INDIA

MINISTRY OF WATER RESOURCES
GOVERNMENT OF INDIA

DEPARTMENT OF AREA DEVELOPMENT
STATE GOVERNMENT OF UTTAR PRADESH

FEASIBILITY STUDY ON IRRIGATION AND DRAINAGE DEVELOPMENT OF SHARDA CANAL CAD PROJECT

VOLUME I

MAIN REPORT

NOVEMBER 1991

Japan International Cooperation Agency

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PREFACE

In response to a request from the Government of India, the Government of Japan decided to conduct a feasibility study on the Irrigation and Drainage Development of Sharda Canal CAD Project and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to India a study team headed by Dr. Yasuhiko KUNIHIRO, Nippon Koei Co., Ltd., two times between September 1990 and March 1991.

The team held discussions with the officials concerned of the Government of India and the State Government of Uttar Pradesh, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

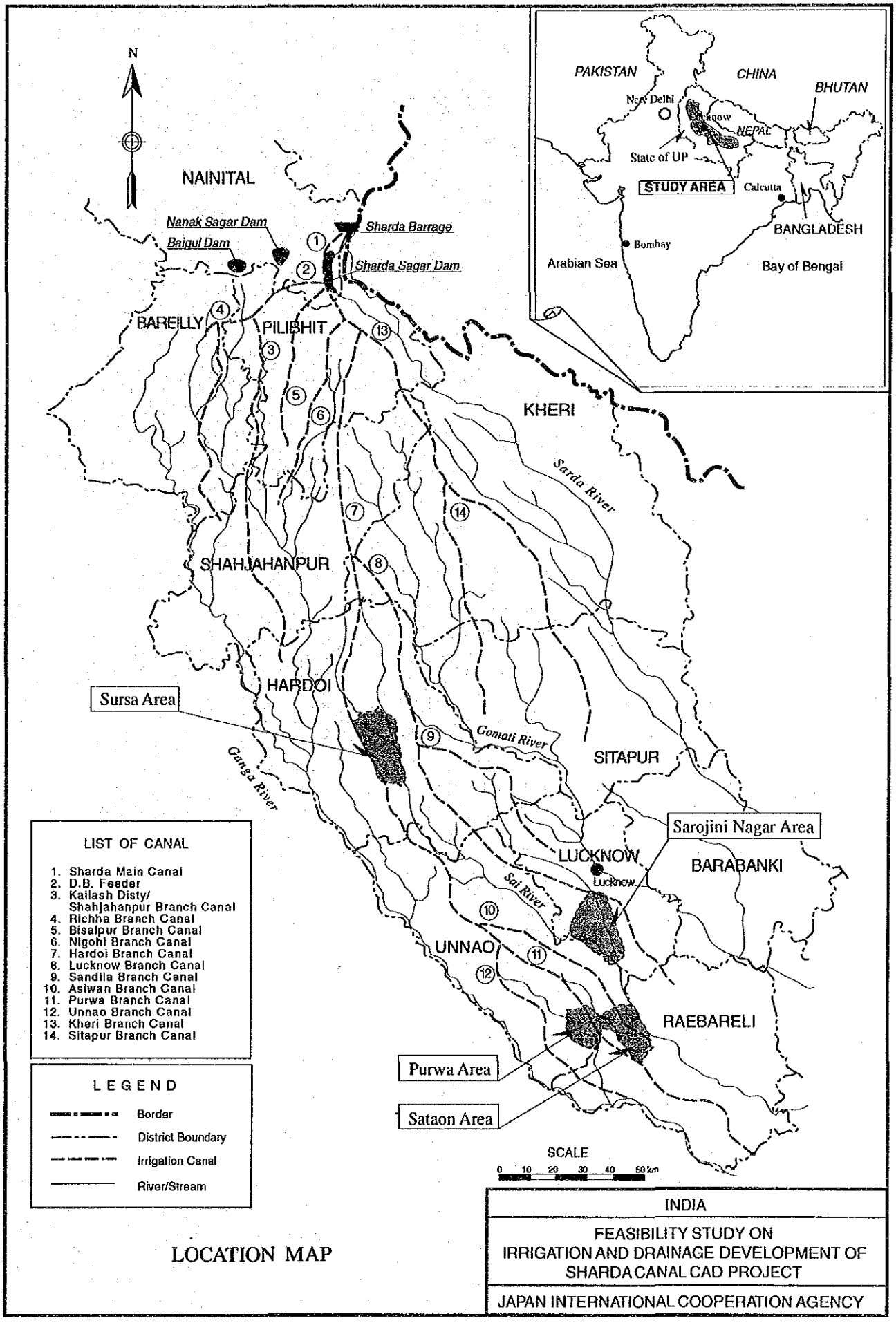
I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of India and the State Government of Uttar Pradesh for their close cooperation extended to the team.

November 1991

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency



LOCATION MAP

SUMMARY

I. HISTORY OF THE PROJECT

1. The Government of India has put the priority to the agricultural development, especially the expansion of irrigation since the First Five Year Plan in 1951. However irrigation utilization and productivity under irrigated agriculture was still low. With a view to improve these aspects, the Command Area Development Programme was launched in 1974-75 by the Government of India.

2. The Government of India requested the technical assistance to the Government of Japan to undertake the feasibility study in February 1988. In reply to the request, the Government of Japan decided to provide the assistance for the study for the Sharda Canal CAD Project through the Japan International Cooperation Agency (JICA).

3. JICA sent the preliminary study team and the Scope of Work (S/W) for performing the feasibility study on the project was agreed upon between JICA and the Ministry of Water Resources of Government of India and the Department of Area Development of Uttar Pradesh State Government on April 19, 1990.

4. JICA organized a study team according to the S/W and commenced the feasibility study from September 5, 1990. The first stage of the study was carried out between September 5,1990 to December 22, 1990 and the second between December 23,1990 and July 31,1991.

5. The Draft Final Report was submitted to the the Government of India in August 1991, and the report was discussed in the meeting of the Steering Committee held on September 4 and 5, 1991. According to the result of the meeting, the comments on the Draft Final Report were raised by the Government of India on October 31,1991. This report was finalized on the basis of the further study.

II. BACKGROUND OF THE PROJECT

6. Current Situation of the National Economy

India is the seventh largest country in the area with a population over 800 million, being the second most populous. Agricultural sector accounts for about 70% employment .

The Gross Domestic Product (GDP) in 1988-89 was Rs.1,885 million, out of which the agricultural sector shares 38.4%. The annual GDP growth averaged 5.9% for the first four years of the Seventh Five Year Plan (1986-1989). The wholesales price index in the corresponding period rose by an average of 6.5%.

GNP in 1988 attained about US$265,600 million The long term debt went up rapidly from US$26,545 million in 1984 to US$51,168 million in 1988. The total debt service went up similarly from US$2,431 million to US$4,958 million during the same period, which correspond to 17.6% and 21.7% to the GNP in the respective year. The export value of goods and services could not,however, keep with up the pace of the above.

7. Socio-Economic Features of Uttar Pradesh State

The total population of the UP State is estimated to be 138.5 million in 1991 on the basis of 25% growth rate during 1971-81 and population of 110.86 million in 1981. Population density in 1981 stood at 377 per square kilometer, compared to 216 for all India average. The farmers constitute about 58.5% of the total work force, and landless agricultural laborers corresponding to 16%, thus about 74% of the State population is directly dependent on the agricultural economy in 1981. The percentage of population below poverty line was 45.3% in 1983-84 in the UP State as against 37.4% in the country.

Agriculture with an allied sector constitute about 46% of the State Domestic Product at 1980-81 price as against 34% of the country. The main crop of the UP State is paddy rice with annual production of 9,420 thousand ton in Kharif and wheat of 19,610 thousand ton in Rabi in 1988-89.

8. Command Area Development Programme

Despite undertaking irrigation development measures since 1951, there was much gap between irrigation potential created and utilization thereof, and agricultural production under irrigated land was lower than anticipated. With a view to improving the situation, the Centrally Sponsored Command Area Development (CAD) Programme was launched in 1974-75.

To execute the CAD programme, 38 CAD Authorities have been established for 60 irrigation projects in 13 states with CCA of about 15 million ha in the initial stage.

Presently 54 CADA are operating for 131 CAD projects in 22 states with CCA of about 18.5 million ha.

Since 1974 the CAD programme has been executed and considerable financial assistance has been rendered. A number of the evaluation studies on the impact of the CAD works has been carried out. On the basis of the studies, it was recognized that the key element in executing the CAD Programme is the removal of the uncertainty in irrigation water supply attributable to

- lack of unified control of water management from the head to outlets
- lack of control structures, measuring devices and distribution canal system
- lack of proper operation and maintenance of the water distribution system
- lack of farmers' participation in irrigation management

III. PRESENT CONDITIONS OF SHARDA CANAL COMMAND AREA

9. Physical Environment

(1) Location and Topography

The UP State is located in the north-eastern part of India along the border of Nepal and China with the geographical extent of 300 thousand km^2. The capital of the Sate is Lucknow, lying 500 km east of New Delhi. The study area extends in the vast plain with altitudes of 100 m to 200 m sandwiched by the Ganges and the Sharda rivers. The study area is gently sloping from the northwest to southeast.

(2) Climate

The UP State lies under a semi-arid climate zone of a semi-tropical area, characterized by four distinctive seasons, i.e., dry winter season(January to February), dry but hot season(March to May), monsoon season (June to September) and post monsoon season(October to December). January is the coldest month, with the minimum temperature below 10 degree centigrade. May is the hottest month having the maximum temperature over 40 degree centigrade. The annual rainfall varies considerably between 800 mm to 1,500 mm. This is a serious physical constraint on the agricultural production.

(3) Geology and Geo-hydrology

Sharda Canal Command Area consists of broad alluvial plains. The flat land is composed of unconsolidated thick layers, and forms a large groundwater basin holding abundant groundwater reserves. The aquifers have 1-5 layers with thickness of 10-50 m lying below 30 m from the ground surface.

(4) Soil

Soils in the Sharda Canal Command area are formed by alluvial deposits by the Sharda river, the Ganga river and their tributaries. Coarse soils occur in the upstream area and fine soils exist in the lower part of the command

10. Socio-Economical and Administrative Setting

The Sharda Canal Command Area is constituted by partial or full inclusion of areas from 11 districts of Nainital, Bareilly, Pilibhit, Shahjahanpur, Kheri, Sitapur, Barabanki, Hardoi, Lucknow, Unnao and, Rae-Bareli. An average land holding size is different in district by district.Nainital has the largest average holding size of 1.83 ha, while Rae Bareli has the smallest with 0.76 ha as the data in 1985-86.

In spite of the continuous decline of its share in the State Product, agriculture sector still shares of 42% to the total State Product in 1987. The number of the workers in agriculture sector accounts for 79 % of the total workers or 23.45 million as of 1981.

11. Present Agricultural Setting

(1) Land Use and Crop Production

The net cultivated areas in the related districts of Sharda Canal Command and Hardoi Branch command are 2,392 thousand ha and 1,023 thousand ha, respectively, or about 70% of the total land. Out of the net cultivated areas, about 50% are irrigated. Major crops in Kharif are paddy, followed by maize and jowar, while wheat and barely are dominantly cultivated in Rabi. Crop yields are generally low with the average of 2.05 ton/ha of paddy and 1.9 ton/ha of wheat. Most serious problem on crop production is insufficient irrigation water in particular in transplanting period for paddy. Water logging and alkalinity problems is another constraints to get better yield.

(2) Agricultural and Extension Services

On-farm level extension activity is shouldered to village development officers and assistant development officers in each block development office. Extension workers encounter constraints such as insufficient number of staff, lack of mobility to reach farmers systematically, etc.

(3) Credit and Insurance Services

There are three types of credit through national, district and cooperative banks to farmers:

Short term loan	:	for field improvement and agricultural inputs
Mid-term loan	:	for animal husbandry, agricultural equipment, small irrigation works, etc.
Long-term loan	:	for small irrigation, well boring, pump sets, tubewell, agricultural machinery

12. Command Area Development Works

Under the U.P. Area Development Act,1976, Sharda Sahayak CAD Authority has been set up. After finishing the CAD works of the Sharda Sahayak Project, Sharda Canal CAD Project for 1.612 million ha was commenced in 1989. The Sharda Canal CAD works are scheduled to be completed by 1995-96 so far as the on-farm works (OFD) for about 550 thousand ha are concerned. The present Sharda Canal CAD works are concentrated on OFD. Osrabandi is ,however, not introduced yet in the completed areas of OFD, and extension services are limitedly provided.

