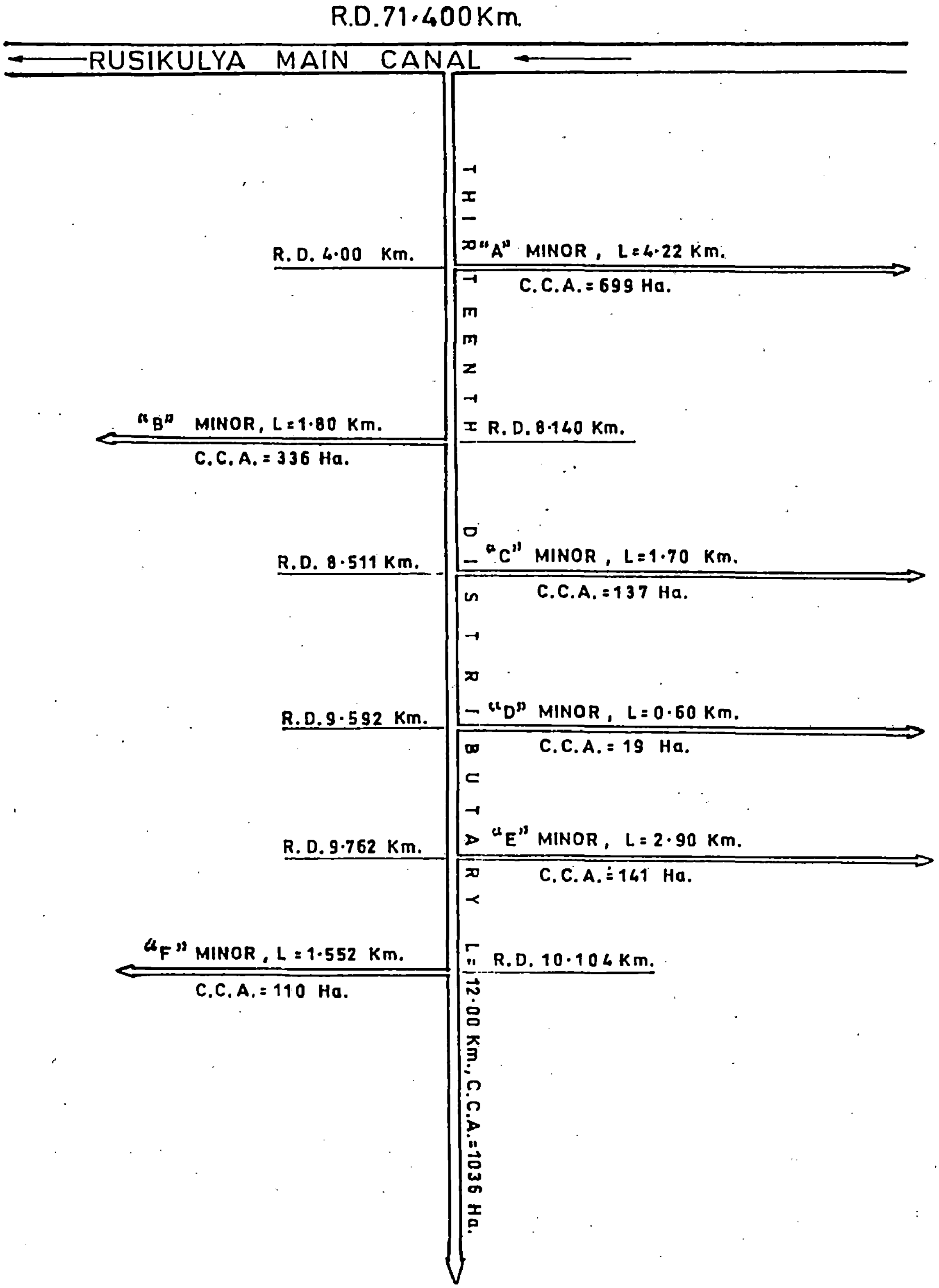


FIG. 2·7

SCHEMATIC DIAGRAM
OF
TWELVETH DISTRIBUTARY
(RUSIKULYA IRRIGATION SYSTEM)



LONGITUDINAL SECTION OF
12 Th. DISTRIBUTARY.
OF RUSHIKULYA CANAL
SCALE V = 1Cm = 2 M. H = 1Cm = 100M.
FIG. 2.8
2.610 Km. TAIL & DROP.
2.134 DROP No. 3.
1.006 Km. DROP No. 2.
0.704 Km. DROP No. 1.
0.140 Km. HEAD OF BANKYAPALLI BRANCH
DESIGN B.L.
SILT DEPOSIT
DESIGN F.S.L
4th. REACH BED FALL 1:5710
3nd. REACH BED FALL 1:3940
2nd. REACH BED FALL 1:3106
00 TO 0.704 1st. REACH BED FALL 1:6212
B = 1.59
B/D = 2.61
B = 1.84
B/D = 3.02
B = 2.78
B/D = 3.82
B = 3.33 m.
B/D = 5.524
R.BANK...
F.S.L.
BED.
M.W.L. 1'-0" ABOVE F.S.L.
DATUM
42.00
40.00
38.00
36.00
34.00
32.00
30.00
DESIGN F.S.L. IN Mtr.
DESIGN BED LEVEL IN Mtr.
EXISTNG BED LEVEL IN Mtr
DISTANCE IN Km.
39.636
38.966
38.966
0.00
39.523
36.658
38.761
35.744
38.761
35.744
0.704
36.408
35.228
35.648
34.467
35.648
34.467
1.006
34.912
31.998
34.180
31.388
34.180
31.388
2.134
31.239
30.544
30.544
2.610



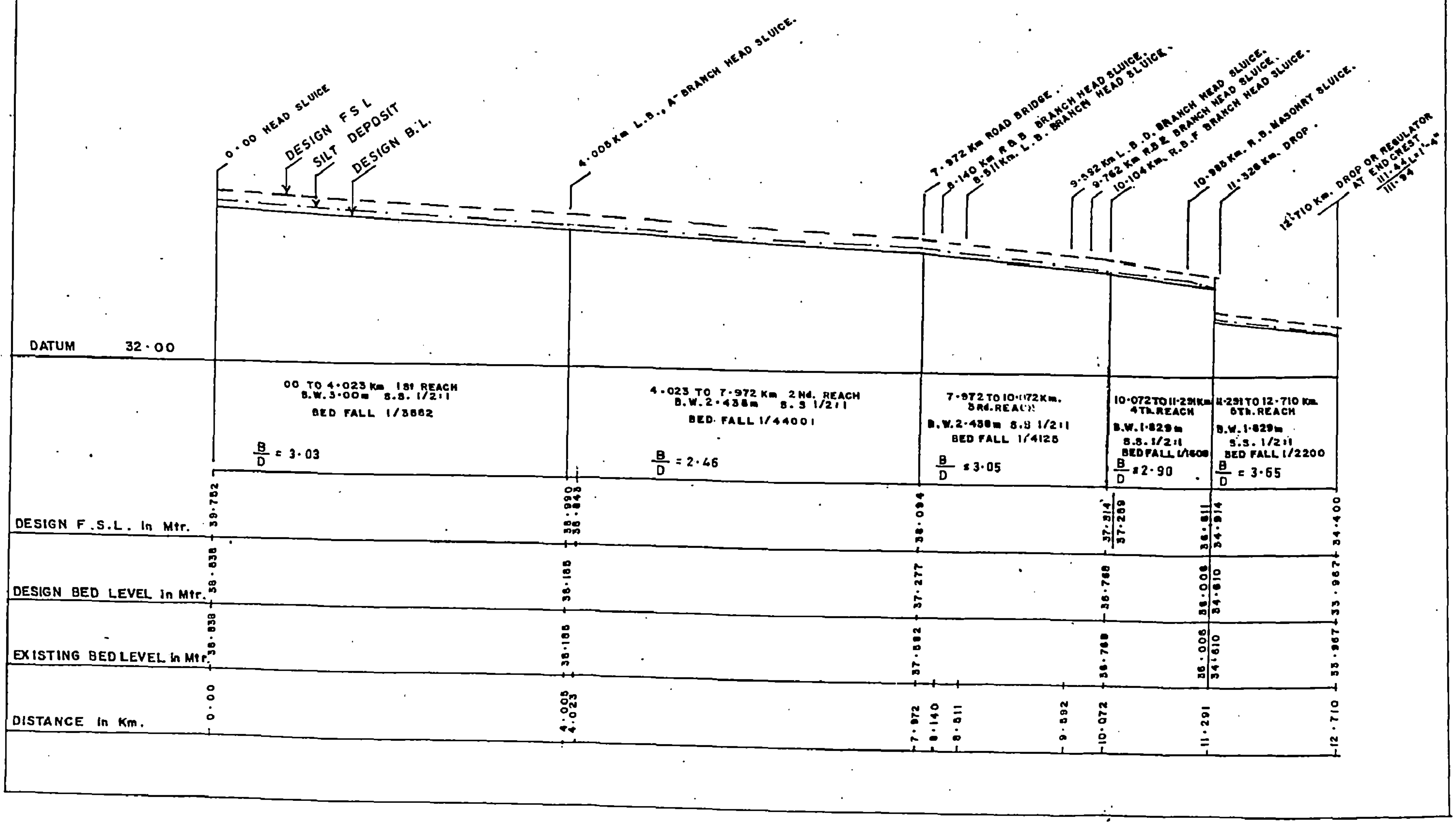
FIG· 2·9

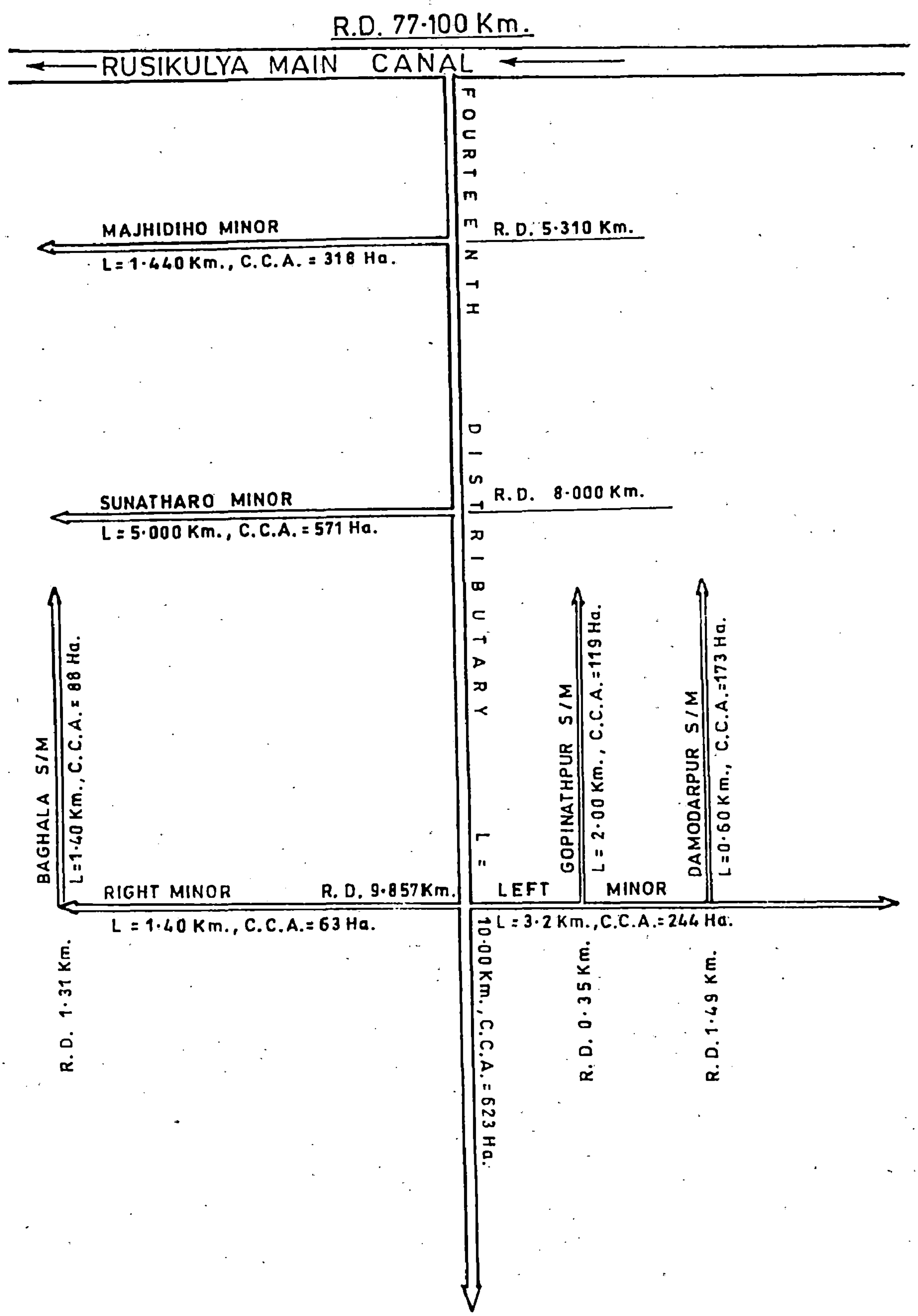
SCHEMATIC DIAGRAM OF THIRTEENTH DISTRIBUTARY
(RUSIKULYA IRRIGATION SYSTEM)

LONGITUDINAL SECTION
OF
13Th. DISTRY. OF_R.CANAL

SCALE:- Hor. 1cm= 400m / Ver. 1cm= 2m.

FIG. 2.10





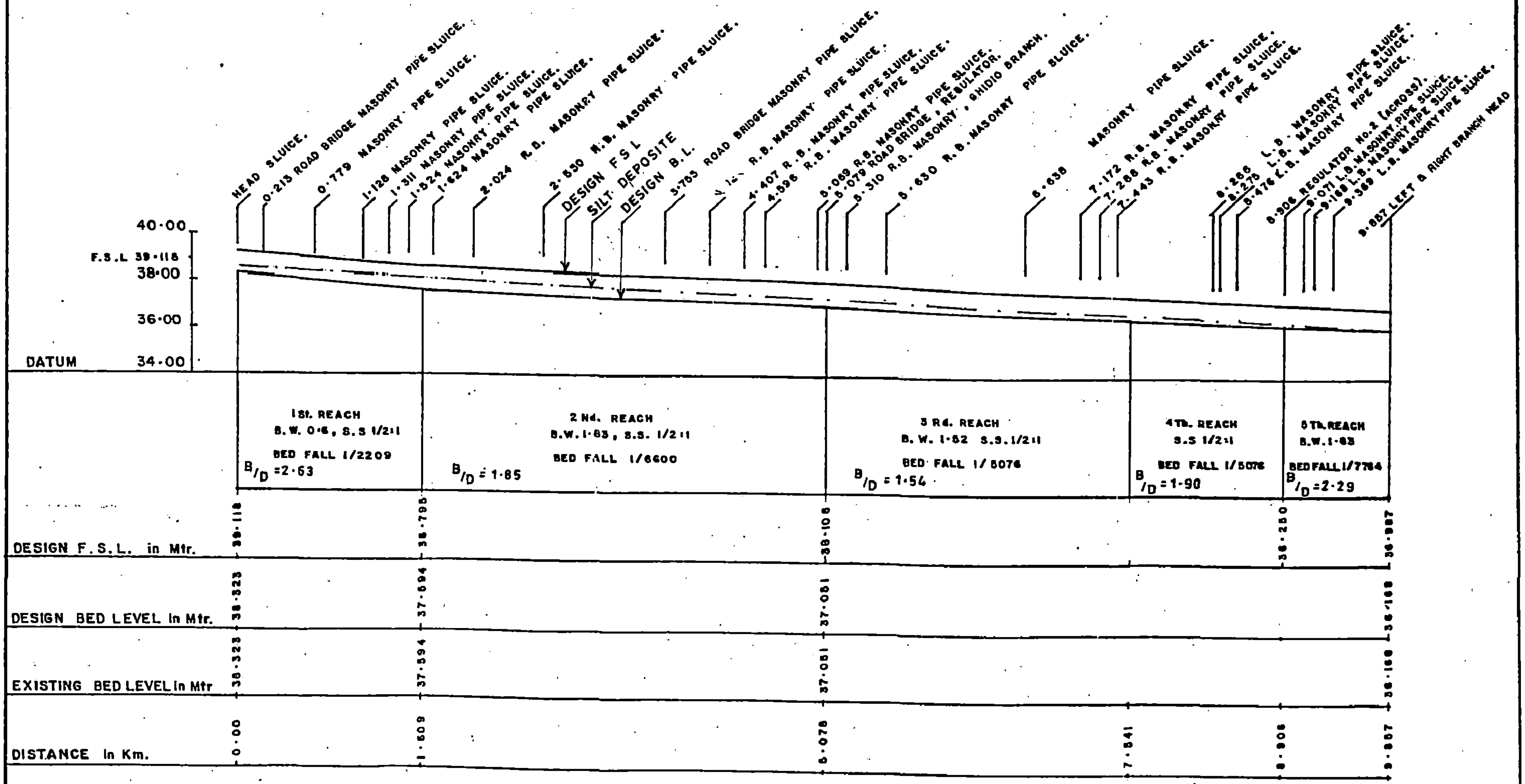
FIG· 2·11

SCHEMATIC DIAGRAM OF FOURTEENTH DISTRIBUTARY (RUSIKULYA IRRIGATION SYSTEM)

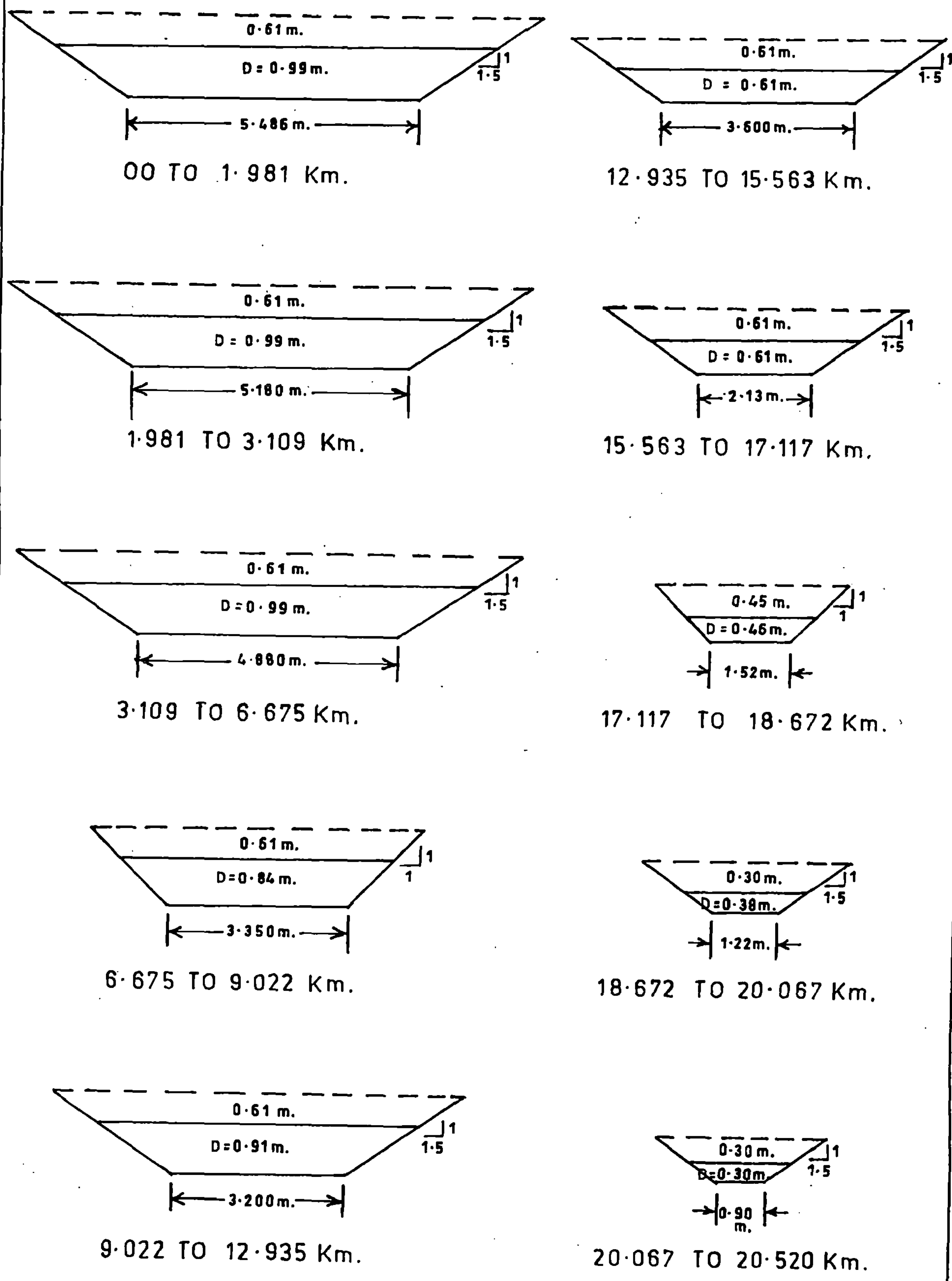
LONGITUDINAL SECTION
OF
14Th. DISTRY. OF R.CANAL

SCALE: Hor. 1Cm= 200m / Ver. 1Cm= 2 m

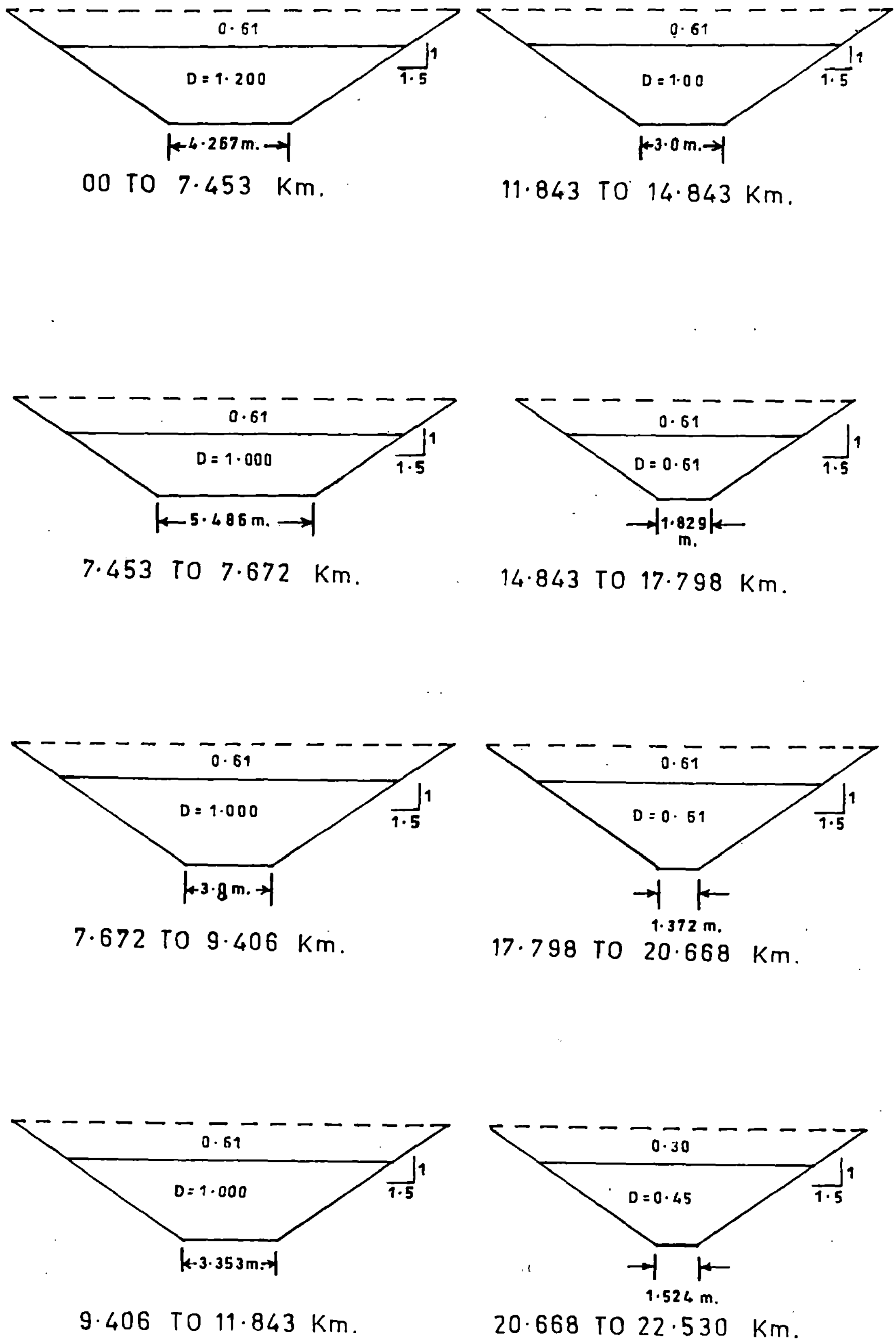
FIG- 2·12



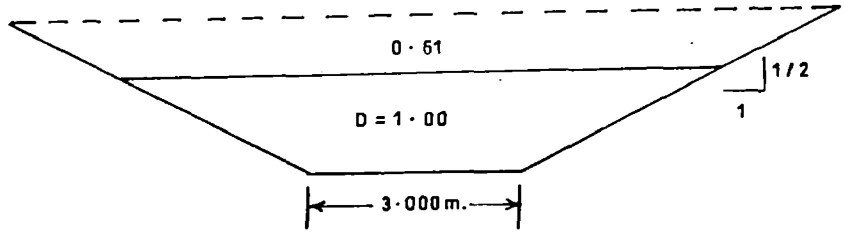
C/S OF DISTRIBUTARY NO. 2 (FIG. 2·13 a)



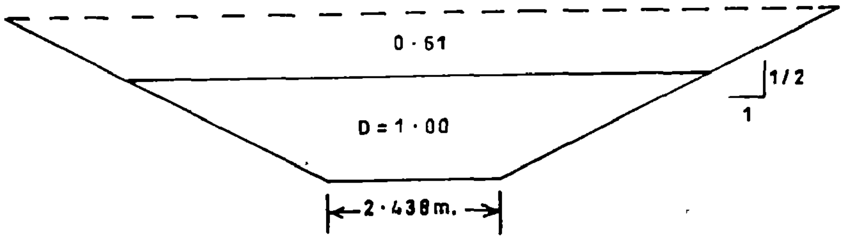
C. S. OF 11th DISTRIBUTARY (FIG. 2·13 b)



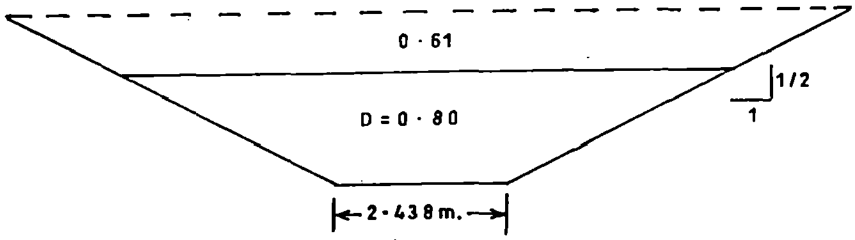
C.S. OF 13th DISTRIBUTARY OF R. CANAL (FIG.2·13c)



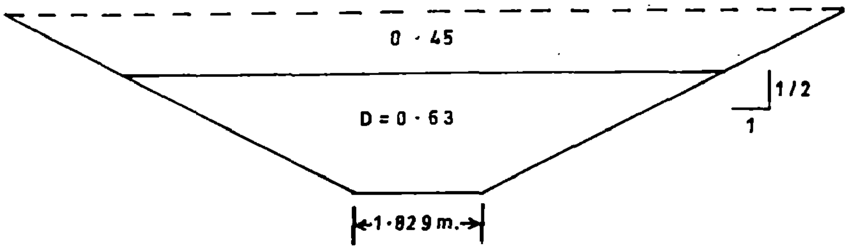
00 TO 4·023 Km.



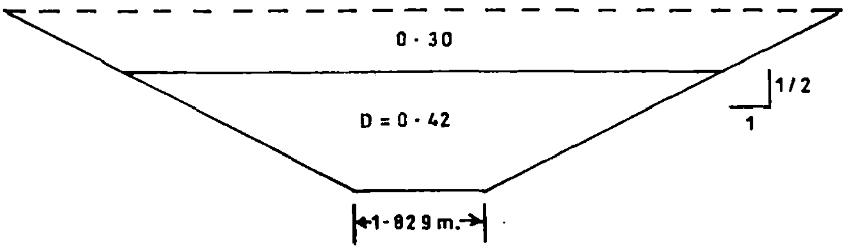
4·023 TO 7·972 Km.



7·972 TO 10·072 Km.

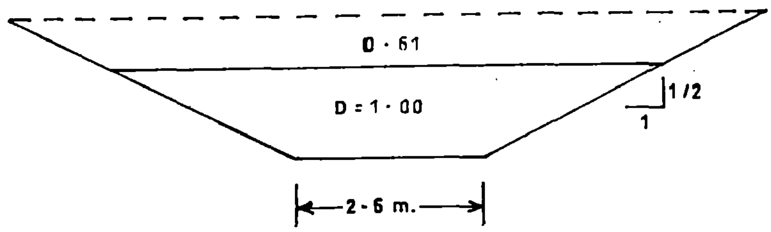


10·072 TO 11·291 Km.

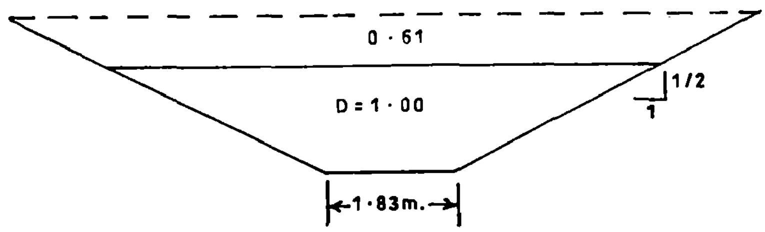


11·291 TO 12·710 Km.

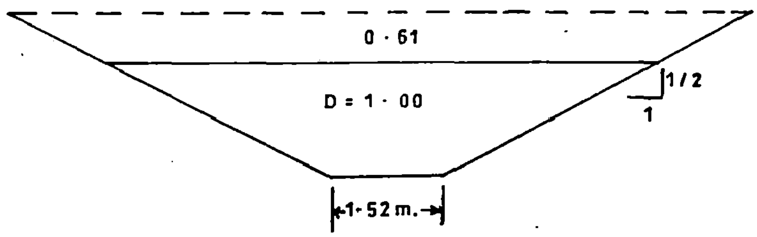
C.S. OF 14th DISTRIBUTARY OF R. CANAL (FIG. 2·13 d)



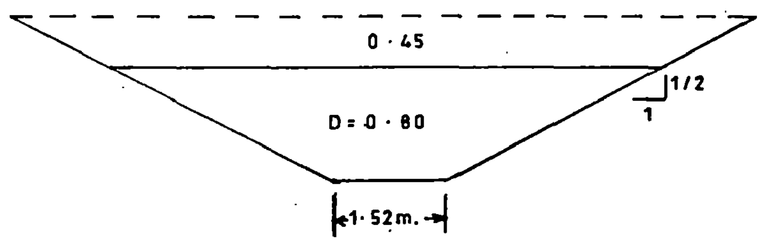
00 TO 1·609 Km.



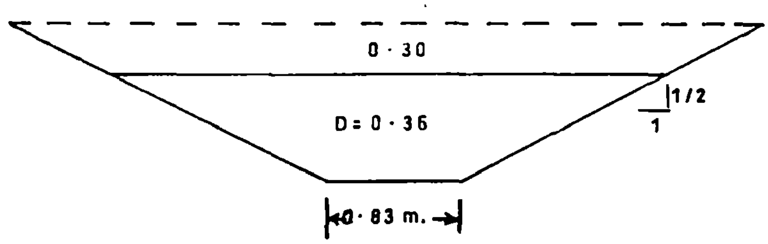
1·609 TO 5·078 Km.



5·078 TO 7·541 Km.



7·541 TO 8·906 Km.



8·906 TO 9·857 Km.