13. Irrigation Works

(1) Sharda Canal System

The Sharda main canal takes off from the Sharda river through an intake at Banbassa in the district Nainital near the border of Nepal, with the present head capacity of 11,500 cusec or 325.5 cumec for culturable command area (CCA) of 1.612 million ha. The irrigation potential is 804 thousand ha, and annual irrigation area averaged to 631 thousand ha or 39% crop intensity to CCA for the recent five years.

(2) Hardoi Branch System

The Sharda main canal bifurcates into Hardoi Branch and Kheri Branch at the tailend. The Sharda Sagar reservoir locating downstream of the main canal augments discharges of Hardoi Branch especially in Rabi season. The Hardoi Branch serves a CCA of 757,772 ha by the head capacity of 5,400 cusec or 152.8 cumec with the canal length of 250 km. The annual irrigation area was 292,000 ha or 39% crop intensity to CCA on an average for the recent five years.

(3) Water Supply

Irrigation deliveries are practiced according to rostering on the basis of 27 and 25 weeks in respective Kharif and Rabi seasons. Actual seasonal deliveries at the respective sections of Hardoi Branch are generally agreed with the schedule in the roster, whereas, the timing of supply much differs in the downstream reaches and offtaking branches in which the ON/OFF operation is made. Reliability of water supply is low, which is attributed to the lack of the overall systematic water management.

(4) Irrigation Efficiency

The present irrigation efficiency of the Sharda Canal system is estimated as follows:

Canal System	Rabi	Kharif
Main canal	0.92	0.95
Hardoi Branch	0.74	0.70
Distributary/Minor	0.80	0.80
Field channel	0.78	0.78
Application efficiency	0.55	0.65
Overall efficiency	0.23	0.27

14. Drainage Works

The geographical gradient is gentle, which results in a poor drainage condition. It allows rainfall and irrigation excess stagnate at the tail, then such condition results high groundwater table occurring water logging and salt affected areas. The water logging and salt affected areas are located mostly in the downstream part of the command. Drainage works are not sufficiently provided.

15 . Groundwater Use

The groundwater is highly utilized in the command area. About 80% of the annual draft is made by the private shallow tubewells. The annual net draft in the related Districts to Sharda Canal command is estimated to be 3,100 MCM in 1989. The net recharge of groundwater in the same area is estimated to be 11,900 MCM. Development potential of the same area will be 2,860 MCM on condition of development stage of 50%.

16. Transportation

The national highway No.23 connect Lucknow with Delhi with about 500 km in length. The railway is available from Lucknow to Delhi and/or Calcutta. The domestic airway connects directly with Delhi and other major cities .

IV. SELECTION OF THE REPRESENTATIVE CAD AREAS

17. Selection Criteria

The representative CAD areas, to which the agricultural development plan will be formulated, are selected from the Hardoi Branch command in accordance with S/W.

(1) Categorization of Blocks by Natural and Socio-economic Conditions

Parameters used in evaluation of the natural conditions are irrigation, poor drainage and salt affected conditions.

Parameters for the socio-economic conditions are farm economy, agricultural support services and social infrastructure development conditions.

(2) Priority Ranking by Scoring of Parameters

(3) Screening for the CAD Progress and Adverse Environmental Impact upon Project Implementation

18. Selected Areas

The selected areas are as follows including the discussion result of Steering Committee dated on December 29,1990:

(1) Representative Area for Improvement of Irrigation Condition

(i) Area-1

District	:	Lucknow
Block	:	Sarojini Nagar
Canal system	:	Amausi distirbutary of Lucknow Branch system

(ii) Area-2

District	:	Rae Bareli
Block	:	Sataon
Canal system	:	Maurawan distributary of Asiwan Branch system

(2) Representative Area for Improvement of Poor Drainage Condition

District	:	Hardoi
Block	:	Sursa
Canal system	:	Badaicha distributary of Hardoi Branch system

(3) Representative Area for Improvement of Salt Affected Area

District	:	Unnao
Block	:	Purwa
Canal system	:	Purwa distributary of Purwa Branch system

V PRESENT CONDITIONS OF THE REPRESENTATIVE CAD AREAS

19. Natural Conditions

(1) Location and Topography

The Sarojini Nagar area is located just in the south of Lucknow city which is the capital of Uttar Pradesh State. The Amausi Distributary is the principal irrigation system which

is served from Lucknow Branch. The geographical extent of the area is 33,488 ha and CCA is 14,862 ha.

The Sataon area is located in the down-most reach of Asiwan Branch and Maurawan Distributary in District of Rae Bareli. The geographical extent of the area is 25,763 ha and CCA is 12,874 ha.

The Sursa area is located in the southeast of Hardoi city in Hardoi district. The Badaicha Distributary taking off from Hardoi Branch is the main irrigation system of the area. The geographical extent of the area is 32,269 ha and CCA is 17,131 ha.

The Purwa area is located south of Purwa town in Unnao District. Purwa distributary and Tikar Distributary which are diverted from Purwa Branch are the main irrigation system of the area. The geographical extent of the area is 20,828 ha and CCA is 12,252 ha.

(2) Climate

The general climatic characteristics of the Representative Areas is similar to the Hardoi command. The coldest month is January when minimum temperature goes down to 8 degree centigrade. The hottest month is May when the maximum temperature goes up to 40 degree centigrade. The annual rainfall varies widely from 300 mm to 1,400 mm. About 75% of the annual rainfall occurs in July to September and 90% of that comes during four months from June to September.

(3) Soils

Soils in the Representative Areas are classified into five categories; a) upland, b) mid-upland, c) midland, d) mid-lowland, and e) lowland. About 70% of the geographical area belong to mid-upland and midland which have high crop productivity, except the Sataon area.

(4) Geo-hydrology

The strata of the Representative Areas generally consist of alternating layers of clay and sand materials. The groundwater lies in sandy layers at about 20 to 30 m below the ground surface. Groundwater tables in Sataon and Sarojini Nagar tend to lower, while those in Sursa and Purwa are not significantly lowering.

20. Socio-economic Conditions

Each of Representative Areas consists of several administrative blocks to which many panchayats and villages belong. The total geographical area of the related blocks is 112,348 ha which includes 57,301 ha of CCA. Total population is about 750,000 with the population density of 680 per km^2. The rate of labor engaging in agriculture sector to total laborers in Sarojini Nagar is about 75%, while other blocks are higher with the rates of 85% to 96%.

21. Agriculture

About 60% of the total land is cultivated, of which 60 to 80% are irrigated. Rate of irrigated land is low in Sataon and Sarojini Nagar area. Comparing to all of Hardoi Branch command, the rate of current fallow land is higher in the Representative Areas.

Main crops in the Representative Areas are paddy in Kharif and wheat in Rabi. Cultivated crops are well diversified in Sursa area, while paddy and wheat are dominant in Purwa. Sorghum is second important Kharif cropping in Sarojini Nagar, Sataon and Purwa areas, while maize is rather important in Sursa area.

Post harvest facilities such as warehouse, godown, mill, etc. have been established by the central and state warehouse corporation.

Smaller farmers tend to keep their harvested grains for domestic consumption. 70% of paddy and 80% of wheat produced by marginal farmers are consumed by themselves. Smaller scale farmers are likely not to be able to live only on agriculture.

There are no farmers' organization in the Representative Areas except cooperatives related to credit input supply and marketing. Agricultural extension is not so active.

22. Irrigation and Drainage

The actual irrigation intensities of the Representative Areas are as summarized below. The irrigation intensities in Sataon and Sarojini Nagar is extremely low compared with other areas.

Area	CCA	Irrigation Area			
		Kharif		Rabi	
		(ha)	(% to CCA)	(ha)	(% to CCA)
Sarojini Nagar	14,862	1,342	9.0	1,821	12.3
Sataon	12,874	259	2.0	404	3.1
Sursa	17,313	2,595	15.0	4,827	27.9
Purwa	12,252	2,908	23.7	3,103	25.3
Total	54,301	7,104	12.4	10,155	17.7

The water deliveries for the respective Representative Areas are summarized below with comparison to the scheduled deliveries in the roster.

Area	Canal System	89/90 Rabi			Kharif		
		Schedule (MCM)	Actual (MCM)	(%)	Schedule (MCM)	Actual (MCM)	(%)
Sarojini Nagar	Amausi Dy.	12.3	16.4	133	18.5	15.8	85
Sataon	Maurawan Dy.	45.2	26.6	59	65.7	37.5	57
Sursa	Badaicha Dy.	7.5	24.4	324	16.6	28.0	169
Purwa	Purwa Dy.	7.8	5.3	68	10.7	8.3	77

The drainage conditions of the Representative Areas are as summarized below.

(Unit: ha)

	Study Area	Inundation Area	Water Logging	Salt Affected	Usar
Sarojini Nagar	33,482	11,599	2,268	5,214	992
Sataon	25,763	16,113	915	1,423	640
Sursa	32,269	2,069	1,991	2,317	817
Purwa	20,828	15,990	1,256	3,080	669

VI. STRATEGY AND OBJECTIVES OF AGRICULTURAL DEVELOPMENT FOR THE REPRESENTATIVE CAD AREAS

23. Development Strategies and Objectives

To improve the socio-economic conditions, the draft Eighth Five Year Plan of Uttar Pradesh State sets the following purposes relating to the agricultural development:

(1) to increase income of rural poor

(2) to improve the quality of rural life

(3) to maximize productivity in agriculture along with diversification and mixed farming in small and marginal holdings and in areas of low productivity.

(4) to consolidate gains from and to improve efficiency and productivity of past investment and of the existing assets

The principal strategies for achieving the above development objectives emphasize the following activities:

(1) Removal of causes for unreliable irrigation water supply and improvement of irrigation efficiency
(2) Even distribution of irrigation water
(3) Improvement of poor drainage and salinity/alkalinity
(4) Improvement of farm technology

24. Basic Measures for Each Representative CAD Areas

The following basic measures will be taken in order to realize the above strategies:

(1) Modernization of existing irrigation facilities
(2) Establishment of drainage system
(3) On-farm development
(4) Groundwater development
(5) Establishment of water management system at on-farm level with farmers
(6) Agricultural training including program for women
(7) Enforcement of the organization of CAD Authority

VII. THE PROJECT

25. Irrigation Plan

The proposed irrigation works are summarized as follows:

(1) Improvement of Existing Irrigation System

Description	Sarojini Nagar	Sataon	Sursa	Purwa
- Setting of existing canal section (km)				
Distributary	55.0	91.8	34.8	35.3
Minor	54.7	19.1	64.9	46.1
- Canal lining (km)				
Distributary	16.4	38.6	19.5	17.8
Minor	16.3	51.6	36.4	20.3
- Additional parallel Mr.				
(nos.)	11	27	10	12
(km)	41.6	104.0	45.0	53.0
- Improvement of existing control structure (nos.)				
Replacement				
Head regulator	1	37	2	4
Offtaking structure	29	40	16	18
Outlet	365	768	386	291
Provision				
Measuring device	32		26	26
Steel slide gate	1	27	2	4
- Improvement of canal inspection road (km)				
Inspection road for Dy.	55.0	91.8	34.8	35.3
Inspection road for Mr.	54.7	19.1	64.9	46.1

(2) Sai River Pump Lift Irrigation Scheme

Pump Lift Irrigation Plan

Description		Sarojini Nagar	Sataon
Pump command area			
- CCA	:	2,167 ha	2,822 ha
- Proposed irrigation area			
Kharif	:	520 ha	677 ha
Rabi	:	542 ha	706 ha
Pump equipment			
- type	:	- Vertical shaft mixed flow --	
- nos.	:	2 nos.	2 nos.
- discharge	:	25 m^3/min/no.	34 m^3/min/no.
- motor output	:	68 kw/no.	102 kw/no.
- total head	:	11 m	14.5 m

(3) Groundwater Development

	Sursa	Purwa
Tubewell		
Type :	Shallow tubewell with screen	Shallow tubewell with cavity type
Number :	900 nos.	280 nos.
Location :	Salinity/alkalinity affected area	Salinity/alkalinity affected area

(4) Establishment of Wireless Communication System

Central control station		
HF radiotelephone	:	1 no.
Data processing unit	:	1 no.
Controlling station		
HF radiotelephone	:	9 nos.
Data processing unit	:	3 nos.
Sub-station		
VHF radiotelephone	:	34 nos.

26. Drainage Plan

Principal features of drainage works are as follows:

Description	Sarojini Nagar	Sataon	Sursa	Purwa
Main and secondary drainage canals (km)				
Improvement	32.7	29.7	48.0	79.2
Construction	49.5	30.6	51.0	36.7
Total	82.2	60.3	99.0	115.9
Improvement of drainage structures				
Bridge (no.)	53	39	64	65
Pipe drainage scheme	-	-	1	-
Subsurface drainage pilot scheme	-	-	-	1

27. On-farm Development Plan

The on-farm development works are summarized below.

Description	Sarojini Nagar	Sataon	Sursa	Purwa
Field irrigation canal (km)				
lining	295	256	344	244
earth	161	139	187	133
Field drainage canal (km)	369	320	430	304
Related structures (nos)				
turnout	2,082	658	2,425	1,716
culvert	760	658	885	626
aqueduct	198	172	231	163
transition	496	429	577	409
drainage culvert	925	802	1,078	763
Chak road	456	395	532	376

28. Improvement Plan of Water Logging and Salt Affected Areas

To improve the water logging and salt affected areas to have better crop production, the following technical measures are proposed:

(a) to improve drainage conditions with vertical drainage
(b) to supply and ensure leaching water

(c) to apply improved crop,soil and water management practices

(d) to apply soil amendment

(e) to use organic material and green manuring

In this context, the improvement of drainage systems, development of groundwater and trial farms are proposed.

29. Agricultural Development Plan

The crop production plan in Kharif and Rabi is summarized below.

Crop Yield	Sarojini Nagar		Sataon		Sursa		Purwa		Total	
	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)
Kharif										
Paddy	8,073	26,645	6,993	23,080	8,989	29,377	6,656	21,965	30,710	101,067
Sorghum/Maize	1,695	3,389	1,468	2,935	2,632	5,263	1,862	3,725	7,655	15,311
Pulse	3,044	4,114	2,637	3,564	3,546	4,792	2,509	3,391	11,735	15,861
Oilseeds	2,051	1,989	1,777	1,723	1,732	1,724	1,225	1,220	6,784	6,656
Rabi										
Wheat	9,772	26,956	8,465	23,350	10,950	29,886	8,056	22,222	67,242	102,415
Pulses	2,229	3,121	1,931	2,704	2,597	3,635	1,837	2,573	8,595	12,033
Oilseeds	1,301	1,078	1,127	933	1,514	1,255	1,072	888	5,014	4,154
Potatoes	780	14,491	676	12,552	909	16,880	643	11,946	3,009	55,869
Permanent										
Sugarcane	-	-	-	-	415	12,450	-	-	415	12,450

30. Plan to Actualize Osrabandi

The farmers' association will first be organized under the guidance of the CADA on the chak basis in the early stage of the project work. The training of farmers on the water management will be made in the selected model chak.

VIII. PROJECT IMPLEMENTATION PLAN AND COST ESTIMATE

31. Implementation Schedule of the Project

The Project works will last for 6 years, including the survey, design and other preparatory works.

In the first year, the establishment of farmers associations is firstly conducted together with survey and design. In the second year, the drainage pilot farm and adaptive trial farms are established so as to early utilize and demonstrate the result of the investigation and trials in the command areas. The modernization and on-farm development works will be started in the second year immediately after selection of the contractors.

32. Organization of the Project Implementation

Implementation of the Projects will be managed basically in accordance with the present organization of the CADA.

Implementation of the Project will need the multi-disciplinary working team. The fundamental components of the Project have to be directly performed by the CADA. Some other components will be carried out by the concerned departments and the CADA will prepare the implementation programme and its budget for implementation, and coordinate and monitor the progress of the works in accordance with the present governmental practice rules. The following divisions will be required for performing the project works, with mobilization of the staffing from the concerned departments:

(1) Administration and Accounting Division

(2) Construction Division, consisting of:
   (a) Irrigation and Drainage Modernization Sub-division
   (b) Canal Maintenance Sub-division
   (c) Water Supply Sub-division

(3) Land and Water Management Division,consisting of :
   (a) Soil Survey Sub-divisions
   (b) On-farm Development Sub-division
   (c) Ground Water Sub-division
   (d) Maintenance Sub-division

(4) Agro-management Division,consisting of:
   (a) Crop Loan Sub-division
   (b) Farm Input Sub-divisions
   (c) Marketing and Storage Sub-division
   (d) Agro-Processing Sub-divisions

(5) Training, Action Research, Monitoring and Evaluation Division
   (a) Extension Sub-division
   (b) Adoptive Research and Trial Farm Sub-division
   (c) Monitoring and Evaluation Sub-division

33. Project Cost

Unit: Rs. million

		Sarojini Nagar	Sataon	Sursa	Purwa	Total
1	Direct Construction Cost	398.7	530.0	548.8	361.4	1,818.9
2	Procurement of Supporting Equipment	2.2	1.9	2.5	1.8	8.4
3	Land Acquisition	5.2	7.4	8.6	3.0	24.2
4	Administration Cost	38.6	33.4	44.9	31.7	148.6
5	Engineering Service	57.7	50.0	67.2	47.6	222.5
	Sub-total	482.9	622.7	672.0	445.5	2,222.6
6	Contingency	240.6	327.0	338.5	222.3	1,128.4
	Total	723.0	949.7	1,010.6	667.8	3,351.1

IX PROJECT EVALUATION

34. Economic Benefits

The project benefit is born as a result of irrigation and drainage development as well as agricultural extension works. Present cultivated area is expected to increase productivity while currently fallow land due to water logging or alkalinity problem recovers its fertility.

The annual incremental benefit at the full development stage is estimated as shown below:

	Area	Cropping Season	Project Area (ha)	With Project Condition: Cultivated Area (ha)	With Project Condition: Primary Profit (Rs.million)	Without Project Condition: Cultivated Area (ha)	Without Project Condition: Primary Profit (Rs.million)	Incremental Benefit (Rs.million)
1	Sarojini Nagar	Kharif	14,862	14,862	105.4	9,237	39.4	66.0
		Rabi		14,862	127.1	9,275	54.9	72.1
		Annual			232.4		94.3	138.2
2	Sataon	Kharif	12,874	12,874	89.5	7,274	25.5	64.0
		Rabi		12,874	107.9	9,006	56.1	51.8
		Annual			197.4		81.7	115.8
3	Sursa	Kharif	17,313	16,880	116.1	9,834	45.5	70.6
		Rabi		16,880	139.8	13,280	94.9	44.9
		Perennial		433	2.9	960	5.2	-2.3
		Annual			258.8		145.6	113.2
4	Purwa	Kharif	12,252	12,252	86.8	6,638	35.0	51.8
		Rabi		12,252	105.8	6,735	36.3	69.5
		Annual			192.6		71.3	121.3
	Total		57,301	57,301	881.3	32,983	392.8	488.5

35. Economic Cost

(1) Economic Capital Cost

The economic capital cost is estimated as shown below:

Unit: Rs.10^6

Description	Sarojini Nagar	Sataon	Sursa	Purwa	Total
1. Direct Construction Cost	320.3	444.2	463.1	307.4	1,535.1
2. Procurement of Supporting Equipment	1.5	1.3	1.7	1.2	5.8
3. Land Acquisition	4.2	5.9	5.7	2.4	19.4
4. Administration Cost	38.6	33.4	44.9	31.8	148.7
5. Engineering Services	57.7	50.0	67.2	47.5	222.4
Sub-total	422.3	534.8	583.8	390.4	1,931.3
6. Contingency	42.2	53.5	58.4	39.0	193.1
Total	464.5	588.3	642.2	429.4	2,124.4

(2) Annual Economic O&M Cost

The total annual economic operation and maintenance cost at the full development stage is summarized below:

Unit: Rs.1,000

Description	Sarojini Nagar	Sataon	Sursa	Purwa	Total
1. Main system					
a. Irrigation Facility					
- Canal	1,060	3,930	1,640	980	7,610
- Augmentation Facilities	670	760	3,930	1,150	6,510
b. Drainage Faculties	1,050	610	1,760	1,490	4,910
c. Service Roads	680	1,100	510	420	2,710
2. On-farm system	2,950	2,620	3,600	2,460	11,630
Total	6,410	9,020	11,440	6,500	33,370

(3) Annual Replacement Costs

Annual replacement cost in terms of economic value is estimated as shown below:

Description	Sarojini Nagar		Sataon		Sursa		Purwa	
	Useful life	Cost (Rs.10^3)	Useful life	Cost (Rs.10^3)	Useful life	Cost (Rs.10^3)	Useful life	Cost (Rs.10^3)
1. Irrigation system								
a. pumping equipment	20	10,348	20	13,230	10	28,936	10	7,984
b. Gate	10	16	10	200	10	16	10	24
2. Supporting equipment	10	1,744	10	1,512	10	2,032	10	1,440

36. Economic Evaluation

The economic internal rate of return for the project is calculated based on the economic cost and benefit and the project implementation schedule. The results are as shown below:

Sarojini Nagar	19.2%
Sataon	13.7%
Sursa	12.0%
Purwa	18.4%
Overall	15.5%

37. Sensitivity Analysis

A sensitivity analysis is as shown below:

Unit: %

Description	Sarojini Nagar	Sataon	Sursa	Purwa	Overall
1. Case (i)	17.7	12.5	10.8	16.9	14.1
2. Case (ii)	17.9	12.7	11.0	17.1	14.4
3. Case (iii)	16.4	11.5	9.9	15.7	13.1

38. Financial Evaluation

A financial analysis of the project is made by the analysis of the typical farm budgets and assessment for repayment of the project construction cost.

(1) Farm Budget Analysis

Typical farm budgets of marginal farmers are prepared for the future with and without conditions. The income of marginal farmers is expected to increase by 50% to 120%. Their economic situations are sure to be improved.

Unit: Rs.

Area	With Project			Without Project			Incremental
	Kharif	Rabi	Total	Kharif	Rabi	Total	Benefit
Sarojini Nagar (0.58ha)	3,195	3,099	6,294	2,082	2,065	4,147	2,147
Sataon (0.58ha)	3,118	3,001	6,119	910	1,868	2,778	3,341
Sursa (0.53ha)	2,839	2,679	5,518	1,627	2,028	3,655	1,863
Purwa (0.56ha)	3,119	2,818	5,937	2,090	1,785	3,875	2,062

(2) Capacity to Pay

Operation and maintenance cost of the irrigation and drainage systems as well as of on-farm facilities is shouldered to beneficial farmers. Incremental benefit of a farmer is estimated at Rs.3,500 to Rs.5,760 per ha. Water charges shown below are only 14% at maximum, which proves that farmers could pay water charge easily.

Annual Financial O&M Costs

Description	Sarojini Nagar		Sataon		Sursa		Purwa	
	Total ($Rs.10^3$)	Per ha (Rs.)	Total ($Rs.10^3$)	Per ha (Rs.)	Total ($Rs.10^3$)	Per ha (Rs.)	Total ($Rs.10^3$)	Per ha (Rs.)
1. Main System	4,000	276	7,600	590	8,700	502	4,600	375
2. On-farm facilities	3,600	242	3,200	249	4,400	254	3,000	245
Total	7,700	518	10,800	839	13,100	756	7,600	620

(3) Repayment

Fund requirement for construction of the project is estimated at Rs.3,351 million. Based on the estimated fund requirement, a cash flow statement is prepared under the following conditions:

(a) 80% of fund requirement is financed by the international organization with loan service fee of 2.5% per annum and a repayment period of 30 years including a grace period of 10 years.

(b) Remaining local currency is financed by the budget allocation of the Government with no interest and no repayment.

The project brings about a great improvement in farm budget and gives an incentive to the farmers in the project area. The government should subsidize loan repayment, loan service fee and a part of O&M cost for the project during the repayment of 30 years.

39. Socio-economic Impact

The following socio-economic impacts are expected through the implementation of the project.

- Improvement of nutritious status
- Generating of employment opportunity
- Women's development
- Enhancement of regional industries
- Improvement of environmental conditions

40. Project Justification

Internal rate of return (IRR) of the project in respective Representative Areas shows different value ranging from 12.0% for Sursa to 19.2% for Sarojini Nagar. The IRR of overall project shows 15.5%.