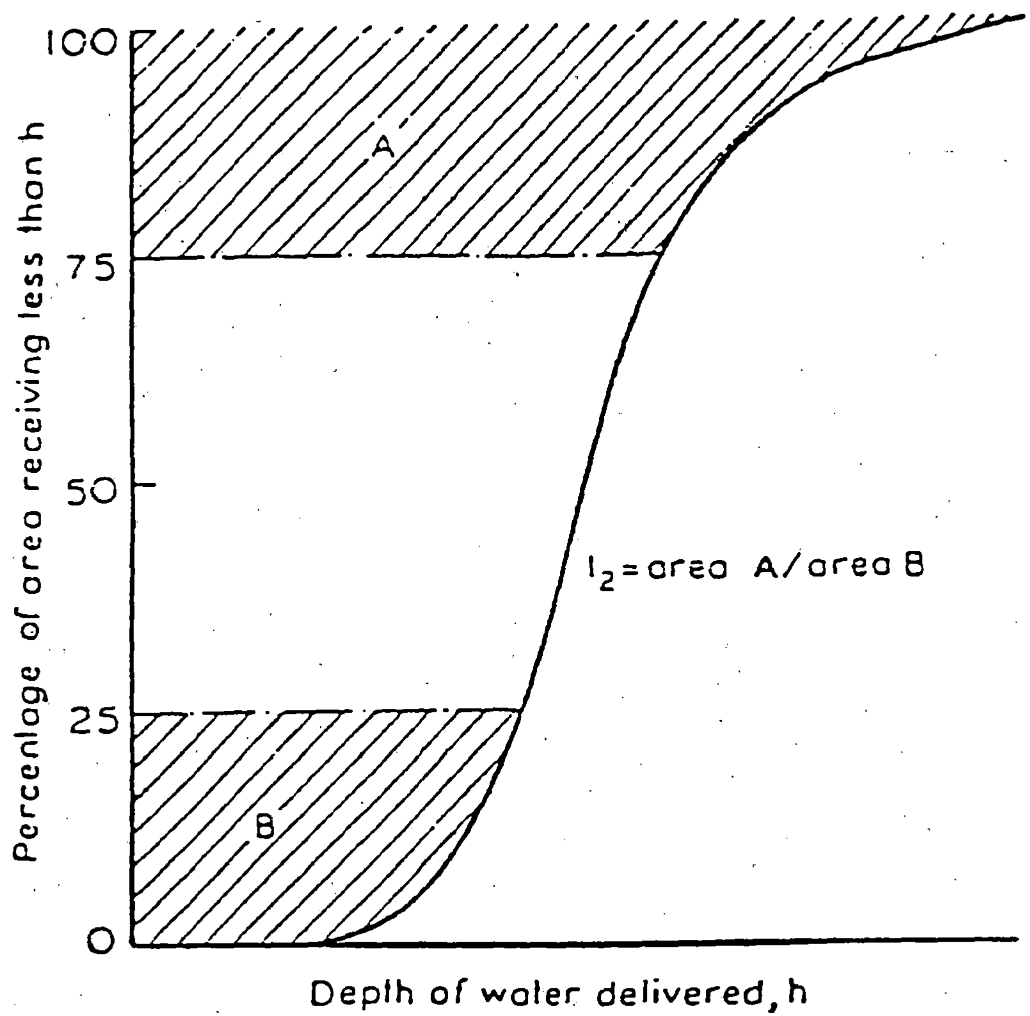


FIG. 3·1 ; Definition of inter-quartile ratio

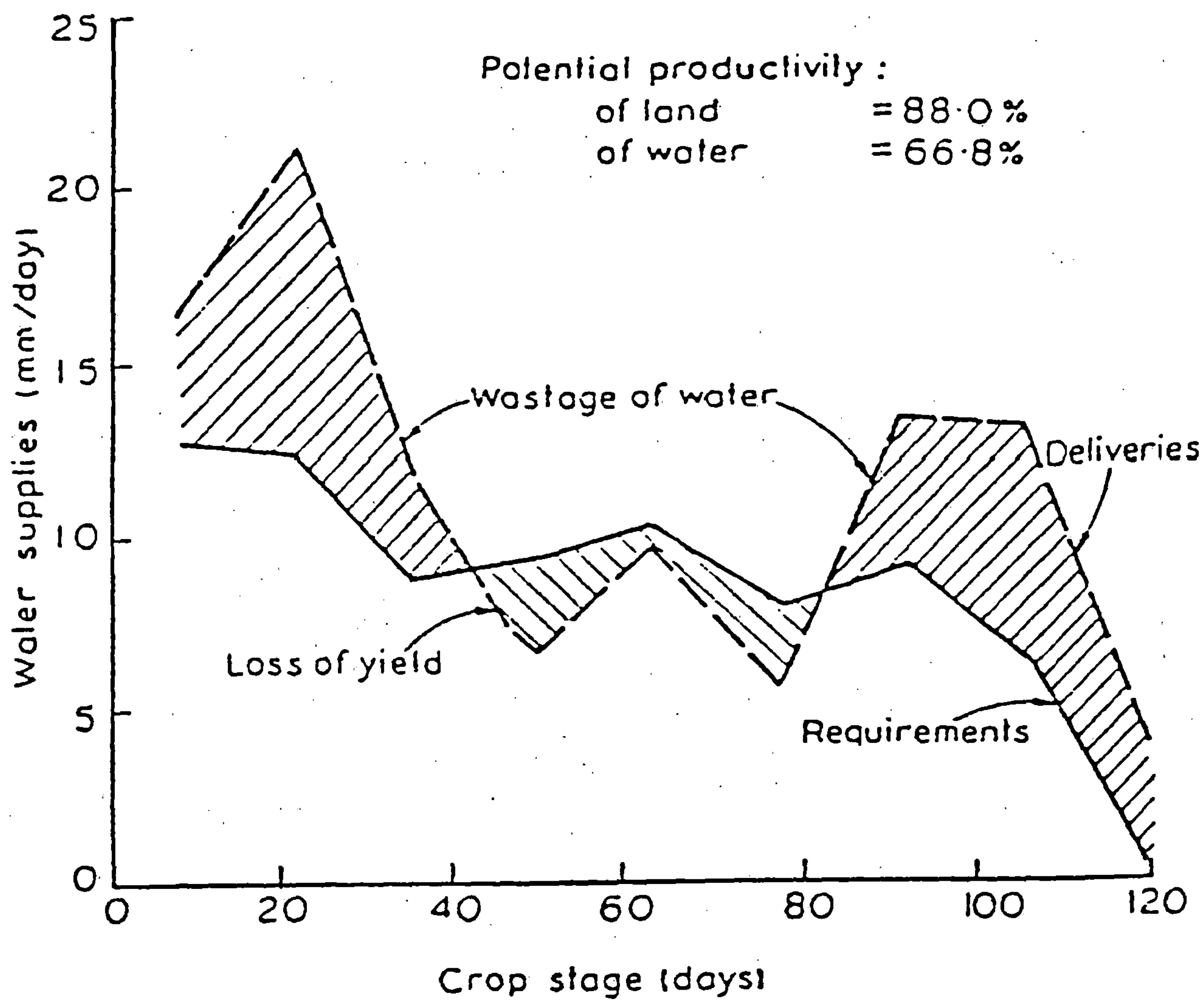


FIG.3·2 : Effect of timeliness of water supply upon productivity of land and water

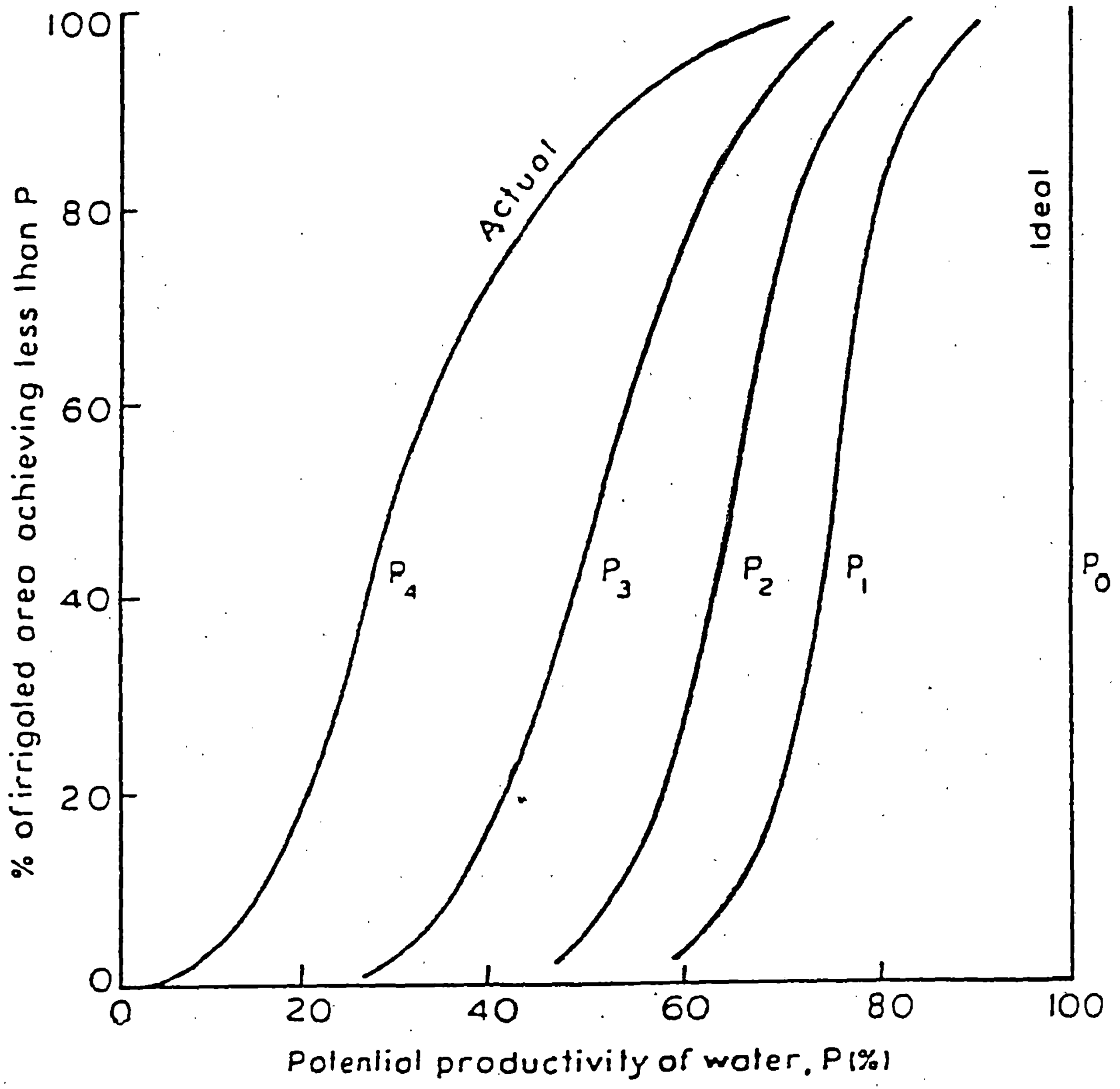


FIG. 3·3 : Effects of different constraints upon potential productivity of water

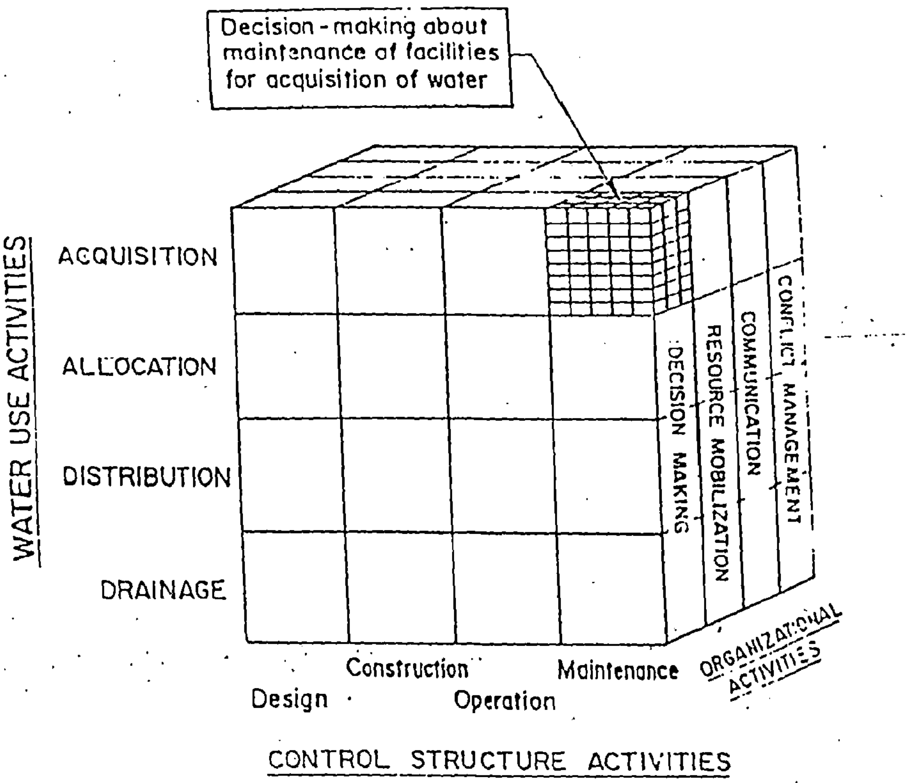


Figure 3·4 - Matrix of irrigation management activities (adopted from Uphoff, 1986).

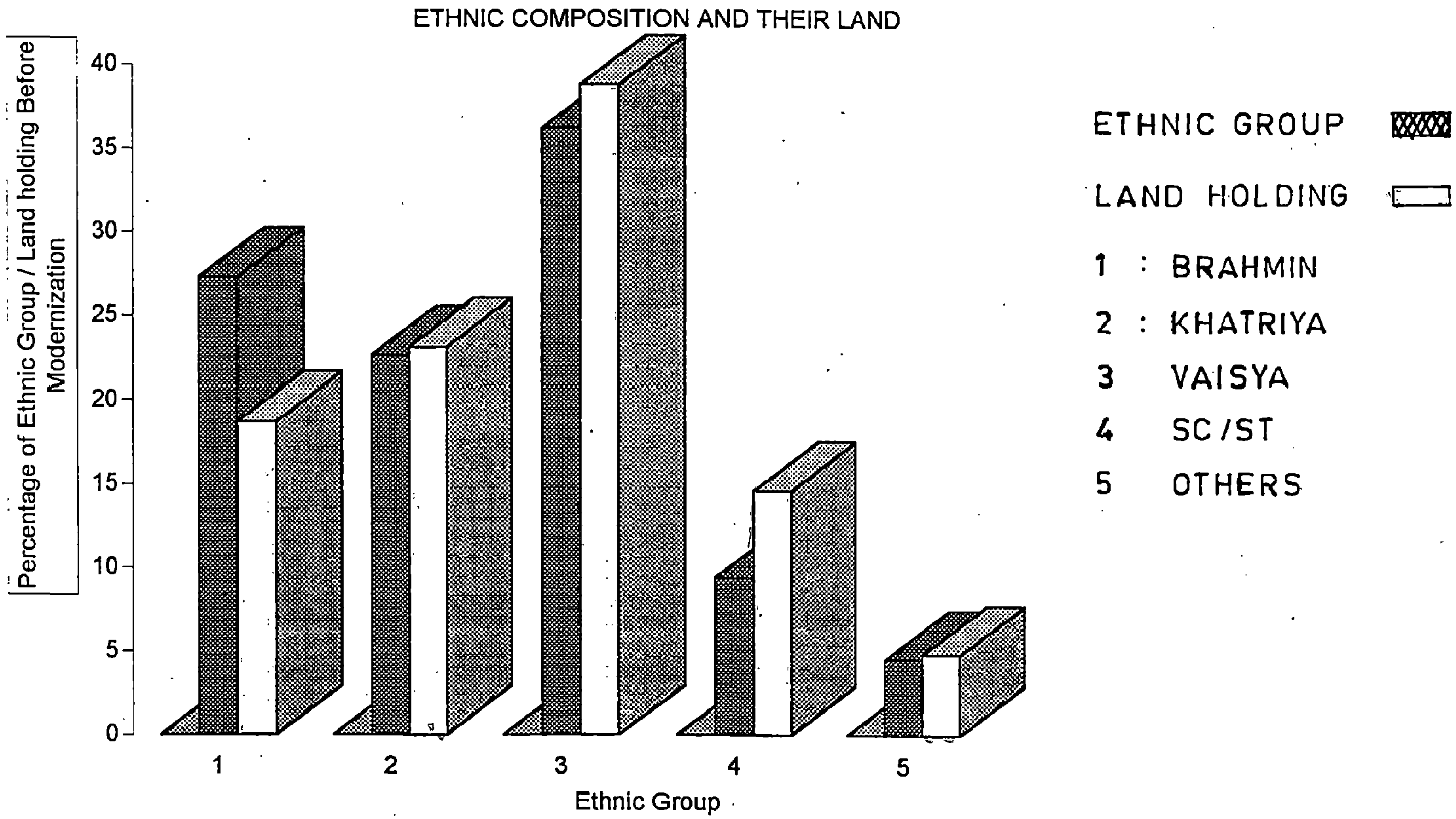

ETHNIC COMPOSITION AND THEIR LAND
Percentage of Ethnic Group / Land holding Before Modernization
0
5
10
15
20
25
30
35
40
1
2
3
4
5
Ethnic Group
ETHNIC GROUP
LAND HOLDING
1 : BRAHMIN
2 : KHATRIYA
3 VAISYA
4 SC /ST
5 OTHERS

Figure: 4.1

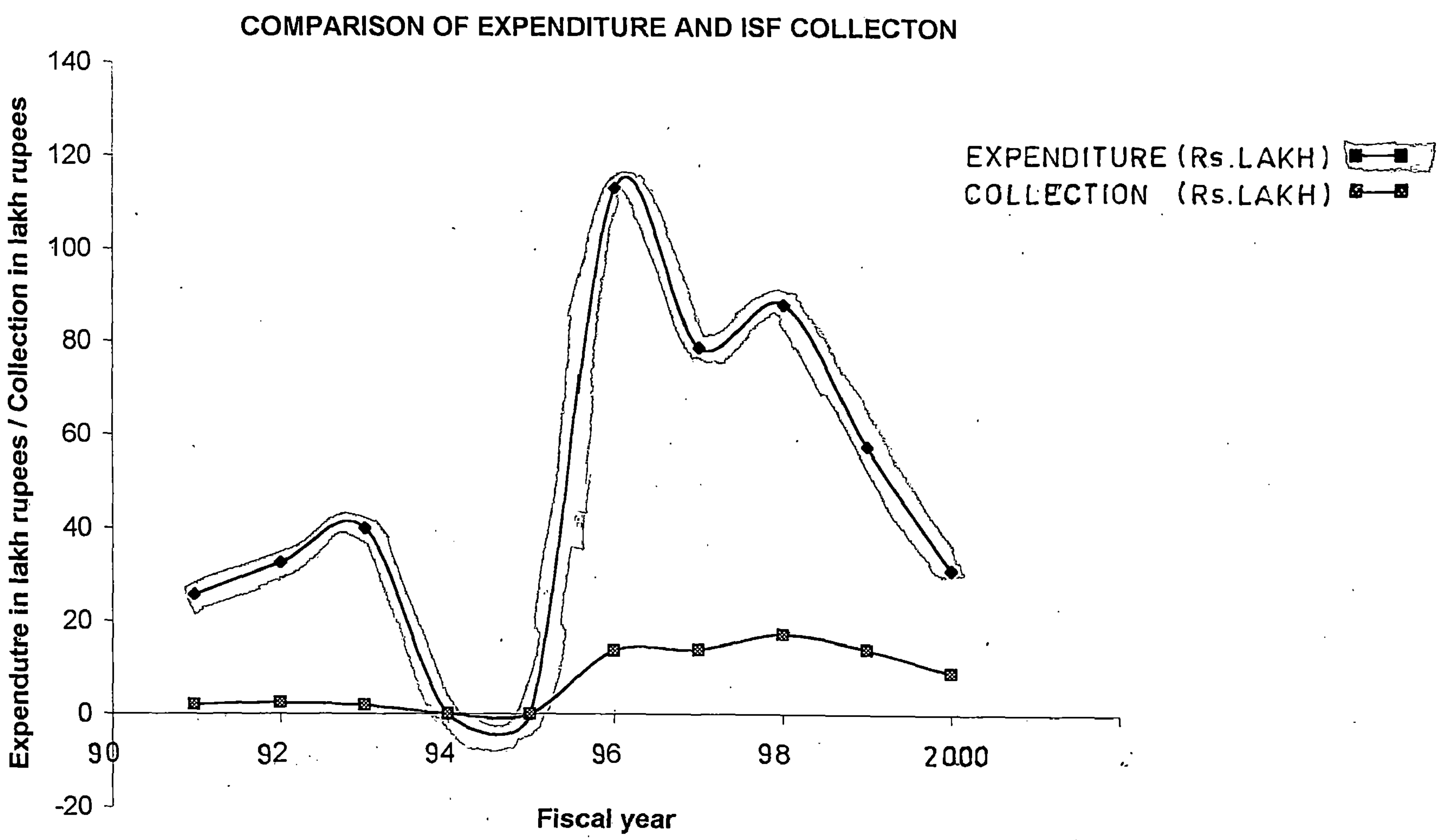

COMPARISON OF EXPENDITURE AND ISF COLLECTON
EXPENDITURE (Rs.LAKH)
COLLECTION (Rs.LAKH)
Expendutre in lakh rupees / Collection in lakh rupees
140
120
100
80
60
40
20
0
-20
90
92
94
96
98
2000
Fiscal year