Sarojini Nagar Area:
The development plan shows the highest IRR of 19.2% among four Representative Areas. Augmentation of irrigation water supply will increase irrigation area and reduce further deterioration of groudwater level. It will also contribute to equitable distribution of water through on-farm development.

Sataon Area:
The development plan shows IRR of 13.7%. The same effect as Sarojini Nagar area will be expected with regards to even distribution of canal water and preventing the deterioration of ground water level.

Sursa Area:
The development plan shows the lowest IRR of 12.0%, reflecting relatively better yield level of crops under the present condition. Drainage improvement will increase Kharif cropping area drastically. Even distribution of water and improvement of nutritious status of farmers are expected from the project.

Purwa Area:
The development plan shows the IRR of 18.4%. Drainage improvement will bring about the increase of cropped area as well as yield increase through the improvement of soil condition. Traffic condition will also be improved, and occurrence of water born diseases will be reduced through the reduction of inundation area and duration.

The IRR of the overall project shows 15.5%. The results of financial analysis reveals the improvement of farm income with repayability of water charge. Considering this IRR and positive socio-economic impacts as mentioned above, in light of the objectives of the State Five-Year Plan, the project is viable.

X. COMPREHENSIVE DEVELOPMENT PLAN OF SHARDA CANAL CAD PROJECT

41. To ensure reliable and equitable delivery of water as well as to enable to introduce systematic water management, the present system deficiencies have to be rehabilitated properly through modernization of the Sharda Canal system.

    To secure the active participation of the farmers in water management through reliable water deliveries, on-farm systems have to be extended to the whole command and be modernized.

    To make water deliveries more reliable through ensuring conjunctive use of canal water and groundwater, as well as to alleviate the water logging and salt problems in the command, the development of groundwater has to be extended.

42. The comprehensive study covering the Sharda Canal command area has to be carried out to identify and formulate the medium and long term development plan on modernization of the canal system and renovation of on-farm works.

XI. MODIFIED PLAN ON THE BASIS OF COMMENTS BY THE GOVERNMENT OF INDIA

43. The modified plan was prepared according to the comments by the Government of India as the cost reduction approach. It will reduce the degree of reliable water supply and efficient use of the limited water sources, resulting in the decrease in agricultural production to be accrued from the modified plan.

44. The economic evaluation of the modified plan shows that the plan is economically feasible with an internal rate of return of 12.2% for the overall area. A financial evaluation is made by the analysis of the typical farm budgets, showing that their financial situations are surely improved. The socio-economic impacts are largely expected through implementation of the plan.

45. The modified plan obliges that the certainty in irrigation water supply which is the key element of CAD works is decrease to the large extent, although the plan is one of the approaches to solve difficulties in land acquisition and the social resistance from the traditional users. Upon implementation of the project with the modified plan, special

efforts to remove the uncertainty in water supply should be taken, such as provision of additional minors on the existing field channel routes, promotion of the actual participation of water users from the beginning of the design stage of the project.

XII. RECOMMENDATION

46. Early Project Implementation

The development plan as originally formulated is technically feasible and economically viable. The plan ensures more reliable irrigation water supply than the modified plan and it contributes to reducing the tailend problems and enhancing the synchronized development of groundwater and surface water in the command. It is recommended that the Government of India/Uttar Pradesh State Government shall make the necessary arrangements for early implementation of the Project so as to effectively demonstrate an impact of implementation of the integrated CAD programme as well as the effect of systematic water management.

47. Organization of Project Implementation

The development plan herein conceived includes various components ranging widely in civil works, agricultural research works, and extension works as the integrated command area development programme. It is suggested that the Sharda Canal CADA shall be strengthened with mobilization of the required staff from the concerned departments of UP State. The technical staff to be engaged in modernization of the irrigation and drainage systems and on-farm development works are mobilized from the Irrigation Department. To effectively operate the Project works, the CADA will also require administrative and technical assistance in executing research works from the CAD participating departments.

48. Early Organization of Farmers Associations and Continuous Guidance for Introducing Osrabandi

To secure active participation of farmers from the initial stage of the Project work, farmers associations in the outlet command shall first be organized with sufficient guidance of the CADA. To effectively introduce the osrabandi system, continuous guidance and training shall be rendered.

49. Environmental Conservation

The tailenders have been suffered from the scarce irrigation water and they have been tried to use groundwater for irrigation by the private tubewells. As a result the groundwater tables in such tailend areas are remarkably lowered and tend to increase in lowering to a large extent in the recent year. This condition is attributed to the lack of interacted management of groundwater development among the government agencies. To maintain the groundwater regime in the command area, the synchronized development of groundwater shall be promoted in well coordination between the departments and agencies concerned.

50. Water Charge

The collection rate of water charges of the Sharda Canal System is low, which is attributed mainly to low reliability of water supply. Farmers react by constructing private tubewells in their fields, and practice irrigation with conjunctive use of the canal water and groundwater from their own tubewells. With the Project, tube wells will be constructed to supplement canal water for conjunctive use. It is, therefore, proposed that the water charges in case of conjunctive use should be rationalized to raise the collection rates of water charges.

51. Comprehensive Development Planning

The diversity and complexity of the irrigation problems in the command area is prevailing. To improve the present conditions, the renovation of the CAD works for water saving and the introduction of osrabandi, and the modernization of the existing irrigation and drainage systems for enabling to introduce systematic water management of the Sharda canal system are required. It is proposed that the comprehensive development planning should be urgently carried out to formulate the medium and long term comprehensive plan on the water management of the Sharda Canal System, on the resources development, and on the renovation of the CAD works.

FEASIBILITY STUDY ON
IRRIGATION AND DRAINAGE DEVELOPMENT OF
SHARDA CANAL CAD PROJECT

MAIN REPORT

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ABBREVIATIONS

BOR	Board of Revenue, UP
CAD	Command Area Development
CADA	Command Area Development Authority
CCA	Culturable Command Area
CGWB	Central Ground Water Board
FAO	Food and Agriculture Organization, United Nations
GDP	Gross Domestic Product
GNP	Gross National Product
GOI	Government of India
GOJ	Government of Japan
GSI	Geological Survey of India (Central)
GWB	Ground Water Board
GWD	Ground Water Department
ID	Irrigation Department, UP
IMD	India Meteorological Department (Central)
IWC	Irrigation Work Circle
JICA	Japan International Cooperation Agency
OFD	On-Farm Development
RSAC	Remote Sensing Application Center, UP
SI	Survey of India
UNDP	United Nation Development Programme
UP	Uttar Pradesh
USDA	United States, Department of Agriculture

ABBREVIATIONS OF MEASUREMENT

Length

cm = Centimeter
m = Meter
km = Kilometer
ft = Foot
yd = Yard

Area

cm^2 = sq.cm = Square centimeter
m^2 = sq.m = Square meter
ha = Hectare
km^2 = sq.km = Square kilometer

Volume

cm^3 = cu.cm = Cubic centimeter
l = lit = liter
kl = Kiloliter
m^3 = cu.m = Cubic meter
gal. = Gallon
MCM = Million Cubic Meters

Weight

mg = Milligram
g = Gram
kg = Kilogram
ton = Metric ton
lb = Pound

Time

sec = s = Second
min = Minute
hr = Hour
d = Day
yr = Year

Electrical Measures

V = Volt
A = Ampere
Hz = Hertz (cycle)
W = Watt
kW = Kilowatt
MW = Megawatt
GW = Gigawatt

Other Measures

% = Percent
PS = Horsepower
° = Degree
' = Minute
" = Second
°C = Degree centigrade
10^3 = Thousand
10^5 = Lakh
10^6 = Million
10^7 = Crore
10^9 = Billion (milliard)

Derived Measures

m^3/s = m^3/sec = Cubic meter per second
cusec = Cubic feet per second
mgd = Million gallon per day
kWh = Kilowatt hour
MWh = Megawatt hour
GWh = Gigawatt hour
kWh/yr = Kilowatt hour per year
kVA = Kilovolt ampere
BTU = British thermal unit

Money

Rs. = Indian Rupees
US$ = US dollar
Yen = Japanese Yen

CONVERSION FACTORS

	From Metric System			To Metric System		
Length	1 cm	=	0.394 inch	1 inch	=	2.54 cm
	1 m	=	3.28 ft = 1.094 yd	1 ft	=	30.48 cm
	1 km	=	0.621 mile	1 yd	=	91.44 cm
				1 mile	=	8 furlongs
					=	5,280 feet
					=	1.609 km
				1 furlong	=	201.17 m
Area	1 cm^2	=	0.155 sq.in	1 sq.ft	=	0.0929 m^2
	1 m^2	=	10.76 sq.ft.	1 sq.yd	=	0.835 m^2
	1 ha	=	2.471 acres	1 acre	=	0.4047 ha
	1 km^2	=	0.386 sq.mile	1 sq.mile	=	2.59 km^2
Volume	1 cm^3	=	0.0610 cu.in	1 cu.ft	=	28.32 lit
	1 lit	=	0.220 gal. (imp.)	1 cu.yd	=	0.765 m^3
	1 kl	=	6.29 barrels	1 gal. (imp.)	=	4.55 lit
	1 m^3	=	35.3 cu.ft	1 gal. (US)	=	3.79 lit
	10^6 m^3	=	811 acre-ft	1 acre-ft	=	1,233.5 m^3
Energy	1 kWh	=	3,413 BTU	1 BTU	=	0.293 Wh
Temperature	°C	=	(°F-32) 5/9	°F	=	1.8°C + 32
Derived Measures						
	1 m^3/s	=	35.3 cusec	1 cusec	=	0.0283 m^3/s
	1 kg/cm^2	=	14.2 psi	1 psi	=	0.703 kg/cm^2
	1 ton/ha	=	891 lb/acre	1 lb/acre	=	1.12 kg/ha
	10^6 m^3	=	810.7 acre-ft	1 acre-ft	=	1,233.5 m^3
	1 m^3/s	=	19.0 mgd	1 mgd	=	0.0526 m^3/s

CHAPTER I INTRODUCTION

1.1 Authority

This is the Final Report on the feasibility study on the Irrigation and Drainage Development of Sharda Canal CAD Project which was undertaken by JICA Study Team under the technical assistant programme of Government of Japan.

The Report consists of the Main Text, Annexes and Drawings. The Main Text including the summary briefly explains the proposed agricultural development plan for four Representative Areas selected from Hardoi Command in Sharda Canal CAD Project area, hereinafter referred to as "the Project" as well as verifies the technical feasibility and economical and financial viability of the Project. The Annexes provide the details of the study results of the respective sectors including the alternative studies. The Drawings was prepared as the essential reference to the development plan of the Project.

The feasibility study was carried out in accordance with the Scope of Work agreed upon between the Ministry of Water Resources of the Government of India, the Department of Area Development of the Uttar Pradesh State Government and Japan International Cooperation Agency dated April 19,1990. The Study was completed through two stages, i.e., Stage I from September 1st, 1990 to December 22nd, 1990 and Stage II from December 23rd, 1990 to July 31st,1991.

The Draft Final Report was submitted to the the Government of India in August 1991, and the report was discussed in the meeting of the Steering Committee held on September 4 and 5, 1991. According to the result of the meeting, the comments on the Draft Final Report were raised by the Government of India on October 31,1991. This report is prepared and finalized on the basis of the further study.

1.2 History of the Project

The Government of India has put the priority to the agricultural development, especially the expansion of irrigation since the First Five Year Plan in 1951. However degree of irrigation application and productivity under irrigated agriculture was still low. With a view to improve these aspects, the Command Area Development (CAD) program was launched in 1974-75 by the Government of India.

In Sharda Sahayak Canal Command, CAD works were completed for the area of 1.4 million ha in 1988-89. The Government of India decided to extend the CAD works to the Sharda Canal Command Area having a culturable commanded area (CCA) of 1.612 million ha. The CAD works of Sharda Canal Command were commenced in 1989 and will be completed by 1995-96 in so far as the on-farm works are concerned.

Although an integrated inter-disciplinary approach was adopted to improve irrigation utilization and productivity,the productivity is still at the marginal level. Accordingly the Government of India requested the Government of Japan to assist in carrying out the study on improvement of irrigation utilization and productivity. The Government of Japan accepted this request under its technical cooperation.

Japan International Cooperation Agency (JICA), which is the official agency responsible for the implementation of the technical cooperation programmes of the Government of Japan,conducted the necessary preparation and prepared the Scope of Work which was agreed upon with the Ministry of Water Resources of the Government of India and the Department of Area Development of the Uttar Pradesh State Government on April 19,1990.

In accordance with the Scope of Work, JICA organized the Study Team, and despatched to the Study area on September 5,1990. The Study was completed in July, 1991.

1.3 Scope of Work

The Scope of Work is summarized as follows:

(1) Objective of the Study

The objective of the study is to formulate an optimum agricultural development plan for the selected areas in the command area of Sharda Canal CAD Project.

(2) Study Area

The study area covers command area of Hardoi Branch Canal within Sharda Canal CAD Project.

(3) Scope of the Study

The study consists of the following two stages:

Stage I

(i) Study on current status of Sharda Canal System and Sharda Canal CAD Project with emphasis on command area of Hardoi Branch Canal.

(ii) Screening and selection of representative CAD areas to be studied in detail in Stage II.

Stage II

(i) Conduct of supplementary study in the selected CAD areas.

(ii) Formulation of an agricultural development plan and preparation of project implementation programme for the selected CAD areas.

CHAPTER II BACKGROUND

2.1 Current Situation of National Economy

2.1.1 Macro Economy

India is the seventh largest country in area, and with a population over 800 million, being the second most populous. Agriculture sector plays an important role in the economy, accounting for about 70% employment. While the share of the agriculture sector in the Gross Domestic Product (G.D.P.) has been declining, the relative dependance of work force and agricultural households has not been declining on a comparable scale. The share of agricultural labor force in total labor force declined only marginally from 73% in 1965 to about 70% in 1980, whereas the share of the agriculture sector in the G.D.P. came down from 48.2% in 1965 to 37.6% in 1980 and to 34.8% in 1989.

The GNP attained in 1988 amounts to about US$265,600 Million. The sectoral shares of GDP are shown in Table 2.1 and as summarized below.

Gross Domestic Product at Factor cost by Industry of Origin

(in 1988-89)

Description	GDP (Rs. Billin)	Proportion (%)
Agriculture,forestry and fisheries	656.39	34.8
Manufacturing and construction	507.34	26.9
Transport and communication	331.40	17.6
Services	179.25	9.5
Public administration	210.43	11.2
Total	1,884.81	100.0

The G.D.P growth has been averaging 4.7% per annum since the mid 1970s. Despite inadequate rainfall leading to severe drought in 1887-88, the growth rate averaged 5.9% during the first four years of the Seventh Five Year Plan (1985-90) period. The wholesale price index in the corresponding period rose by an average of only 6.5%. The changes of GDP and wholesale prices for the period of 15 years from 1974/75 to 1988/89 are as shown in Table 2.2.

The long term debt went up rapidly from US$26,545 Million in 1984 to US$51,168 Million in 1988. While this magnitude doubled, the total debt service went up similarly from US$2,431 Million to US$4,958 Million during the same period. The export value of goods and service could not, however, keep pace with the above. The exports contributed to US$16,160 Million in 1984 and went up to US$21,610 in 1988.

The total external debt, as a percentage of GNP, went up from 17.6% in 1984 to 21.7% in 1988 and is likely to reach about 29% in 1991. The ratio of total debt service to export of goods and services has been increasing from 15.0% in 1984 to 22.9% in 1988, and expected to reach about 26.3% in 1991. Total interest payment as a percentage of GNP went from 0.7% in 1984 to 1.1% in 1988 and expected to increase further up to about 1.7% in 1991. These details along with related features are provided in Table 2.3 and are summarized below.

External Debt

(Unit : US$ Million)

Description	1984	1986	1988	1990
GNP	192,538	227,411	265,594	261,957
Exports of Goods & Service	16,160	16,467	21,610	27,451
Total External Debt	33,857	48,351	55,325	69,910

2.1.2 Agricultural Economy

The instability features of Indian agricultural production system, attributable largely to vagaries of monsoon rainfall, are fairly significant. The growth rates of agricultural production in different years since 1980-81 are given below.

Growth Rate of Agricultural Production

Year	Growth Rate (%)	Year	Growth Rate (%)
1980-81	15.6	1985-86	2.4
1981-82	5.6	1986-87	-3.7
1982-83	3.8	1987-88	-0.8
1983-84	13.7	1988-89	20.8
1984-85	1.2	1989-90	1.0

The first three years of the Seventh Plan (1985-90) were marked by a succession of unfavorable monsoons culminating in the drought of 1987-88. The average growth rate of agriculture during 1980-81 to 88-89 was 5.7%.

The changes in percentage distributions of operational holdings in various categories are as shown below.

Operational Holdings

	Size of Holding	Percentage of Distribution					
		No. of Holding			Area of Holding		
		1985-86	1980-81	1970-71	1985-86	1980-81	1970-71
Marginal	below 1	58.0	56.5	51.0	13.1	12.2	9.0
Small	1 - 2	18.2	18.0	18.9	15.5	14.1	11.9
Semi-Medium	2 - 4	13.6	14.0	15.0	22.2	21.2	18.5
Medium	4 - 10	8.2	9.1	11.2	28.7	29.7	29.7
Large	10 & above	2.0	2.4	3.9	20.5	22.8	30.9
Average (ha)		-	-	-	1.68	1.84	2.28

Source: Statistical Outline of India 1989-90,
Department of Economics & Statistics,DOI

The average size of farm shrunk from 2.28 ha in 1970-71 to 1.68 ha in 1985-86. Besides, 58% of operational holdings in 1985-86 are marginal farms accounting for only 13.1% of the total area of all operational holdings, whereas 2% of large farms account for about 20.5% of the total area.

The agricultural production in 1988-89 achieved rice of 70.7 million ton, wheat of 54.0 million ton and sugarcane of 204.6 million ton as shown in Table 2.4. The deviations in production are largely attributable to vagaries of monsoon rainfall.

The time trend in the total values of agricultural exports and imports, and their relative shares in the total exports and imports is as shown in Table 2.5. It may be observed that the share of agriculture produce has been declining both in exports as well as imports; the relative decline in the value of agricultural imports has been more significant mainly due to drastic reduction in the import of foodgrains.

2.2 Socio Economic Features of Uttar Pradesh State

2.2.1 General Economic Features

The U.P. State has been divided into 5 geo-economic regions (Hilly, Western, Central, Eastern and Bundelkhand), 11 administrative Divisions (each headed by a Divisional Commissioner), 62 Districts (each headed by a District Magistrate), 263 Tehsils (each headed by a Tehsildar) and 895 Blocks (each has a Block Development Officer to coordinate development activities). There are 112,566 residential villages. The geographical extent of UP state is 294,400 square km.

The total state population was 110.9 million, according to 1981 census as shown below.

Total Population and Agricultural Employment

(Unit: 1,000)

Description	Men	Women	Total
Total population	58,819	52,043	110,862
Agricultural employment			
Farmers	17,615	1,342	18,957
Agricultural laborers	4,188	989	5,177

Source: Uttar Pradesh Annual 1987-88,
Information & Public Relations Department,UP

The rate of increase during 1971-81 was 25.5%. The population estimate for 1991 works out to 13.85 millions on assumption of 25% growth rate during 1981-91. Population density in 1981 stood at 377 per square kilometer, compared to 216 for all India average. The density in U.P. shows a magnitude higher by 74.5%.

The constitutional head of the State is the Governor, under whose overviewing role functions the Council of Ministers headed by the Chief Minister. The functional/field administrative departments and organization are headed by Commissioners/Directors. The administrative/revenue divisions are headed by Divisional Commissioners, and the Districts by District Magistrates. The administrative units below the District level are; Tehsil, Block and the village unit.

The farmers constitute about 58.5% of the total work force, and landless agricultural laborers at 16%, thus indicating about 74% of the State population is directly dependent on the agricultural economy as per 1981 data.

The estimated irrigation acreage in 1988-89 was 22.49 million hectares. The percentage of irrigated area in the total cultivated area is estimated at 53% for 1986-87 with the cropping intensity estimated at 146%.

Agriculture and allied sector constitute about 46 % of the State Domestic Product (at 1980-81 prices) whereas the corresponding share of these sectors for the country as a whole is about 34%.

The gap between per capita income of the State and the country widened over the years and there appears little chance of narrowing down soon. The average growth rate of primary sector consisting mainly of agricultural sector was only about 1.2% per annum during the first 3 years of the Seventh Plan period. Table 2.6 provides comparative statement of average annual growth rates of income during various plan period commencing the early 1950's.

2.2.2 Agricultural Setting

Although there has been rapid increase in agricultural production of the UP State over the years, there exists considerable additional potential or constraint for raising the productivity. The fragmented land holding is one feature that can hardly be altered in favour of farm production efficiency. Instead, it becomes relevant to raise the efficiency of application of various other inputs in the production system.

The targets and achievements in agricultural production in Uttar Pradesh State during the Seventh Plan period (1985-90) are shown in Table 2.7, and the production of the major crops in 1988-89 is summarized below.

Production of Major crops in Uttar Pradesh

(Unit: 1,000 ton)

Crops	Production	Crops	Production
1. Food grains			
Kharif		Rabi	
a. Rice	9,420	g. Wheat	19,611
b. Sorghum	502	h. Barely	865
c. Millet	840	i. Gram	1,167
d. Maize	1,199	j. Peas	322
e. Kharif pulses	160	k. Arhar	661
f. Others	336	l. Lentil	352
2. Oilseeds	1,160		
3. Pulses	2,662		

2.3 Prospective Goal of Eighth Five Year State Development Plan

To improve and enhance the socio-economic situation, the State Government of Uttar Pradesh has prepared the Eighth Five Year Development Plan (draft) covering the implementation period of 1991 to 1995.

The development plan set out the following goals as target growth:

(1) Overall average annual average growth rate at 6%

(2) Sectoral targets consisting of
- 4.2% for agriculture and animal husbandry
- 12 % for manufacturing
- 6 % for the remaining sectors

The main objectives for achieving the goals and/or target growth emphasize the following:

(1) To raise income of rural poor

(2) To improve quality of life in rural areas

(3) To ensure that reasonable share in public facilities is available to poor people

(4) To maximize productivity in agriculture along with diversification and mixed farming in small and marginal holdings and in areas of low productivity

(5) To bring down population growth to 1.8 per cent per annum

(6) To achieve a faster growth in manufacturing sector and promotion of industries which have larger potentialities of employment

(7) To consolidate gains from and to improve efficiency and productivity of past investment and of the existing assets

(8) To promote faster development of backward areas in order to reduce intra-state disparities in levels of development

(9) To undertake special measures for the overall economic and social development of the weaker sections of the society, particularly of scheduled caste/scheduled tribes, and of women and children, and

(10) To strengthen panchayati raji institution in rural areas and local self-governing institution in urban areas and local self-governing institutions in urban areas and to make them effective media for formulation and implementation of development schemes

The basic objective of the Plan is to ensure that the needs of ordinary people and the quality of their life become the central focus of planning even as the plan seeks to promote rapid overall development and diversification of the economy and to strengthen the infrastructure base. Employment has been described as the central thrust of the plan and growth is viewed as a means to the provision of reasonable minimum living standard and essential social amenities as quickly as possible

The Command Area Development Programme in the Eighth Five Year Plan is positioned as a part of an irrigation sector plan. The main objectives of the CAD programme is ensure effective water utilization and equitable distribution of irrigation water through integrated water management for optimizing agricultural production in command area.

To achieve this objective the following strategies were proposed:

(1) To remove uncertainty in irrigation water supply and increase water use efficiency

(2) To construct field channels, field drains and water control structures

(3) To encourage farmers to participate on-farm development works and maintenance of the system

(4) To encourage farmers to organize water users association

(5) To make adaptive trials and demonstration for optimum water management

(6) To train or educate people who are engaging in CAD programme

(7) To promote conjunctive use of surface and groundwater , and

(8) To facilitate monitoring and evaluation system for effective implementation of CAD programme which is conductive to increase of agricultural production

2.4 Command Area Development Program

Expansion of irrigation has been the main element of the strategy of the Government of India for increasing food crops production. To realize the above, development of irrigation facilities has been undertaken. The approach has been to expand irrigation to the newly needed areas and ensure efficient use of the available irrigation facilities.

Despite undertaking irrigation developmental measures, there was much gap between irrigation potential created and utilization thereof, and agricultural production under irrigated lands was lower than the anticipated.