Figure: 4.2

ABSTRACT OF AVERAGE DEMAND & SUPPLY (BEFORE AND AFTER MODERNIZATION) IN HEAD REACH OF DIFFERENT DISTRIBUTARIES

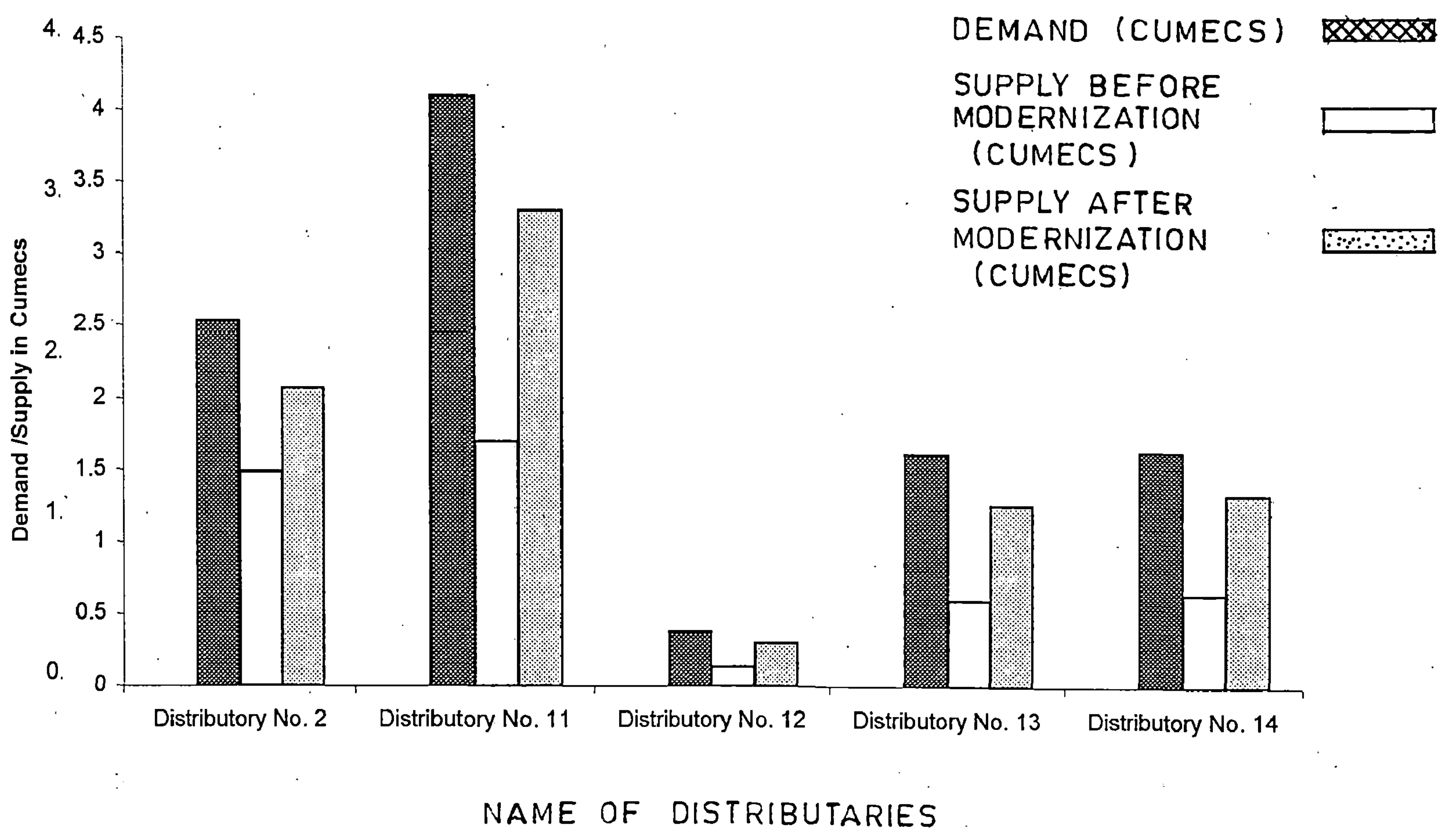
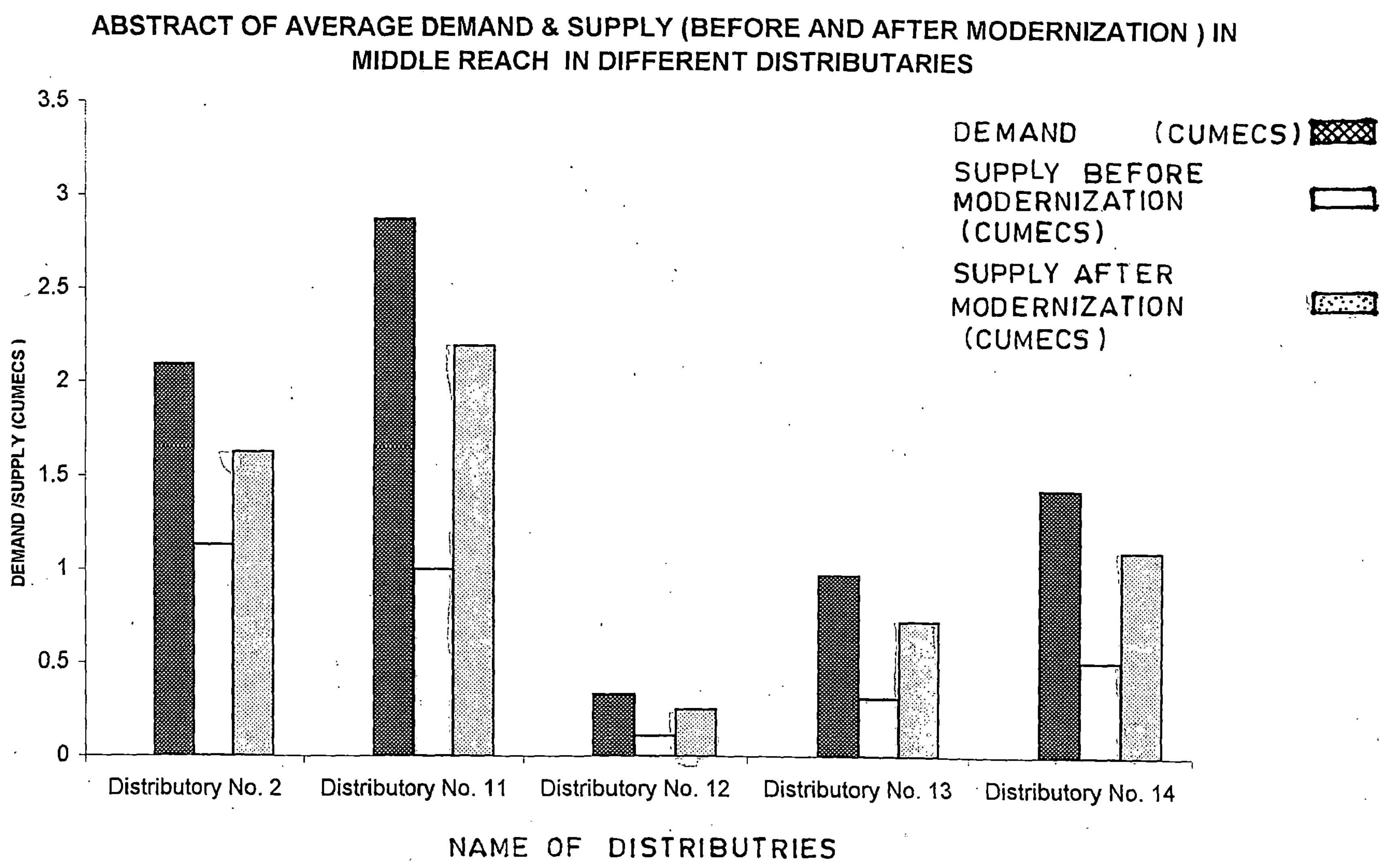
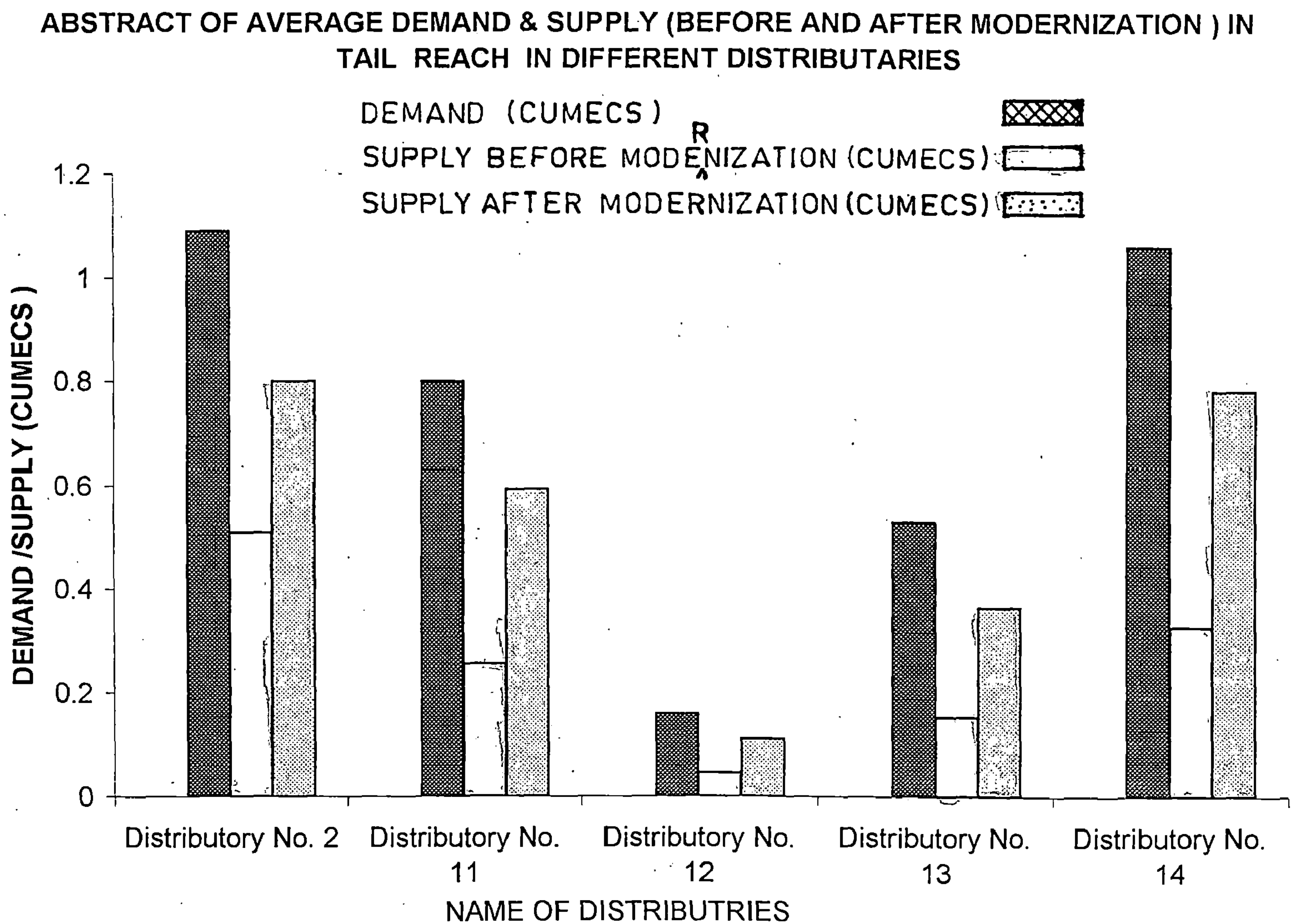


Figure: 4.3



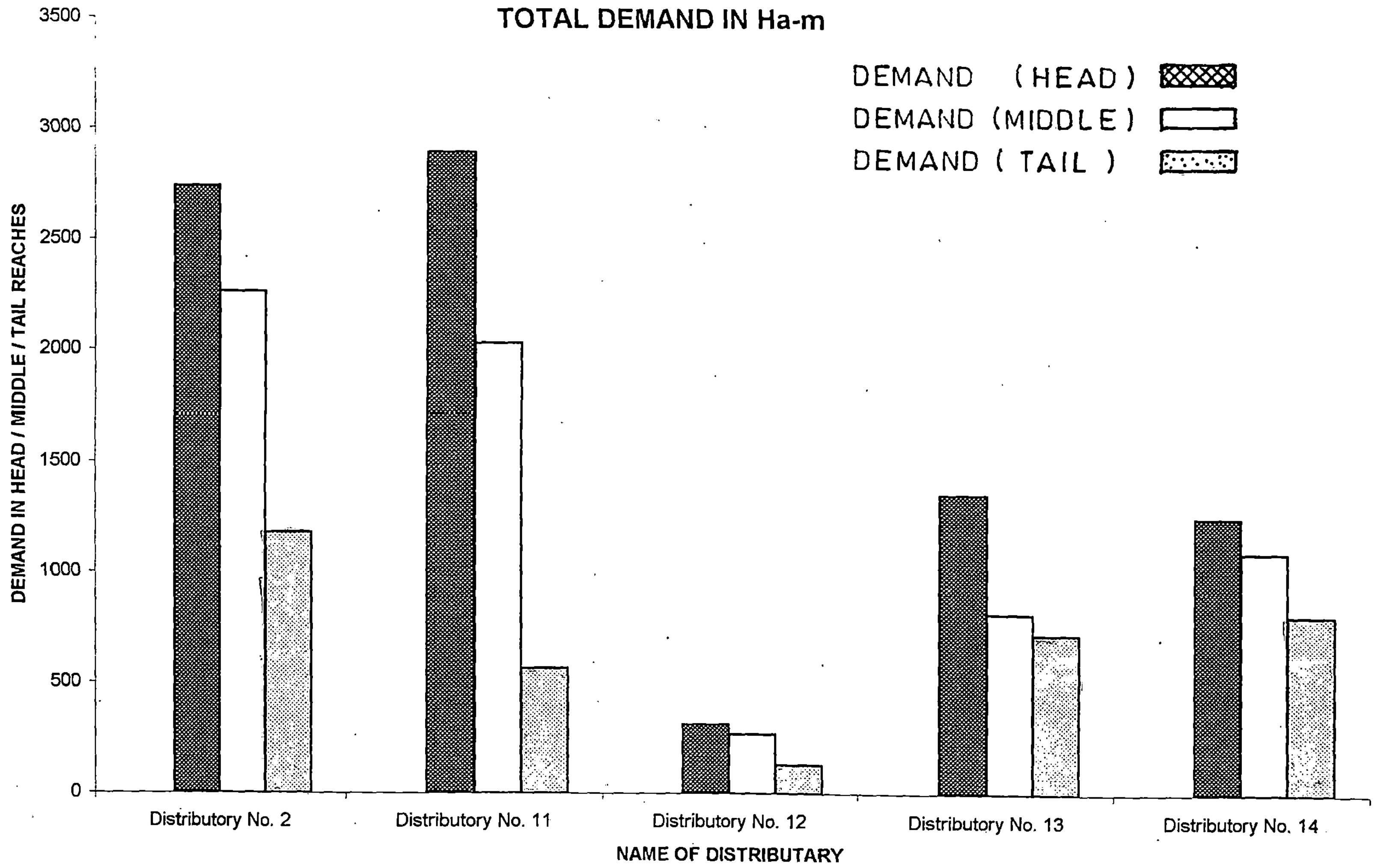
ABSTRACT OF AVERAGE DEMAND & SUPPLY (BEFORE AND AFTER MODERNIZATION) IN MIDDLE REACH IN DIFFERENT DISTRIBUTARIES
DEMAND (CUMECS)
SUPPLY BEFORE MODERNIZATION (CUMECS)
SUPPLY AFTER MODERNIZATION (CUMECS)
DEMAND /SUPPLY (CUMECS)
3.5
3
2.5
2
1.5
1
0.5
0
Distributory No. 2
Distributory No. 11
Distributory No. 12
Distributory No. 13
Distributory No. 14
NAME OF DISTRIBUTRIES

Figure : 4.4



ABSTRACT OF AVERAGE DEMAND & SUPPLY (BEFORE AND AFTER MODERNIZATION) IN TAIL REACH IN DIFFERENT DISTRIBUTARIES
DEMAND (CUMECS)
SUPPLY BEFORE MODERNIZATION (CUMECS)
SUPPLY AFTER MODERNIZATION (CUMECS)
DEMAND /SUPPLY (CUMECS)
1.2
1
0.8
0.6
0.4
0.2
0
Distributory No. 2
Distributory No. 11
Distributory No. 12
Distributory No. 13
Distributory No. 14
NAME OF DISTRIBUTRIES