With objectives of attaining effective utilization of irrigation potential and upliftment of agricultural production in irrigated lands, the Government of India decided Centrally Sponsored Command Area Development Program in selected irrigation commands to be taken up in the Fifth Five Year Plan in 1974

In 1974/75, Command Area Development Authorities (CADA) have been established by the state governments. In the initial stage, 38 CADA have been established for 60 irrigation projects with CCA of 15 million ha in the country. Presently, 54 CADA are operating for 131 CAD projects with CCA of 18.4 million ha.

Under the U.P. Area Development Act,1976, three Command Area Development Authorities have been set up in U.P., i.e. Ramganga Reservoir Project,Gandak Canal Project and Sharda Sahayak Project commanding CCA of 4.31 million ha. Under this centrally sponsored Command Area Development Program, the activities being carried out are as follows:

(1) On-farm development works consisting of field irrigation channels, field drains, land levelling/shaping operation and consolidation of land holdings/realignment of field boundaries where required

(2) Modernization of existing irrigation system for ensuring efficient operation and maintenance, including wireless communication network

(3) Introduction of rotational systems of water distribution within the outlet command

(4) Adoption of suitable cropping pattern and rostering system of irrigation

(5) Strengthen of agricultural extension services, including arrangement of supply for agricultural inputs, services and credit

(6) Provision of adequate drainage network in the command area and modernization of existing system

(7) Development of ground water for conjunctive use

(8) Development of necessary infrastructure in the shape of roads, markets and warehousing facilities within the command area

(9) Adaptive trial, demonstrations, farmers training, farmers participation and action research

In Sharda Sahayak Canal Command, CAD Works were completed for the area of 1.4 million ha in 1988-89. The Government of India decided to extend the implementation of Area Development Program to the Sharda Canal Command of 1.612 million ha. The CAD works have been commenced in 1989 and are scheduled to be completed by 1995-96 in so far as on-farm works are concerned.

Since 1974 the Centrally Sponsored CAD Programme has been executed and considerable financial assistance has been rendered by the Government of India. A number of the evaluation studies on the impact of the CAD works has been carried out. On the basis of the studies, it was recognized that the key element in executing the CAD Programme is the removal of the uncertainty in irrigation water supply attributable to:

- lack of unified control of water management from the head to outlets,
- lack of control structures, measuring devices and distribution canal system
- lack of proper operation and maintenance of the water distribution system
- lack of farmers' participation in irrigation management

CHAPTER III PRESENT CONDITIONS OF THE SHARDA CANAL COMMAND AREA

3.1 Present Conditions

3.1.1 Physical Conditions

(1) Location

The plain of India lies over the three major river basins of Indus, Ganges and Brahm Putra. The plain covers the area of 2,400 km in length and 240 km to 320 km in width. This vast plain is almost flat with the average gradient of 1:8,000. Thanks to its fertile soil condition, the population density of the plain is one of the highest in the world.

The Uttar Pradesh (U.P.) State is located in the north-eastern part of India along the border of Nepal and China with the geographical extent of 300,000 km^2. The Sharda Canal Command Area which includes the study area lies almost in the center of the State, extending over a vast alluvial plain formed by both the Ganges and the Sharda rivers with an area of some 160,000 km^2.

(2) Climate

The UP State lies under semi-arid climate zone of semi-tropical area, characterized by the following four distinctive seasons;

i) dry winter season from January to February,
ii) comparatively dry but hot season from March to May,
iii) monsoon season from June to September, and
iv) post monsoon season from October to December.

Annual rainfall in the Sharda Canal Command Area is higher in upper reach areas with more than 1,500 mm while smaller in the lower reaches with around 800 mm. Rainfall distribution pattern in a year is almost the same throughout the Sharda Canal Command Area. The other climatic condition is similar throughout the whole Area.

The climate data at Lucknow is presented below as a representative place.

Climatic Data at Lucknow

Item	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Temperature (°C)													
Maximum	22.6	26.1	32.0	38.2	39.4	38.4	33.7	33.8	33.6	32.6	29.4	24.1	32.0
Minimum	7.8	10.7	11.7	20.4	24.8	26.9	26.3	25.9	24.6	19.1	12.7	9.0	18.3
Mean	15.2	18.4	21.9	29.3	32.1	32.7	30.0	29.9	29.1	25.9	21.1	16.6	25.2
Rainfall (mm)1/	16.2	18.5	8.4	7.7	13.9	86.8	295.4	271.8	194.5	34.6	5.2	6.3	959.3
Relative Humidity (%)													
Mean	72.2	57.7	46.3	30.1	38.0	51.5	78.6	77.1	77.2	71.2	68.4	77.6	62.1
Wind speed (m/sec)													
Mean	1.4	2.0	2.7	3.5	3.9	3.3	2.5	2.9	2.1	1.0	0.6	0.9	2.2
Evapotranspiration (mm/day)													
ETpan	1.6	2.8	5.0	5.0	7.4	7.4	3.7	3.7	3.5	2.7	1.9	1.5	3.9
Sunshine hours (hours/day)	7.7	8.7	8.7	8.9	8.6	7.4	4.3	5.7	5.7	8.4	8.2	6.2	7.4

Remarks: Data is acquired from India Meteorological Department, UP, unless otherwise mentioned.
1/: Board of Revenue

The agro-climate in the Sharda Canal Command Area is classified into three seasons; (i) Kharif (rainy season) from June to September, (ii) Rabi (dry season) from October to March and (iii) Zaid from February to May when winter vegetables are cultivated.

(3) Geology and Geo-hydrology

The Ganga alluvial tract extends towards the northwest-southeast direction, covering an area of approximately 200,000 km^2. This submerged basin was aggraded by sediments of a Neogene system and a Quaternary system with the thickness of more than 1,000 m.

The sediments are composed of unconsolidated, thick layers, and forms a large ground water basin. Underground geologic formation consists of alternated strata of horizontally continuous coarse-grain layers which form aquifers, and fine-grain layers which generally are non-aquifers. The aquifers have 1-5 layers with the thickness of 10-50 m up to the depth of 100 m. According to the geological profiles, the thickest aquifers are found in the Hardoi and Sitapur Districts on the middle reaches, followed by the Shahjahanpur and Pilibhit Districts. On the other hand, aquifers in Lucknow, Unnao and Rae Bareli Districts on the lower reaches are inferior in both thickness and number to those in other districts.

Ground water is widely used in Sharda Canal Command Area for both irrigation and domestic purposes. The number and density of these wells by districts are shown below:

Numbers of Tubewell in Related Districts in Sharda Canal Command

District	Command Area (ha)	Government T.W. Nos.	Government T.W. Nos. per 1,000ha	Private T.W. Nos.	Private T.W. Nos. per 1,000ha	Other Wells Nos.	Other Wells Nos. per 1,000ha
Nainital	68,522	83	1.2	892	13.0	9,698	141.5
Pilibhit	309,372	78	0.3	6,353	20.5	34,249	110.7
Bareilly	260,465	220	0.8	1,939	7.4	42,735	164.1
Shahjahanpur	396,539	301	0.8	6,087	15.4	59,743	150.7
Kheri	364,632	604	1.7	8,548	23.4	38,615	105.9
Hardoi	598,817	550	0.9	3,844	6.4	64,530	107.8
Barabanki	30,074	8	0.3	91	3.0	5,207	173.1
Sitapur	567,164	544	1.0	4,737	8.4	52,214	92.1
Lucknow	215,841	237	1.1	11,925	55.2	25,751	119.3
Unnao	458,519	149	0.3	5,760	12.6	44,586	97.2
Rae Bareli	149,762	159	1.1	13,503	90.2	10,686	71.4
Total	3,419,707	2,933	0.9	63,679	18.6	388,014	113.5

Source: Statistic Magazine, Office Finance and State Office, Finance and State Department, State Planning Institute, U.P., 1989

Lucknow and Rae Bareli on the lower reaches have by far more numbers of private tubewells than other districts. Tubewells are main irrigation water source. Of the total irrigation area of 20.3 million ha as of 1989, some 60% or 12 million ha is commanded by private tubewells, 8% or 1.7 million ha by government-owned tubewells, and 28% or 5.8 million ha by canals.

The net recharge of groundwater in the related Districts of the Sharda Canal Command Area is estimated at 11,900 MCM according to the G.W.D. The amount of the net draft of groundwater is estimated at approximately 3,100 MCM or 26% of the stage of development, as shown in Table 3.1.

On assumption of the upper limit of groundwater development of 50%, the groundwater development potential in the related districts is estimated to be 2,853 MCM.

Ground water table fluctuates seasonally. It becomes higher at post-monsoon with the depth of 2 meters to 5 meters and lower at pre-monsoon by 1 to 3 meters. Ground water table generally is lower at upper reach of the Sharda Canal Command Area. With some exceptional cases, the quality of ground water is considered suitable for irrigation.

(4) Soils

Soils in India are often categorized according to the land system. The land system in the Sharda Command Area is divided into three portions; a) Lowland located adjacent to inland ponds and marshy area such as ox-bow lakes; b) Upland on the natural levee formed along rivers; and c) vast Midland which forms back plain of Upland.

Upland soils are generally characterized by coarse-texture, high permeability and low ground water table. The pH of these soils shows neutral to slightly alkaline and generally is suitable for cultivation because of its high fertility and high productivity.

Midland generally has the two types of soils; i) medium texture and moderate permeability with medium ground water level, and; ii) fine texture, low permeability with high ground water table. The former soils show moderately to strongly alkaline with small concretion of calcium carbonate in its deep layer. Improvement of drainage condition and/or input of soil amendments like gypsum are necessary for increasing productivity.

The latter soils extend generally over poor drainage areas. Ground water table in these soils is high and partially waterlogged. Soil pH shows extremely alkaline (pH >9.0). Hard concretion of calcium carbonate so-called "kankar" is accumulated in soil layers in some places. Only a part of this land can be cultivated only for paddy with very low yield. Application of soil amendment such as gypsum and pyrite and leaching should be taken for better yield.

Lowland soils develop on old alluvial deposits in depression, of which texture is generally fine. Ground water table is always high, making these soils usually reduced condition. Soil pH then shows nearly neutral. Presently paddy is cultivated. Poor drainage and very low permeability are the constraints to get better yield. Intensive drainage measure should be taken to improve productivity.

(5) Hydrology

The Sharda river with the catchment area of 14,960 km^2, is the water supply source to the Sharda Irrigation System. Irrigation water is diverted at Banbassa headworks in Nainital District. Annual distribution of river discharge follows rainfall distribution. The peak discharge is only recorded in August. The average discharge is 20,000 cusec, and the base flow is estimated at about 4,500 cusec from the lowest discharge recorded in February.

3.1.2 Socio Economy

(1) Administration and population

The Sharda Canal Command Area is constituted by partial or full inclusion of areas from the 11 districts of Uttar Pradesh State; Nainital, Bareilly, Pilibhit, Shahjahanpur, Kheri, Sitapur, Barabanki, Hardoi, Lucknow, Unnao and Rae-Bareli. The general features of the related 11 districts are shown on Table 3.2 and summarized below.

Number of related District	:	11
Number of Tehsil (1988)	:	48
Number of Block (1988)	:	163
Population (in thousand in 1981)	:	20,348
Geographical area	:	54,493 sq.km
Total agricultural reporting area	:	5,469,215 ha

(2) Social and Economical Aspects

The national highways are generally well-established, connecting major cities in and around the State. All of the national roads are asphalted. State, district and urban roads are also extended to connect the major towns. The railway is available from Lucknow to Delhi and/or Calcutta. The other routes of railway are also available, extending along with the above mentioned national highways. The domestic airway connects Lucknow directly with Delhi and other major cities such as Agra, Gorakhpur, Allahabad and Calcutta.

Water supply systems have not been developed well except big cities. Almost all villages depend their domestic water on river water and/or groundwater. Dug wells with hand pumps have been facilitated in every village.

Gobar gas plants, which produce methane gas through anaerobic fermentation have been established according to the rural energy supply program by the U.P. government since the fifth Development Plan. Thousands of plants have been constructed in order to improve their hygienic condition, to utilize animal and human wastes as fertilizer, and to save forest resources, etc. However, many of the plants have not been operated well probably due to operation and maintenance problems.