Figure : 4.5



TOTAL DEMAND IN Ha-m
DEMAND (HEAD)
DEMAND (MIDDLE)
DEMAND (TAIL)
3500
3000
2500
2000
1500
1000
500
0
DEMAND IN HEAD / MIDDLE / TAIL REACHES
Distributory No. 2
Distributory No. 11
Distributory No. 12
Distributory No. 13
Distributory No. 14
NAME OF DISTRIBUTARY

Figure : 4.6

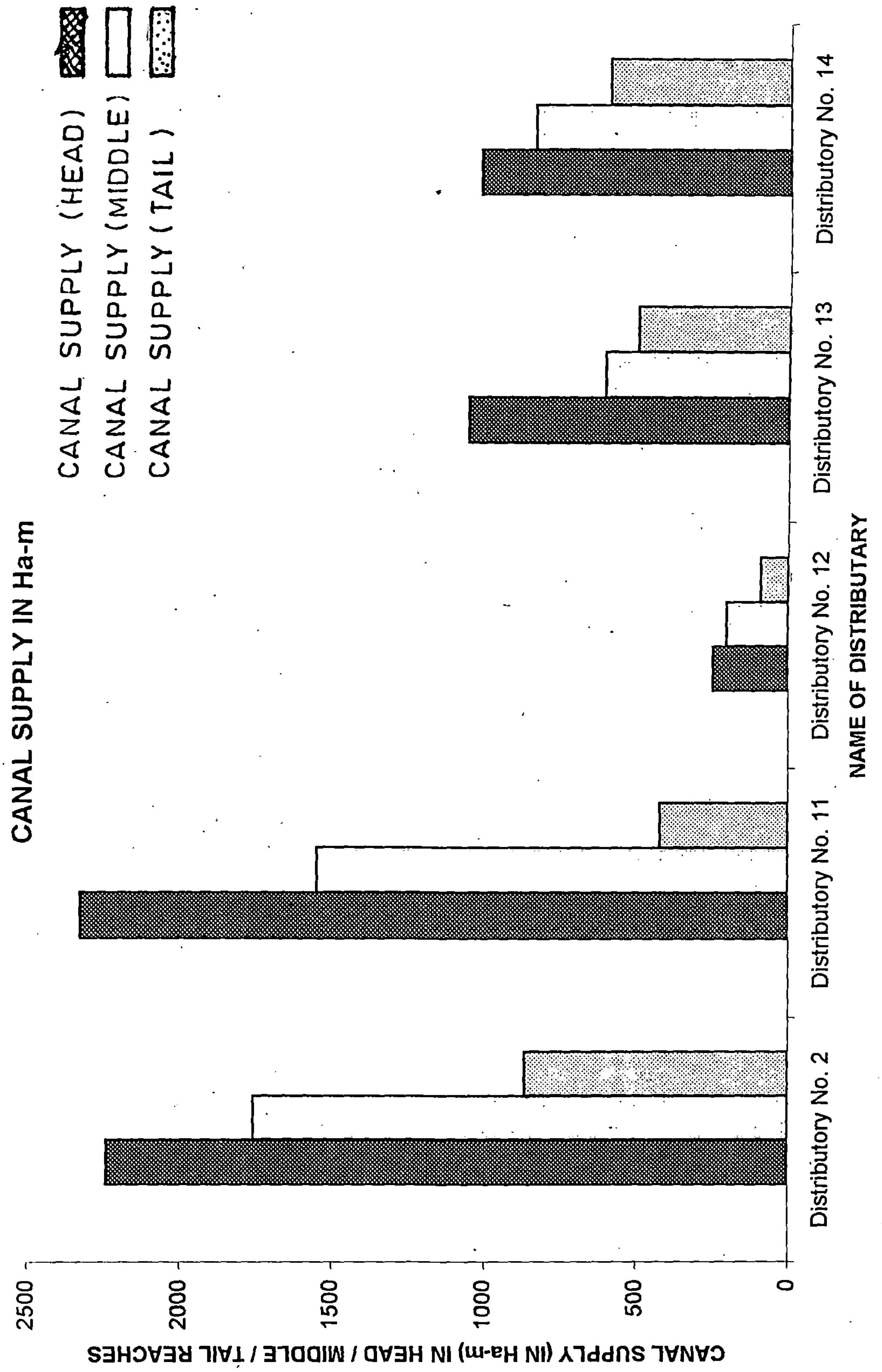

CANAL SUPPLY IN Ha-m
CANAL SUPPLY (HEAD)
CANAL SUPPLY (MIDDLE)
CANAL SUPPLY (TAIL)
CANAL SUPPLY (IN Ha-m) IN HEAD / MIDDLE / TAIL REACHES
2500
2000
1500
1000
500
0
Distributory No. 2
Distributory No. 11
Distributory No. 12
Distributory No. 13
Distributory No. 14
NAME OF DISTRIBUTARY

Figure : 4.7

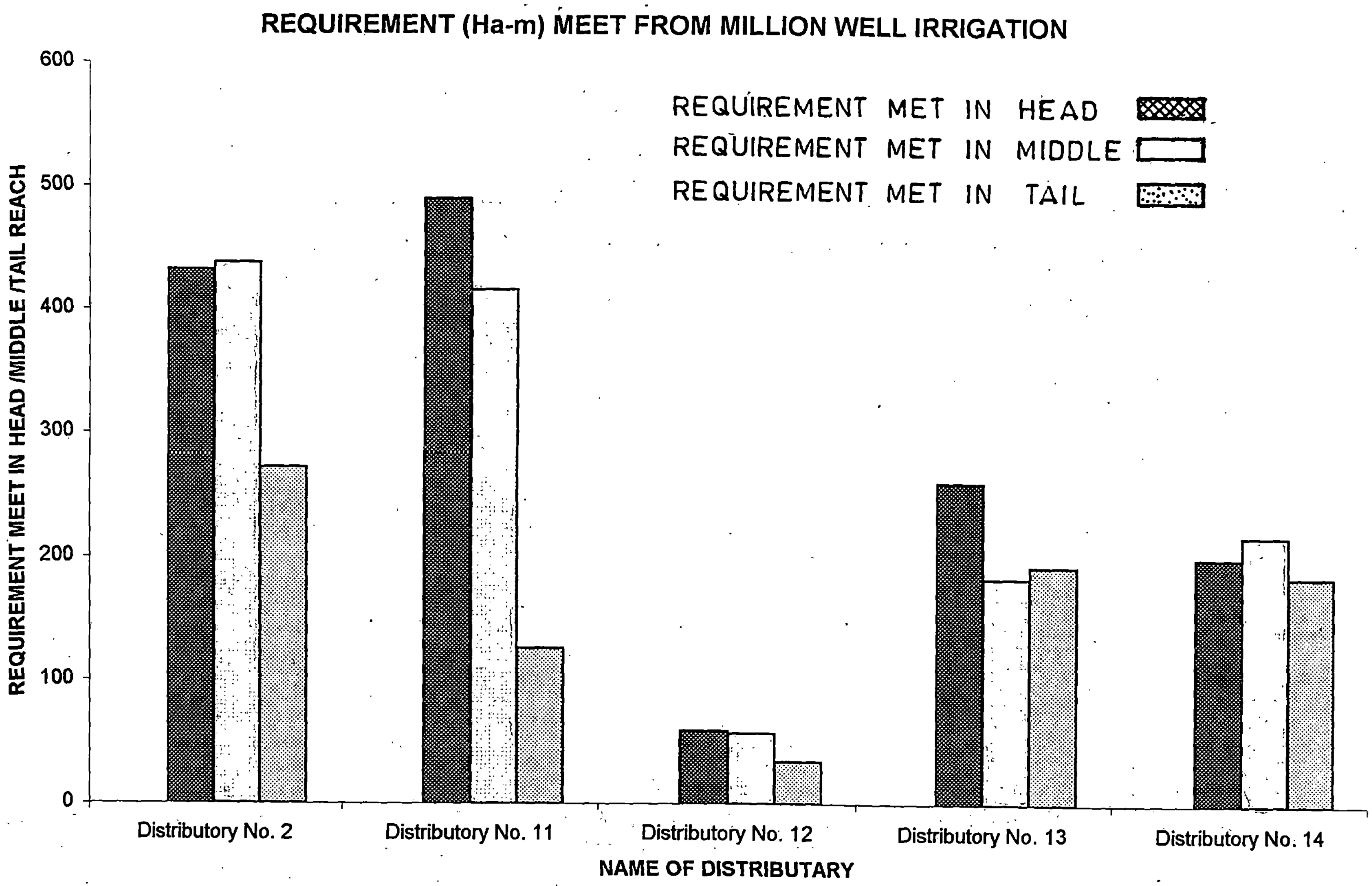

REQUIREMENT (Ha-m) MEET FROM MILLION WELL IRRIGATION
REQUIREMENT MEET IN HEAD /MIDDLE /TAIL REACH
600
500
400
300
200
100
0
REQUIREMENT MET IN HEAD
REQUIREMENT MET IN MIDDLE
REQUIREMENT MET IN TAIL
Distributory No. 2
Distributory No. 11
Distributory No. 12
Distributory No. 13
Distributory No. 14
NAME OF DISTRIBUTARY

Figure : 4.8

EXTRA WATER REQUIREMENT (Ha-m) MEET FROM PRIVATE TUBE WELL IRRIGATION (EXPERIMENTAL)

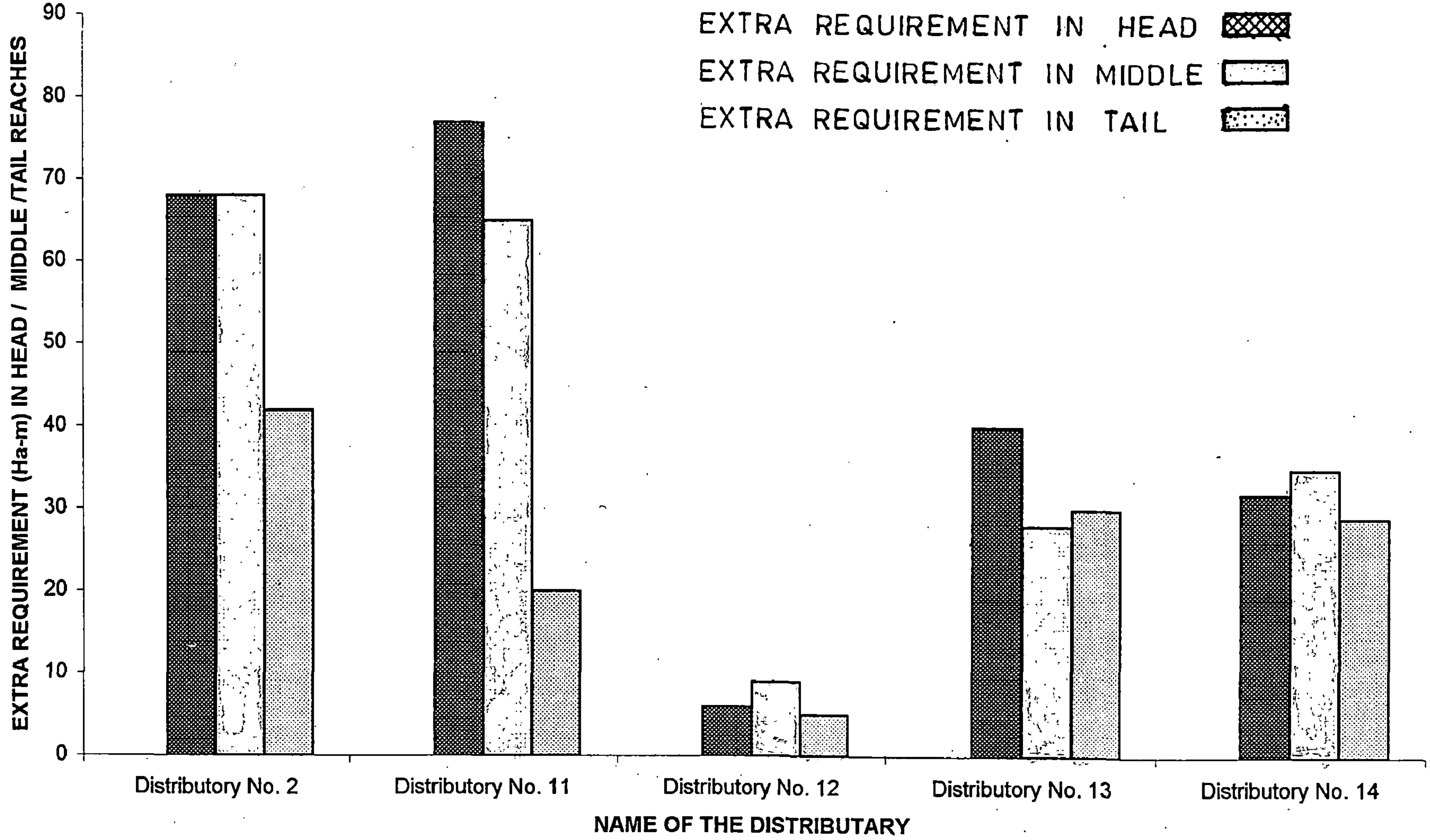


Figure : 4.9

LAND IRRIGATED BY CANNAL IRRIGATION AFTER MODERNIZATION (Ha)

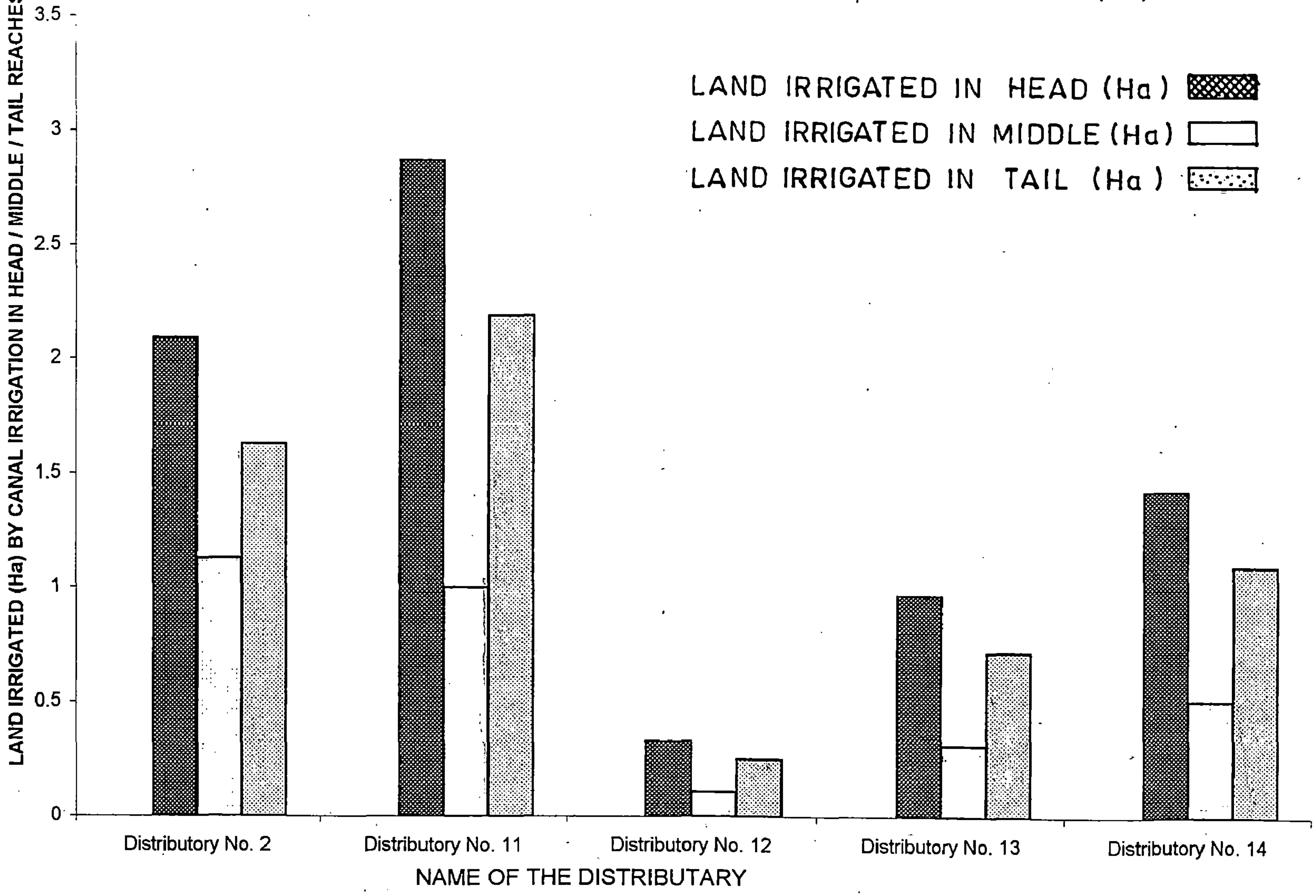


Figure : 4.10

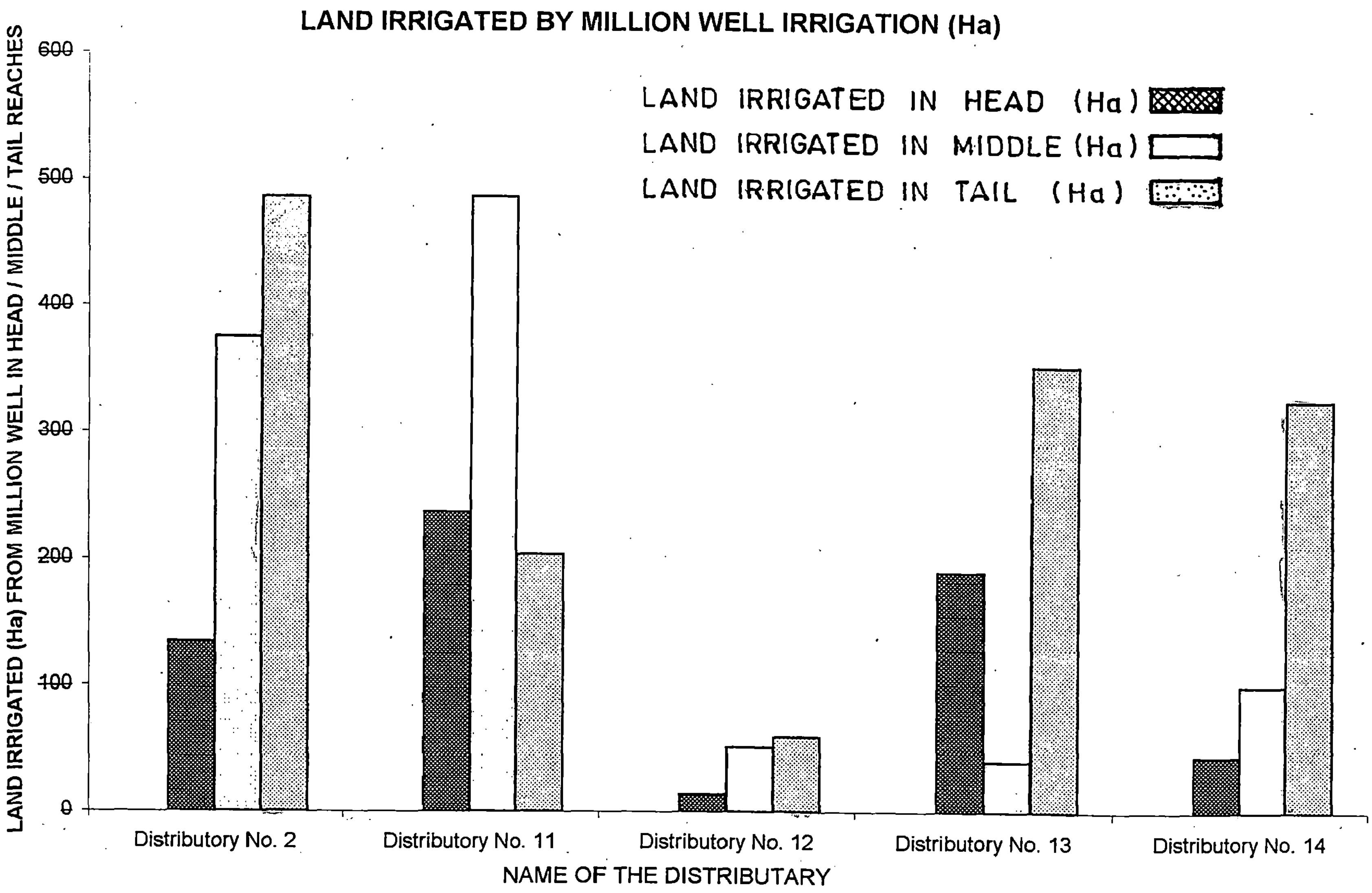

LAND IRRIGATED BY MILLION WELL IRRIGATION (Ha)
LAND IRRIGATED IN HEAD (Ha)
LAND IRRIGATED IN MIDDLE (Ha)
LAND IRRIGATED IN TAIL (Ha)
LAND IRRIGATED (Ha) FROM MILLION WELL IN HEAD / MIDDLE / TAIL REACHES
600
500
400
300
200
100
0
Distributory No. 2
Distributory No. 11
Distributory No. 12
Distributory No. 13
Distributory No. 14
NAME OF THE DISTRIBUTARY

Figure : 4.11

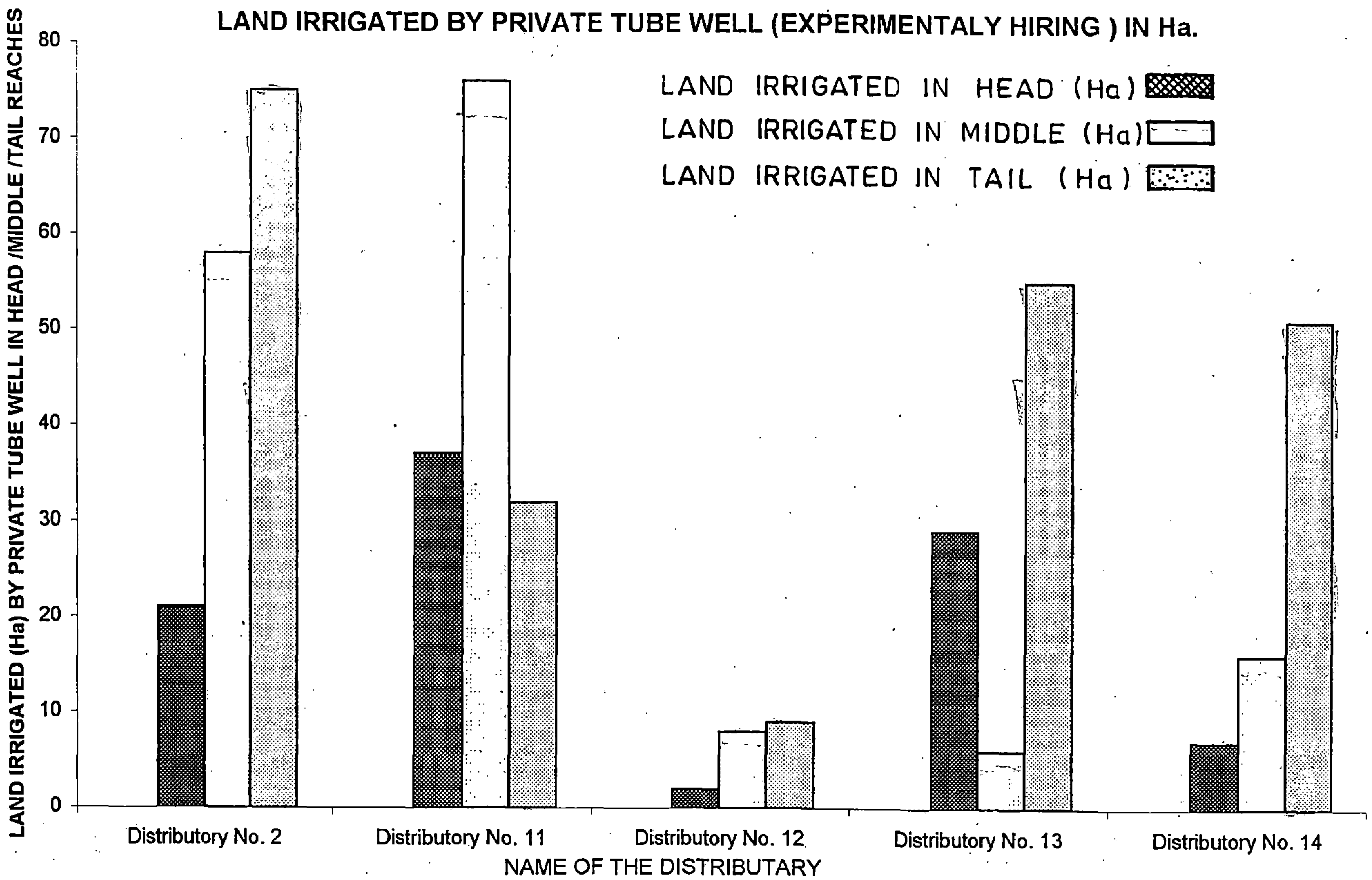
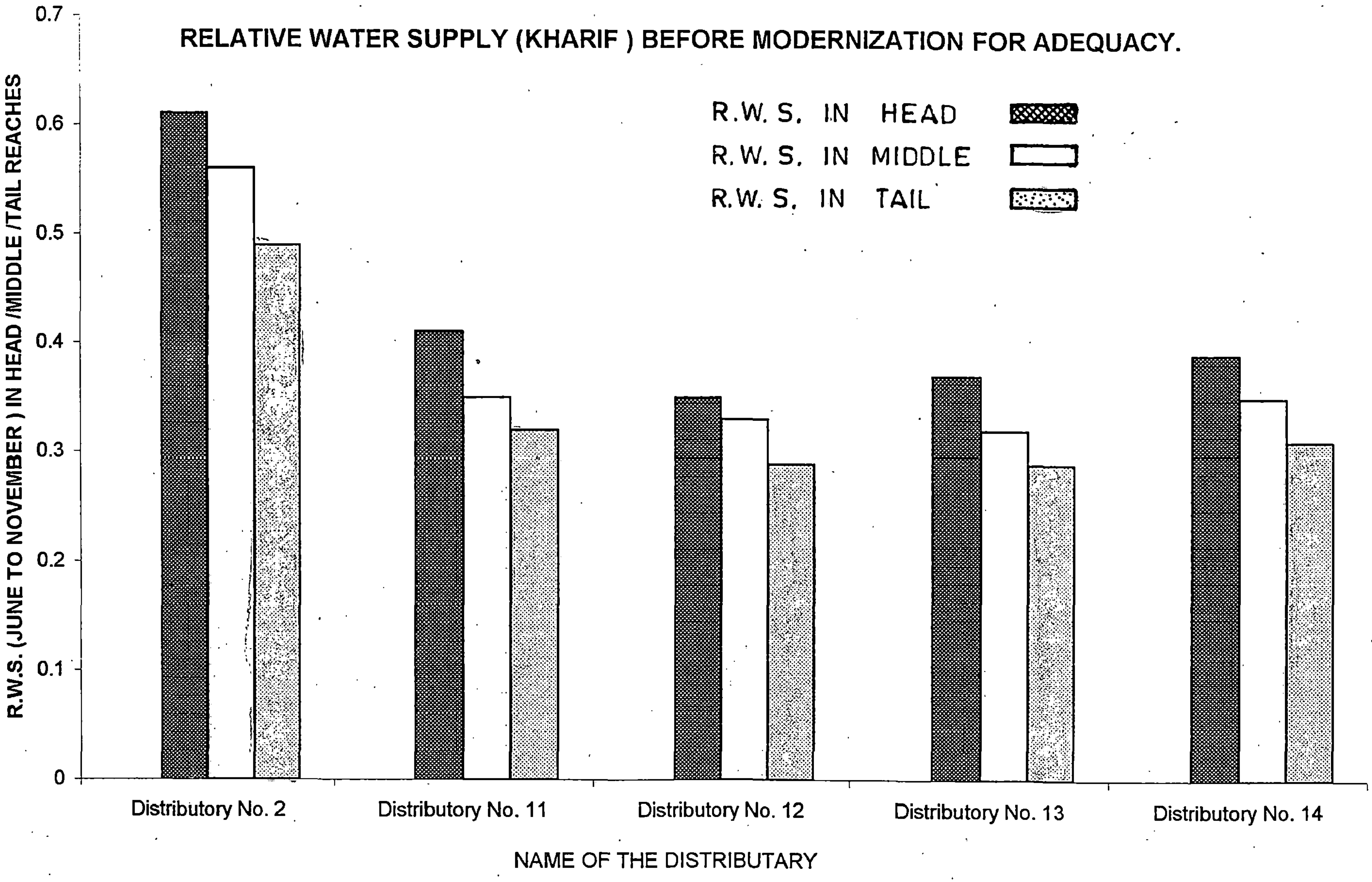

LAND IRRIGATED BY PRIVATE TUBE WELL (EXPERIMENTALY HIRING) IN Ha.
LAND IRRIGATED IN HEAD (Ha)
LAND IRRIGATED IN MIDDLE (Ha)
LAND IRRIGATED IN TAIL (Ha)
LAND IRRIGATED (Ha) BY PRIVATE TUBE WELL IN HEAD /MIDDLE /TAIL REACHES
0
10
20
30
40
50
60
70
80
Distributory No. 2
Distributory No. 11
Distributory No. 12
Distributory No. 13
Distributory No. 14
NAME OF THE DISTRIBUTARY

Figure : 4.12



RELATIVE WATER SUPPLY (KHARIF) BEFORE MODERNIZATION FOR ADEQUACY.
R.W. S. IN HEAD
R.W. S. IN MIDDLE
R.W. S. IN TAIL
R.W.S. (JUNE TO NOVEMBER) IN HEAD /MIDDLE /TAIL REACHES
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Distributory No. 2
Distributory No. 11
Distributory No. 12
Distributory No. 13
Distributory No. 14
NAME OF THE DISTRIBUTARY

Figure : 4.13

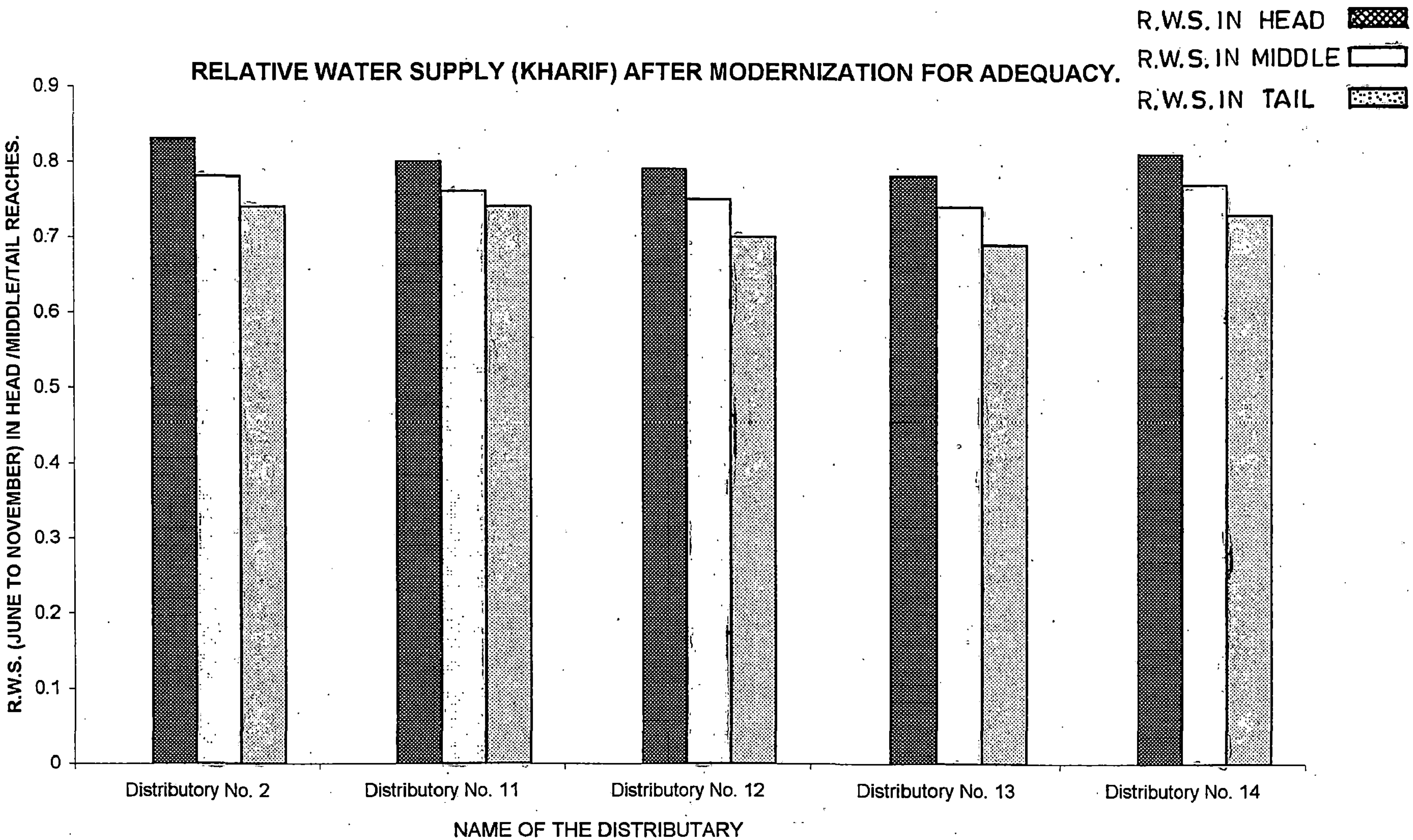
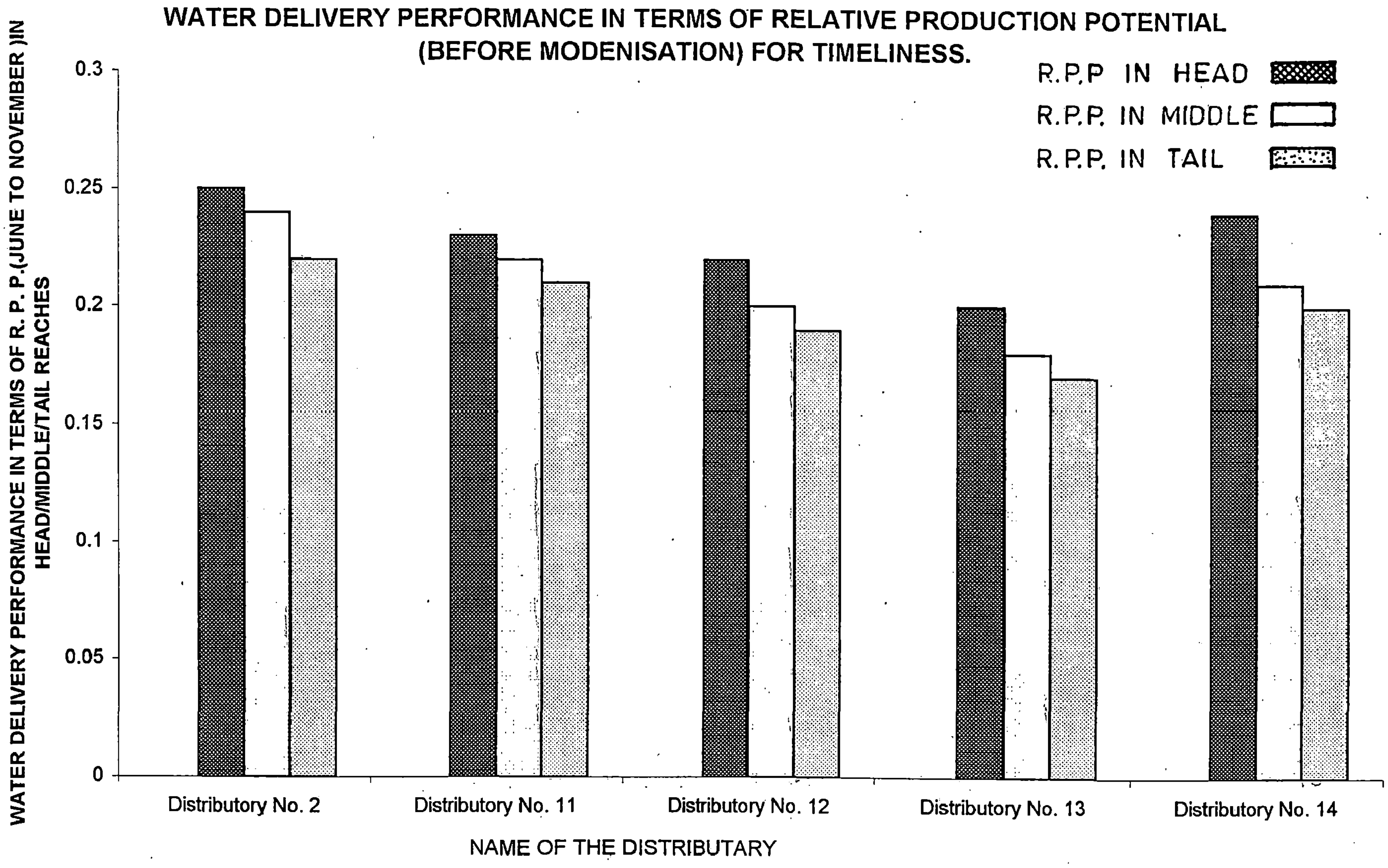