An average land holding size in 1985-86 varies District by District. Nainital has the largest average land holding size of 1.83 ha while Rae Bareli has the smallest with 0.76 ha, as shown on Table 3.3. Comparing with the past data, the number of operational holdings tends to increase, then size of holdings tends to decrease. In Kheri, Lucknow, Hardoi, Unnao and Rae Bareli Districts, about 70% of the total holdings was of the range less than 1 hectare area (marginal farmers).

Some other important social indicators in Sharda Canal Command Area are shown on Table 3.4. Literacy rate is generally low throughout the Area ranging from 18 to 40%. The number of hospitals or primary health centers seems insufficient. Electrification rate of the villages varies from district to district, from the level of 40% (Sitapur, Barabanki, Hardoi and Shahjahanpur) to almost 100% (Lucknow and Rae Bareli).

Women occupy a low status in Indian society. Their contribution to the economy and public life is largely under estimated by ignoring the productive value of their work within the household. Even if employed, they receive less wages than their male counterparts. Generally women are discriminated against in the distribution of basic services such as health and education. As a result, levels of mortality and morbidity are higher amongst them.

In spite of a continuous decline of its share in the State products, agriculture sector is still the largest single sector with a percentage contribution of 42% in 1987. Secondary and tertiary sectors contribute 21 and 37 per cent, respectively. The number of workers in agriculture sector accounts for 79% of total workers or 23.45 million, as of 1981.

(3) Land Use

Present land use in the Sharda Canal Command Area and the Hardoi Branch Command are summarized as below.

Present Land Use in Related Districts in Sharda Canal and Hardoi Branch Command

No.	Land Use	Sharda Area (1000ha)	Sharda Area (%)	Hardoi Area (1000ha)	Hardoi Area (%)
1	Net cultivated	2,392.3	70.0	1,022.9	64.2
	(1)Irrigated	(1,724.3)	(50.4)	(779.0)	(48.9)
	(2)Non-irrigated	(668.0)	(19.5)	(243.5)	(15.3)
2	Current fallow	250.4	7.3	145.9	9.2
3	Other fallow	114.4	3.3	72.4	4.5
4	Barren but arable land	93.9	2.7	61.6	3.9
5	Garden and trees	50.7	1.5	32.2	2.0
6	Pasture land	16.4	0.5	12.9	0.8
7	usar/uncultivable	93.6	2.7	57.3	3.6
8	forest	105.3	3.1	59.7	3.8
9	Others	302.7	8.9	127.6	8.0
	Total	3,419.7	100.0	1,592.6	100.0

Source: Reported Area Based on the Cadastral Survey.

3.1.3 Agriculture

(1) Farm Production and Farming Practice

The total arable land and cropped area in each season are as shown below:

Total Arable Land and Cropped Area in Related Districts in Sharda Canal Command

(Unit: ha)

District	Total Arable Land	Kharif Total	Kharif Irrigated(%)	Rabi Total	Rabi Irrigated (%)	Zaid	Sugarcane Total	Sugarcane Irrigated (%)
Nainital	45,698	41,539	60.3	38,249	78.0	81	7,318	54.9
Pilibhit	173,756	128,093	82.8	140,359	88.9	1,166	47,453	78.9
Bareilly	163,980	125,294	56.2	129,682	79.9	3,571	34,881	87.5
Shahjahanpur	243,808	168,446	61.3	213,879	85.6	4,109	32,093	93.9
Kheri	204,661	118,563	51.1	149,836	79.0	760	77,287	70.6
Hardoi	327,087	168,075	19.6	293,025	81.6	868	23,420	79.9
Barabanki	15,651	14,172	28.7	12,723	94.1	3,904	1,013	88.5
Sitapur	280,959	210,749	11.6	234,161	58.6	6,386	61,640	42.7
Lucknow	88,225	59,002	46.2	87,372	86.7	5,542	667	92.8
Unnao	279,118	178,616	42.5	200,562	78.4	1,913	3,173	92.5
Rae Bareli	66,481	44,151	44.1	65,263	78.9	818	2,770	98.2
Total	1,889,424	1,261,088	43.7	1,566,775	78.8	267,166	291,715	71.6

Source: State Ministry of Agriculture, 1987.

In five districts of Shahjahanpur, Kheri, Hardoi, Lucknow and Rae Bareli, planted areas in Kharif are rather smaller than those in Rabi season. Considering the irrigated area of sugarcane, Lucknow and Rae Bareli may be less irrigated districts in Kharif season. Considering that main irrigated crop in Kharif is by far paddy, water may be one of the limiting factor for expanding cultivation area in these two districts.

Sugarcane, one of the most water-demand crops, are cultivated more in the upper reach area than in the lower reach area. The ratio of sugarcane planted area to cultivated area is more than 10% to 38% in upper reach area and less than 1% to 7% in lower reach area.

Major crops in Kharif season are cereal crops like paddy, maize, jowar, followed by pulses like pigeonpea and black/green gram, while wheat and barley are dominantly cultivated in Rabi, followed by pulses and oilseed crops. As for Zaid crops, potatoes and winter vegetables are cultivated. The cultivated area, yield and production of those crops in the Sharda Canal Command are summarized as follows:

Cultivated Area, Yield and Production in Related District in Sharda Canal Command

Crop/Season	Cultivated Area (ha)	Production (ton)	Yield (ton/ha)
Kharif			
Paddy	811,584	1,666,904	2.05
Maize	122,805	131,503	1.07
Jowar	89,538	123,283	1.38
Bajra	34,138	33,116	0.97
Arhar	65,916	49,962	0.76
Urdmoong	74,191	17,631	0.24
Groundnut	58,918	49,219	0.84
Rabi			
Wheat	1,183,896	2,233,371	1.89
Barley	196,289	271,496	1.38
Gram	103,250	66,826	0.65
Pea	16,181	13,409	0.83
Mustard	67,159	42,382	0.63

Source: Directorate of Statistics, State Ministry of Agriculture, 1990.

Crop yields are generally low. Paddy yield in Sharda Command Area is 2.05 ton/ha on an average, ranging from 2.9 ton/ha in Nainital to around 1.5 ton/ha in Hardoi, Sitapur, Lucknow, Unnao and Rae Bareli as shown in Tables 3.5 and 3.6. In case of yields of wheat and barley, there is no significant difference among districts, except Shahjahanpur district

which showed an extremely high yield in 1988-89 crop season. Sugarcane yield is rather high in upper reach area.

While sugarcane farmers in upper reach area use agro-machinery and practice modernized farming based on rather large holding size and on sufficient capital, other farmers in the Area generally follow traditional farming practice; oxen-plowing, low level of farm input, insufficient farm management, manually threshing, etc. Chemical fertilizer, especially nitrogenous one is commonly used for paddy, wheat and sugarcane, while the use of agro-chemicals is still not popular. New methods of farming practices seems not have been extended.

Most serious problem on crop production is insufficient irrigation water. In Kharif, as puddling water for paddy is not secured, transplanting is not able to be done at an ideal season, which bring about yield decrease. Wheat does not receive sufficient amount of water or timely irrigation, which causes poor performance.

Water logging and alkalinity problem is another constraint to get better yield. Aside from the sodium toxicity, high soil pH induced zinc deficiency especially on paddy. Rapid drain after Kharif will make early sowing of wheat possible, which will result in yield increase.

(2) Post Harvest and Marketing System

Farmers stock their products in their own storage facilities. Marketed products are collected and stocked in go-downs generally owned by private enterprises. Since most farmers are of subsistence level, not much crops are marketed in cities. Small markets open in village centers or rural centers usually twice a week. Some farmers sell a part of their products at those markets nearby.

An important institutional mechanism is the State Agricultural Products Mandi Parishad. This system plays a role of the marketing centers with requisite infrastructure for competitive interface between buyers and sellers.

(3) Farm Economy

Considering that most farmers are in the bracket of marginal and small land holding size and that average paddy yield is only about 2.0 ton/ha, above samples are all better ones. Based on the average holding size of marginal farmers of 0.5 ha, average yield of paddy, and

unit paddy price of Rs.2/kg, simple rough calculation shows the gross income of only Rs.2,000. Even if they get another harvest in Rabi, as considerable part of their products will go for their home consumption, it is easily imagined that marginal farmers will not be able to earn enough income only from agricultural activity to sustain their living.

(4) Farmers' Organization

Various rural institutions and cooperatives have been formed since 1951 when the All India Rural Credit Survey Committee formulated national policy on cooperatives. Reflecting past credit oriented cooperative development, there are still on cooperatives. In spite of the Government efforts, however, cooperative development has not been well-diversified.

In Uttar Pradesh State, following institutions have been established:

- Apex	12
- Primary Agricultural Credit Societies	8,597
- District Cooperative Bank	57
- Marketing Societies	268
- Seed Stores	2,256

Through CAD project, establishment of water management societies has been envisaged. However, due to unreliable water supply and incompletion of on-farm development, such societies have never been established yet.

(5) Agricultural Supporting Services

(a) Agricultural research

State Agricultural Universities (SAUs) undertake the said research work on behalf of the State Government. The Study Area is located under the coverage area of G.B. Pant and Chandra Shekhar Azad Universities. Those universities have outlying research or experimental stations to meet specific local needs, though most research activities are concentrated at main campus level.

Other research institutes in U.P. include the centrally administered Indian Institute of Sugarcane Research and Central Institute of Horticulture for Northern Plain both of which are located in Lucknow.

(b) Agricultural extension

On-farm level extension activity is shouldered to Village Development Officer and Assistant Development Officer (agriculture) in each Block Development Office. Village development officers usually have multi-purpose tasks, cover five to ten villages or thousand of farmers and are burdened with substantial administrative works. Many constraints on extension workers for efficient activities have been enumerated as follows:

- Insufficient number of staff;
- Lack of mobility to reach farmers systematically and regularly;
- No practical training in relevant technology;
- Limited prospects for advancement; and
- Very few linkage with research.

It is expected that the above constraints on the present extension officer would be solved through the T&V system recently adopted in U.P. State.

(c) Farm input supply

Three state agricultural universities, State owned seed corporation and National Seed Corporation are the source of certified seed distribution. The seed supply of wheat and pulses are far below to meet the demand.

Marketing of fertilizer is in the hands of private traders, cooperatives and the national cooperative federation IFFCO (Indian Farmers Fertilizer Cooperative). A supply of fertilizer seems sufficient.

(d) Credit

There are three types of credit according to the purposes provided through national, district and cooperative banks to farmers:

Short-term loan : There are two phases; (i) loan for field improvements and (ii) loan for agricultural inputs in the form of commodities.

Mid-term loan : Loan for animal husbandry, agricultural equipment, small irrigation works, dunlop cart, etc.

Long-term loan : Loan for small irrigation, well boring, pump set, tubewell, agricultural machineries like tractor, trolly, power thresher, etc.

According to the data on U.P.Cooperative Bank, a loan recovery rate of Lucknow Division as of June, 1990 reveals rather low as 23 percent of the total demand.

3.1.4 Irrigation Works

(1) General Features of Sharda Canal System

(a) Sharda Canal System

The Sharda Main Canal takes off from the Sharda river at Banbassa in the District Nainital. The Canal networks were completed in 1928. The capacity of the main canal is 11,500 cusec or 325.5 cumec for covering the culturable command area (CCA) of 1.612 million over the 11 districts. The existing Sharda Canal System consists of 14 branch canals shown in Fig. 3.1, many distributary canals and minor canals.

The irrigation potential area is 804 thousand ha, while annual actual irrigation areas average to 631 thousand ha for the recent five years, consisting of Kharif cropping of 301 thousand ha and Rabi cropping of 330 thousand ha.

(b) Hardoi Branch System

The Sharda Main Canal bifurcates into the Hardoi Branch Canal and Kheri Branch Canal at 45 km downstream from the intake structure. Sharda Sagar reservoir located in the upstream of the bifurcation, augments discharges of Hardoi Branch Canal especially in the Rabi crop season.

Hardoi Branch Canal flows down and joins an outlet channel diverted from the Sharda Sagar reservoir at about 13 miles downstream from the head. The Hardoi Branch Canal diverts four (4) major branch canals; Lucknow Branch Canal at 55 miles downstream from the head, Asiwan Branch Canal at 142 miles, Purwa and Unnao Branch Canals at the tail end, respectively. The Lucknow Branch Canal again branches the Sandila Branch Canal at 55 miles. Each branch canal is equipped with such related structures as bridge, fall, culvert, syphon and so on. Each branch canal takes off many numbers of the distributary canals and minor canals. Some of

distributary and minor irrigation canals are reported to be not fully functioning due to silting, weeds, much seepage, etc.