RELATIVE WATER SUPPLY (KHARIF) AFTER MODERNIZATION FOR ADEQUACY.
R.W.S. IN HEAD
R.W.S. IN MIDDLE
R.W.S. IN TAIL
R.W.S. (JUNE TO NOVEMBER) IN HEAD /MIDDLE/TAIL REACHES.
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Distributory No. 2
Distributory No. 11
Distributory No. 12
Distributory No. 13
Distributory No. 14
NAME OF THE DISTRIBUTARY

Figure : 4.14



WATER DELIVERY PERFORMANCE IN TERMS OF RELATIVE PRODUCTION POTENTIAL
(BEFORE MODENISATION) FOR TIMELINESS.
R.P.P IN HEAD
R.P.P. IN MIDDLE
R.P.P. IN TAIL
WATER DELIVERY PERFORMANCE IN TERMS OF R. P. P.(JUNE TO NOVEMBER)IN HEAD/MIDDLE/TAIL REACHES
0.3
0.25
0.2
0.15
0.1
0.05
0
Distributory No. 2
Distributory No. 11
Distributory No. 12
Distributory No. 13
Distributory No. 14
NAME OF THE DISTRIBUTARY

Figure : 4.15

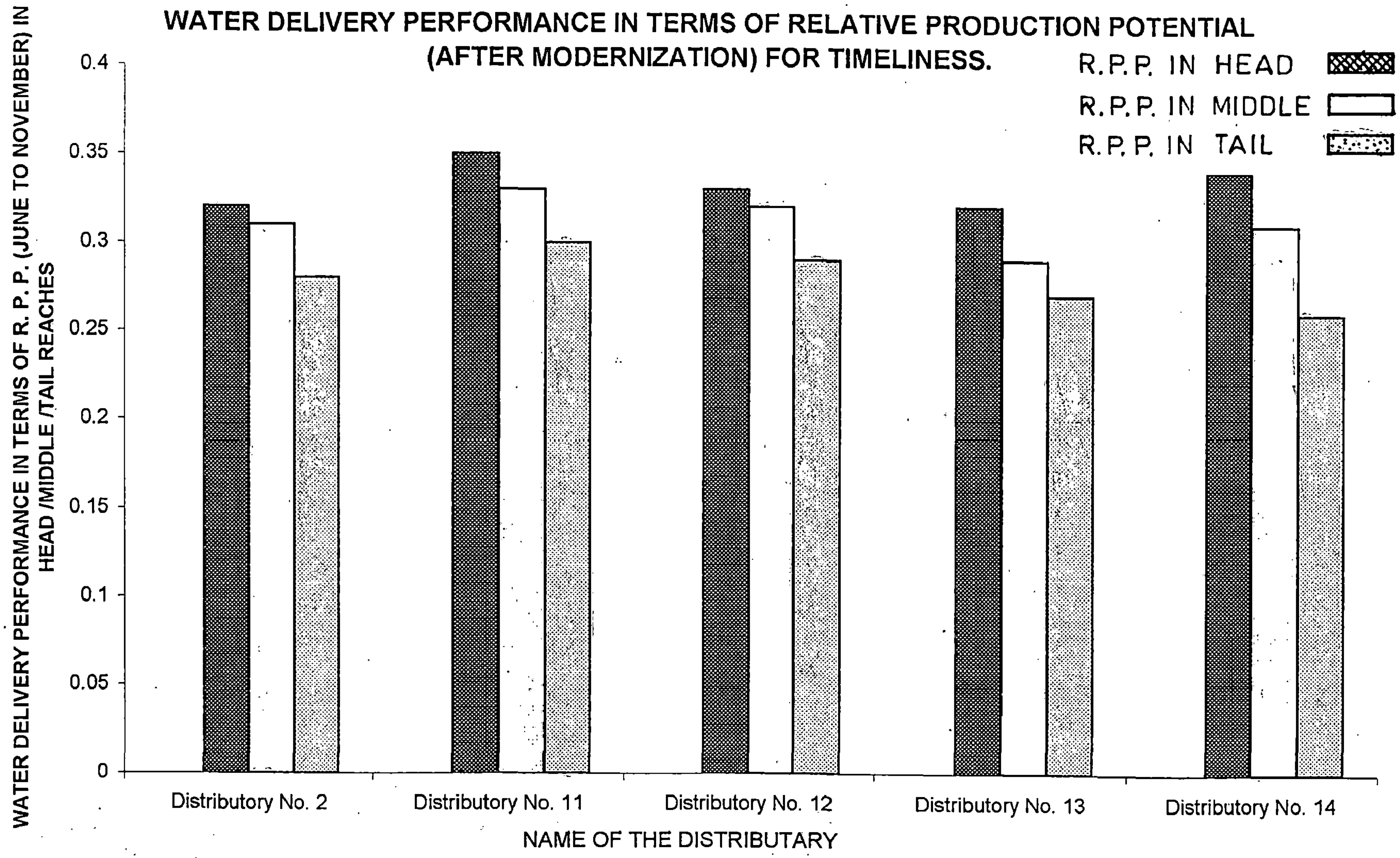
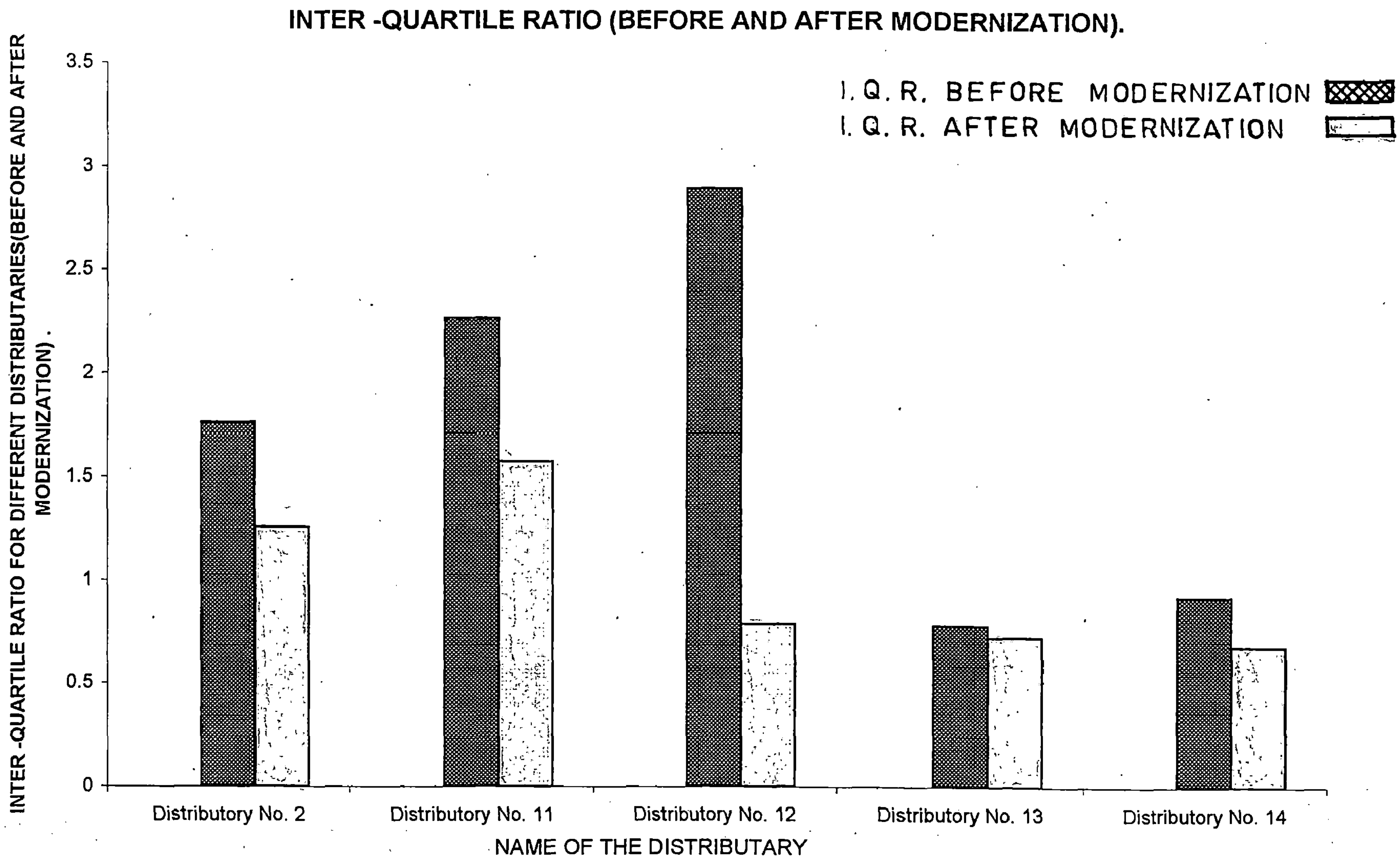

WATER DELIVERY PERFORMANCE IN TERMS OF RELATIVE PRODUCTION POTENTIAL
(AFTER MODERNIZATION) FOR TIMELINESS.
R.P.P. IN HEAD
R.P.P. IN MIDDLE
R.P.P. IN TAIL
WATER DELIVERY PERFORMANCE IN TERMS OF R. P. P. (JUNE TO NOVEMBER) IN HEAD /MIDDLE /TAIL REACHES
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Distributory No. 2
Distributory No. 11
Distributory No. 12
Distributory No. 13
Distributory No. 14
NAME OF THE DISTRIBUTARY

Figure : 4.16



INTER -QUARTILE RATIO (BEFORE AND AFTER MODERNIZATION).
I. Q. R. BEFORE MODERNIZATION
I. Q. R. AFTER MODERNIZATION
INTER -QUARTILE RATIO FOR DIFFERENT DISTRIBUTARIES(BEFORE AND AFTER MODERNIZATION) .
3.5
3
2.5
2
1.5
1
0.5
0
Distributory No. 2
Distributory No. 11
Distributory No. 12
Distributory No. 13
Distributory No. 14
NAME OF THE DISTRIBUTARY

Figure : 4.17

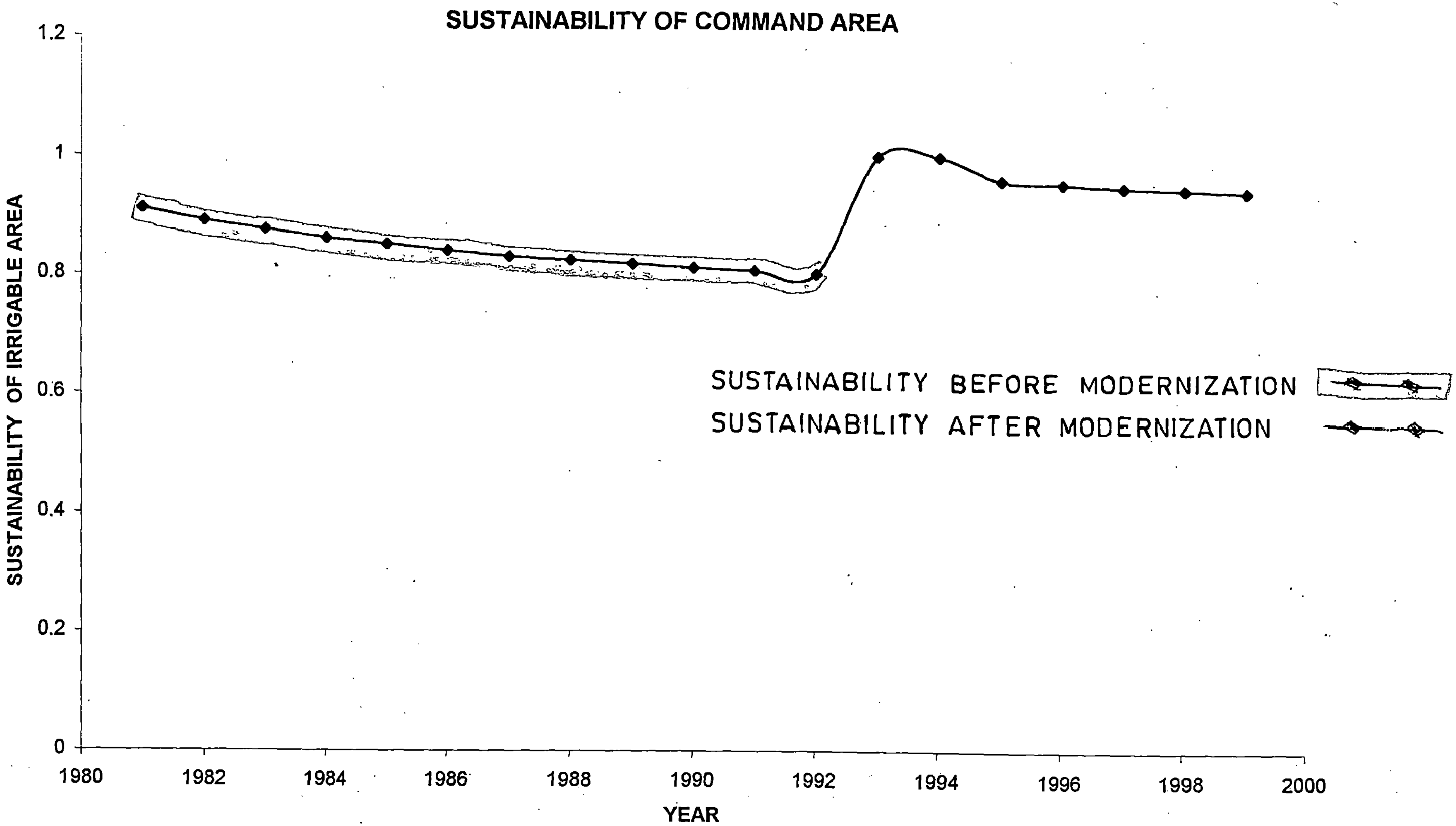

SUSTAINABILITY OF COMMAND AREA
SUSTAINABILITY OF IRRIGABLE AREA
1.2
1
0.8
0.6
0.4
0.2
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
YEAR
SUSTAINABILITY BEFORE MODERNIZATION
SUSTAINABILITY AFTER MODERNIZATION

Figure : 4.18

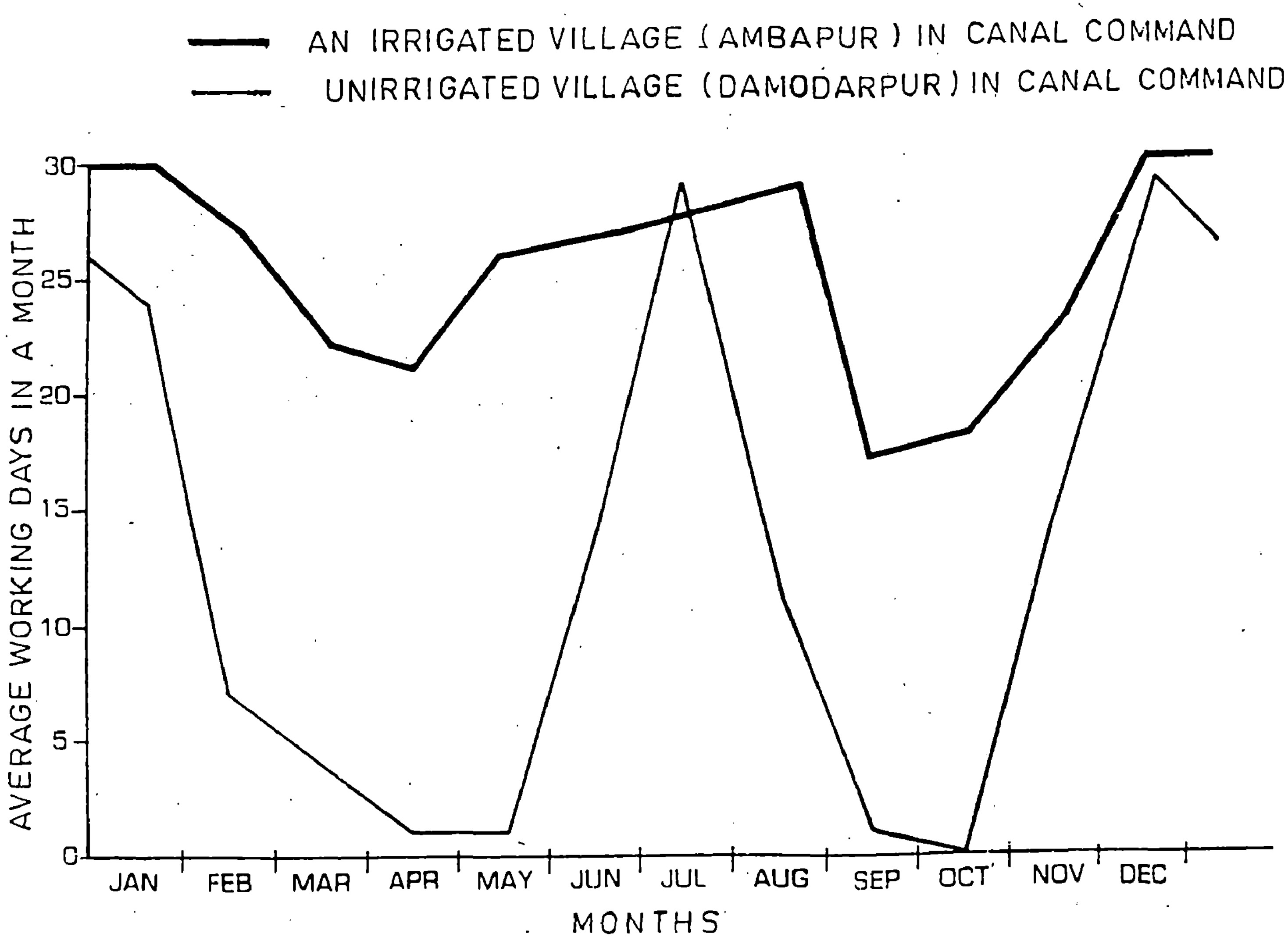
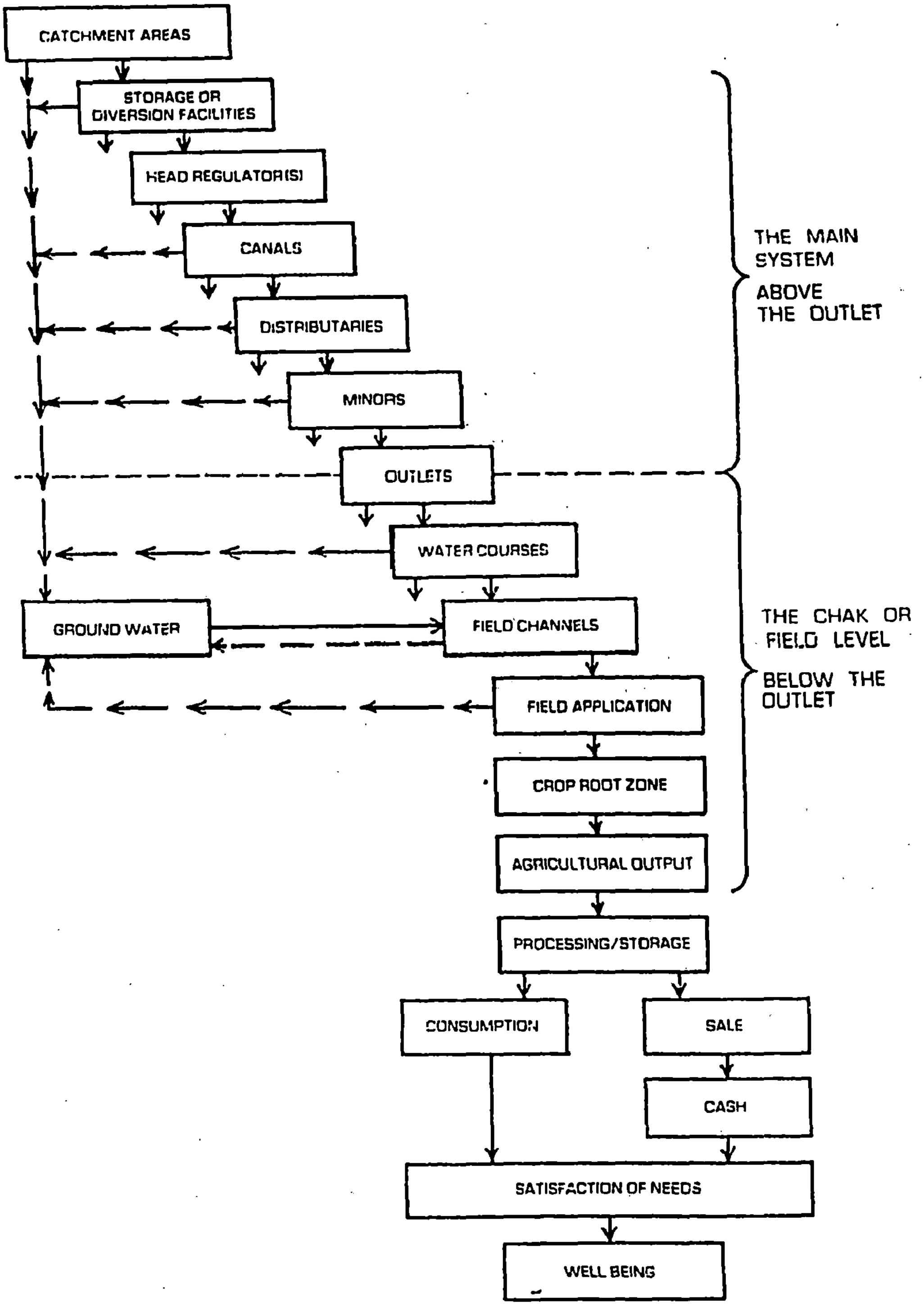


FIG. 4·19 - AVERAGE NUMBER OF DAYS OF EMPLOYMENT OF CASUAL LABOURERS AS AGRICULTURAL WORKERS



Notes: Adapted and extended from Keller and Peterson 1986. 25

→ → → = seepage

FIG.4-20 - CORE FLOWS IN CANAL IRRIGATION SYSTEM

C^{++} PROGRAM

```
//A C++ PROGRAM FOR PUMPING TEST ANALYSIS//
#include<iostream.h>
#include<conio.h>
#include<math.h>

        void main()
        { float T,Q,S;
         clrscr();
         char a,aquifer, name[20];
         float b,K,r2,r1,s1,s2,t,n,W,u,r,h1,h2,h0;
         const float pi=3.1416;
         cout<<"Enter your name:\t";
         cin>>name;
         cout<<name<<".This program tries to illustrate the analysis of Pump Test Data.\n";
         cout<<"Would you like to continue with analysis.\n"<<"Enter 'y' for yes and 'n'for no\n";
         cin>>a;
              if(a=='y'|| a=='Y')
              {
               cout<<name<<". Do you want to analyze CONFINED or UNCONFINED aquifer.Write 'c'\n";
               cout<<"or 'u' according to your choice.\t";
               cin>>aquifer;
               cout<<"Let me check your entry\n";
                      if(aquifer=='c'|| aquifer=='C')
                      {
                       cout<<endl<<endl<<endl<<"///TEST FOR CONFINED AQUIFER///"<<endl <<endl;
                cout<<"O.K"<<name<<".Let me introduce you with the terms being used in this analysis\n";
                cout<<"* S is STORAGE COEFFICIENT\n";
                cout<<"This analysis is based on THIEM EQUATION .Here we find out certain\n";
                cout<< "Parameters of the aquifer so that we would become able to find out.\n";
                cout<<"TRANSMISSIVITY,RECHARGE CAPACITY,STORAGE CAPACITY of the aquifer.\n";
                cout<<"We will use the equation\n"<<"\t"<<"T=(Q*log(r2/r1))/(2*pi*(s1-s2))\n";
                cout<<"This equation enables calculation of T from the pumping rate Q and the\n"<<"Equilibrium drawdowns s1 and s2
measured ir two observation wells at\n";
                cout<<"distances r1 and r2 from the pumped well respectively.\n";
                cout<<"STORAGE COEFFICIENT 'S'can be determined in a relatively simple manner\n";
                cout<<"with the Transient Flow Equation i.e.\n"<<"S=(Q*W(u))/(4*pi*T)\n"<<"where W(u) is Well Function and can be d
etermined for the particular values \n";
               cout<<"of u at fixed value of r (the distance of the observation from the pumping\n";
               cout<<"site.However, here you have to provide with few parameters ...such as \n";
               cout<<"r2,r1, s1,s2 and W from the data acquired. "<<endl;
               cout<<"\n";
               cout<<"Enter the values of r1 and r2 respectively (in meters):\t";
               cin>>r1>>r2;
               cout<<endl;
               cout<<"Enter the values for Hydraulic Conductivity K(const.) and width of aquifer b\n"<<"(in meters) respectively:\
t";

               cin>>K>>b;
               cout<<endl;
               Q=(2*pi*K*b*(s1-s2))/(log(r2)-log(r1));
               T=(Q*log(r2/r1))/(2*pi*(s1-s2));
               cout<<"Enter the value for exponetial integral 'u' and time elapsed after \n";
               cout<<"the start of pumping 't'(in minutes):\t";
               cin>>u>>t;
               cout<<"Enter the distance 'r'(in meters) from the pumping site :\t";
               cin>>r;
               cout<< endl<<endl;
               S=(4*T*u)/((r*r)/t);
               cout<<"######### RESULTS#########"<<endl<<endl;
               cout<<"The Transmissivity of the confined aquifer is :\t"<<T<<"square meter per day "<<endl;
               cout<<"The Storativity of the aquifer is :\t"<<S<<endl;
               cout<<"##########################################";
             }
             else if(aquifer=='u'|| aquifer=='U')
             {
```

```
cout<<endl<<endl<<endl<<"/////////ANALYSIS OF DATA FROM UNCONFINED AQUIFER ////////"<<endl<<endl;
cout<<name<<", Let me introduce you with the terms being used in this analysis \n";
cout<<"*T is TRANSMISSIVITY\n"<<"*K is HYDRAULIC CONDUCTIVITY \n"<<"* S is STORAGE COEFFICIENT\n";
cout<<"This analysis is based on THIEM EQUATION. Here we find out certain \n";
cout<<"parameters of the aquifer so that we would become able to find out \n";
cout<<"TRANSMISSIVITY,RECHARGE CAPACITY,STORAGE CAPACITY of the aquifer.\n";
cout<<"We will use the equation \n"<<"\t"<<"T=(Q*(log(r2)-log (r1)))/(2*pi*((s1-((s1*s1)/(2*h0)))-(s2-((s2*s2)/(2*h
0))));"<<endl;

cout<<"This equation enables calculation of T from the pumping rate Q and the \n";
cout<<"equilibrium drawdowns s1 and s2 measured in two observation wells at\n";
cout<<"distances r1 and r2 from the pumped well respectively\n";
cout<<"STORAGE COEFFICIENT 'S' can be determined in a relatively simple manner\n";
cout<<"with the Transient Flow Equation i.e.\n\t"<<"S=(4*T*u)/(rpow2/t)\n";
cout<<"However, here you have to provide with few parameters ... such as \n";
cout<<"Q,r2,n,s1,s2,t and u from the data acquired.";
cout<<endl<<endl;
cout<<"Enter the values of r2 and r1(in meters):\t";
cin>>r2>>r1;
cout<<endl<<endl;
cout<<"Enter the value of Hydraulic Conductivity K(constant):\t";
cin>>K;
cout<<endl<<endl;
cout<<"Enter the values of drawdowns s1 and s2 (in meters):\t";
cin>>s1>>s2;
cout<<endl<<endl;
cout<<"Enter the values of h1 and h2 and initial water column h0 (in m):\t";
cin>>h1>>h2>>h0;
cout<<endl<<endl;
cout<<"Enter the value of distance(in meters) from the pumping well 'r'\t";
cin>>r;
cout<<endl<<endl;
cout<<"Enter the value of time elapsed during pumping t(in minutes)\t";
cin>>t;
cout<<endl<<endl;
cout<<"Enter the value for exponential integral 'u'\t";
cin>>u;
cout<<endl;
Q=(pi*K*((h2*h2)-(h1*h1)))/(log(r2)-log(r1));
T=(Q*(log(r2)-log(r1)))/(2*pi*((s1-((s1*s1)/(2*h0)))-(s2-((s2*s2)/(2*h0)))));
S=(4*T*u*t)/(r*r);
cout<<"###################*************#########"<<endl<<endl;
cout<<"The Well Discharge is "<<Q<<"cubic meter per day."<<endl<<endl;
cout<<"The Transmissivity of the confined aquifer is :\t"<<T<<"square meter per day "<<endl<<endl;
cout<<"The Storativity of the aquifer is :\t"<<S<<endl;
cout<<"################################"<<endl;
}
else
{
  cout<<name<<".You have entered wrong choice"<<endl;

}
}
}
```

Enter your name: ABINASH
ABINASH, This program tries to illustrate the analysis of Pump Test Data.
Would you like to continue with analysis.
Enter 'y' for yes and 'n' for no Y
ABINASH, Do you want to analyze CONFINED or UNCONFINED aquifer. Write 'c' or 'u' according to your choice. C
// TEST FOR CONFINED AQUIFER /////////////////
O.K.ABINASH, Let me introduce you with the terms being used in this analysis.
* T is TRANSMISSIVITY
* K is HYDRAULIC CONDUCTIVITY
* S is STORAGE COEFFICIENT
This analysis is based on THIEM EQUATION. Here we find out certain parameters of the aquifer so that we would become able to find out TRASNMISSIVITY, RECHARGE CAPACITY, STORAGE CAPACITY of the aquifer.
We will use the equation

T= (Q*log(r2/r1))/(2*pi*(s1-s2))

This equation enables calculation of T from the pumping rate Q and the equilibrium drawdowns s1 and s2 measured in two observation wells at distances r1 and r2 from the pumped well respectively.
STORAGE COEFFICIENT 'S' can be determined in a relatively simple manner with the Transient Flow Equation i.e.

S=(Q*W(u))/(4*pi*T)

Where W(u) is Well Function and can be determined for the particular values of u at fixed value of r (the distance of the observation from the pumping site. However, here you have to provide with few parameters ... such as r2, r1, s1, s2 and W from the data acquired.
Enter the values of r1 and r2 respectively (in meters): 100 200
Enter the values for Hydraulic Conductivity K(const.) and width of aquifer b (in meters) respectively : 75 30
Enter the value for exponential integral 'u' and time elapsed after the start of pumping 't' (in minutes): 0.000242 15
Enter the distance 'r' (in meters) from the pumping site: 100
############# RESULTS ########################
The Transmissivity of the confined aquifer is : 2250 square meter per day.
The Storativity of the aquifer is : 0.003267
###

SUCCESS WITH IRRIGATION ACTION RESEARCH

APPENDIX –V

HOW TO SUCCEED WITH IRRIGATION ACTION RESEARCH

Rural development's all the rage
And irrigation's reached the stage
When finds will flow if you can say
Actin research is on the way.
The title's new, the techniques old,
The pickings rich for all the bold.

Success eludes none but those fools
Who do not heed some simple rules.
Reconnaissance you do not need.
Prepare your programme with all speed.
For what to test no need to care
Choose any dogma that your hear.

Field leveling and OFD,
8 hectare chaks, warabandi.
Lining the channels or rotation,
Conjunctive use, participation-
Pick any action that you will
If fashionable, it fits the bill.

To choose the site, criteria
Are simple, obvious and clear.
The most important one by far's
A tarmac road for motor cars.
As well, it must be close to town
For rapid transit up and down.

Make sure the water flow is steady.
Have your staff there always ready.
If water's short at system level,
Get it first, and let the devil
Take the hindmost at the tail.
For science, your interest must prevail.

Make sure the biggest farmers gain-
Their PR's needed to explain
To VIPs on their brief stops
The splendid impact on their crops.
(Small farmers should not be a worry
No one will meet them in a hurry.)

Recruit the bankers to your team
And organize a credit stream.
Good fertilizer, HYVs
And pesticides are sure to please.
And if you want to get first prize
Why then it's best to subsidize.

So when it comes to harvest day
You'll be all right –thanks NPK!
Crop-cutters, here's the patch of field
Where you will get the highest yield.
And none will say you are a liar
If you make it even higher.

If any area does badly
Cut it out, reject it gladly.
Say special factors made it fail-
A water shortage, pests or hail.
The only truth there is to tell
Is found in places which do well.

So all is fine. You have succeeded.
The will to win was what was needed.
The yields were treble, water half
-You at the back, what makes you laugh?-
The farmers, they are satisfied
It shows how very hard you tried.

Thus is achieved the vital task.
In praise and glory humbly bask.
Honoured for service and devotion
-Who knows?-You may now get promotion.
If others fail to replicate
For lack of water, that's their fate.

The Reply
Ah, academic casting doubt,
Your do not know what you're about.
You safely criticize the few
Courageous ones who risk and do.

The armchair critic's petty mind.
Can always flaws and errors find.
However much abuse is hurled
Action researchers change the world.