(2) Operation and Maintenance (O&M)

(a) O & M Organization

The operation and maintenance of Sharda Canal System is executed by the Department of Irrigation, UP, with three Irrigation Work Circles (I.W.C.) under the administration of the Chief Engineer for Sharda Canal System.

The communication system used for conveying the information of O&M consists of telephone and telegraph lines of canal telegraph offices. The existing system is outdated and are liable to occur break downs. O&M equipment are provided only with minimum requirement. Maintenance works are commonly executed on the contract basis.

(b) Water Supply Operation

The irrigation water supply schedule, so called "Roster", is prepared on the weekly basis for every six months before commencement of the cropping so as to ensure the water requirement of crops for 24% of Kharif and 25% of Rabi Culturable Command Area (CCA), respectively. The Roster is determined and prepared by the Irrigation Department of U.P.

As the Irrigation Department is responsible only for water distribution practice up to canal systems, it is common in water shortage period that farmers in the head reaches strengthen the outlet and damage the gates of the distributor/minor canal, or construct cross bands and breach channel banks in order to maximize their supplies. The farmers at the tail end are obliged to receive uncertain supplies, by irrigating at night and cultivating other crops requiring less water.

(2) Irrigation Practices

(a) Irrigation Area

The irrigated areas commanded by the Hardoi Branch System for the recent five years are estimated at the representative sections on the basis of the data from the Irrigation

Department, UP. The average irrigated area at the head of Hardoi Branch Canal is 292 thousand ha against the CCA of 757 thousand ha, consisting of 129 thousand ha of the Kharif cropping and 163 thousand ha of the Rabi cropping, as shown in Table 3.7. The summary is as follows:

Irrigation Intensity of Hardoi Branch Command

Location	CCA	Proposed Irrigation Area	Irrigated Area	% to P.I.A.	% to C.C.A.
1. Hardoi Branch					
1) at head	757,772	373,359	291,989	78.2	38.5
2) at 23 miles	723,599	354,564	284,249	80.2	39.3
3) at 53 miles	668,895	327,760	257,590	78.6	38.5
4) at 99 miles	308,771	151,299	115,009	76.0	37.2
5) at tail	152,379	74,647	59,828	80.1	39.3
2. Lucknow Branch					
1) at head	281,443	137,907	108,625	78.8	38.6
2) at 72 miles	97,570	47,810	36,478	76.3	37.4
3. Sandila Branch	71,672	35,119	26,549	75.6	37.0
4. Asiwan Branch					
1) at head	85,511	41,920	28,345	67.6	33.1
5. Purwa Branch					
1) at head	74,565	36,537	33,893	92.8	45.5
2) at 30 miles	32,638	15,993	13,953	87.2	42.8
6. Unnao Branch					
1) at head	77,814	38,110	25,935	68.1	33.3
2) at 33 miles	31,465	15,399	8,129	52.8	25.8

As shown above, the ratio of the actual irrigated area to the proposed irrigation area of Asiwan, Unnao and Sandila Branches are lower than the average, suggesting uneven distribution of water.

(b) Water Supply

The seasonal water deliveries of the Main Canal and respective section of Hardoi Branch generally coincide with the scheduled deliveries. The comparison of the actual and scheduled deliveries at the Main Canal and Hardoi Branch is as shown in Fig. 3.2, and that for the Main Canal and Hardoi Branch at a head is summarized below:

Location	Kharif (1989 & 1990)			Rabi (1989 / 90)		
	Roster (MCM)	Actual (MCM)	Rate (%)	Roster (MCM)	Actual (MCM)	Rate (%)
Main Canal	4,440	4,136	93	2,774	3,021	109
Hardoi Branch (Head)	2,203	2,170	98	1,490	1,580	106

Whereas, the weekly discharges are much different from the scheduled discharges especially in the downstream sections as shown in Fig. 3.3. Since the water supply for those sections is not achieved as scheduled, it is normal that reliable water distribution in the commands of distributor and minor canals can not be attained.

Irrigation efficiency of the Sharda Canal System is estimated on the basis of the analysis of discharge data, field measurement and reference data on similar project as shown below:

Present Irrigation Efficiency

Canal System	Rabi	Kharif
Main Canal	0.92	0.95 1/
Hardoi Branch	0.74	0.70 1/
Distributary/Minor	0.80	0.80 2/
Field Channel	0.78	0.78 3/
Application Efficiency	0.55	0.65 3/
Overall Efficiency	0.23	0.27

Remarks: 1/ Estimated from the actual discharge data
2/ Estimated from measured values by field experiment
3/ Based upon Report of Upper Ganga Project in Water Management Manual Government of India.

A large amount of water losses is conceived to be occurring from the Main Canal through minor canals. With introduction of systematic operation of canal system and improvement of field water management, utilization efficiency of irrigation water is expected to be much raised.

3.1.5 Drainage Condition

The extent of waterlogged/marshy area and saline/alkaline problem areas by districts, as indicators of drainage condition, is as shown below:

Water Logging and Salt Affected Areas

Name of District	Geographical Area (km^2)	Waterlogged/Marshy Area *1 (ha)	(%)	Saline/Alkaline Problem Area*2 (ha)	(%)
Nainital	6,794	N.A.	-	N.A.	-
Pilibhit	3,499	N.A.	-	N.A.	-
Bareilly	4,120	N.A.	-	18,600	4.5
Shahjahanpur	4,575	N.A.	-	21,800	4.8
Kheri	7,680	N.A.	-	24,100	3.1
Hardoi	5,986	N.A.	-	35,600	5.9
Barabanki	4,401	N.A.	-	24,000	5.5
Sitapur	5,743	N.A.	-	20,000	3.5
Lucknow	2,528	4,600	1.8	25,600	10.1
Unnao	4,558	12,800	2.8	48,700	10.7
Rae Bareli	4,609	6,200	1.3	59,800	13.0

Remarks: N.A.: Data not available.
Source : *1: Remote Sensing Applications Center, U.P.
*2: Agriculture Department, U.P.

The upstream area of the Sharda Command has relatively high slope gradients and coarse soil textures, which make drainage easy. On the other hand, middle to lower areas of the Command Area have very flat topography and relatively fine soil textures, which result in the increase of waterlogged/marshy areas.

Although some measures have been taken to improve poor drainage condition, drainage canal density has not been sufficient in general, and such several technical problems on drainage works are identified: (i) that major drainage facilities of the Area are not arranged systematically, and (ii) that canal alignment does not follow topography.

Density of Drainage Canal

Name of District	Nos. of Block	Density of Drainage canal (100m/ha<)	(<25m/ha)
Shahjahanpur	4	3 Blocks	-
Hardoi	17	6	5 Blocks
Lucknow	6	1	2
Unnao	16	5	3
Rae Bareli	5	4	1

3.2 Sharda Canal Command Area Development

After the completion of the CAD works in the Sharda Sahayak Canal Command for the area of 1.4 million ha in 1988-89, the Government of India decided to extend the implementation of CAD Program to the Sharda Canal Command Area.

After the revision of the schedule of the CAD works of Sharda Canal CAD Project for the area of 1.6 million ha, it has been decided that on-farm development works would to be completed by 1995-96.

The progress of CAD works so far is as shown below and the locations of the works are as shown in Fig. 3.4.

Progress of CAD Works as of December 1990

Unit: ha of CCA

Sharda Command	Sharda Canal System	Hardoi Branch
Completed unit area	125,250	0
On-going unit area	642,400	128,300
(Executed area)	85,100	13,700
(Surveyed area)	138,500	54,600
(Planned area)	115,300	42,500

The facilities completed as of December 1990 are as follows:

(1)	Field irrigation channels		
	- Earth canal	:	7,778 km
	- Lining canal	:	12 km
(2)	Related structures	:	339 nos.
(3)	Field Drains	:	419 km

The shortcomings noticed on CAD Authorities were mainly that neither the functionaries responsible for water releases nor those in charge agricultural extensions were working under CADA. These mal-functions can be found in unproper implementation of osrabandi without consent of beneficial farmers, lack of proper training for CADA officers and farmers and lack of planned implementation of On-farm Development Works.

The planned or reported scale of OFD works to be completed in one year is considered to be too big for proper implementation.

The actual achievement on completion of "Osrabandi" is almost none in the Sharda Canal System. Under the condition of CADA that there are few skilled officials and technicians especially in irrigation field, "Osrabandi" can not easily be introduced to farmers.

CHAPTER IV SELECTION OF REPRESENTATIVE AREAS

4.1 Basic Ideas on Selection of Representative CAD Areas

The Sharda Canal Command confront existence of such problems as salinity/ alkalinity affected areas, water-logged areas and low irrigation efficiency. The feasibility study is required to be carried out with special attention to the solution of those problems. The study area was confined to the command area of Hardoi Branch Canal in accordance with the Minutes of Meeting on discussion of Scope of Work dated April 19,1990.

Selection of the representative CAD areas, for which the agricultural development plan is formulated, is made through categorization of the area from the view point of natural and socio-economic conditions. The work flow chart is as shown in Fig. 4.1.

4.1.1 Categorization from Natural Conditions

The following parameters are used in categorization of the Study area from the view point of the natural condition:

(i) Irrigation Condition
(ii) Poor Drainage Condition
(iii) Salt Affected Condition

(1) Irrigation condition

The irrigation condition is evaluated by the following four parameters:

(a) Irrigation rate

Irrigation conditions fluctuate widely depending on the location and canal system. Irrigation ratios of annual irrigation area to the proposed one are employed for evaluation. The higher priority for selection is given to the area with a low rate.

(b) Canal Conditions

Inefficient operation and maintenance of canal facilities have reduced their functions. With improvement of less functioning canal and introduction of efficient water management, the irrigation potential created will be efficiently utilized.

(c) Irrigation Rate by Government Canals

Irrigation in the study area is effected by both government owned canal systems such as the Sharda canal and farmers owned facilities. Irrigation areas served by government owned facilities are very different from those served by farmers owned facilities, and vary from 5% to 85% of the total irrigation area. The areas which are less served by the government system will be given the higher priority.

(d) Dependence on Ground Water in Irrigation

There are about 40 thousand tubewells for irrigation purposes, of which 97% are privately owned small size tubewells. The density of tubewells differs widely according to location depending on the availability of canal water. It is considered that areas with a high density of tubewells definitely require irrigation water.

(2) Poor drainage condition

Categorization of the study area with respect to poor drainage condition was carried out on the basis of the following parameters:

(a) Drainability

The Sharda canal command extends over a vast alluvial plain lying between the Ganga and Sharda rivers. The major Sharda canals run almost from northwest to southeast parallel with those rivers. Natural drains follow these topographic features. The area located inland (mid land) is inherently less capable of draining itself by reason of being remote from the main drainage streams and being surrounded by high land, etc. To evaluate the extent of necessity of drainage, the ratio of mid land to the geographical area is employed.

(b) Poor Drainage Area Ratio

A large amount of water logging and marshy land is located in the mid land. The high rate of water logging and marshy land to the mid land means that drainage improvement will be urgently required.

(c) Drainage Canal Density

Drainage canals provided in the study area have reduced their functions because of inefficient maintenance. It is considered that poor drainage conditions in the areas will effectively be improved by means of establishing of efficient drainage networks.

(3) Salinity/Alkalinity Affected Condition

The study area was categorized in terms of salinity/alkalinity affected conditions by the following parameters:

(a) Alkalinity

According to the criteria of the Government of India for classification of alkaline soils, those with pH 8.5 to 9.0 are grouped as "alkaline", and those with more than 9.0 are classified as "strongly alkaline". Alkalinity/ salinity affected conditions of the areas was demarcated by use of the ratios of alkalinity and strong alkalinity areas to the geographical area.

(b) Soil texture

Coarse textured soils are generally highly permeable and capable of supplying oxygen to the root zone, and they also have high moisture and fertilizer holding capacities. The ratio of coarse soils to the geographical area is used as an index to evaluate the productivity of the soil in this categorization.

(c) Land Use

The cultivated area in the related districts of the Sharda canal command amounts to about 2.4 million ha or 70% of the geographical area. While, the alkalinity and salinity affected area is estimated to be 98 thousand ha or 4% of the geographical area. To prevent the cultivated area from degrading by alkalinity/salinity, the area with

higher ratio of cultivated area will be given high priority for development. Then, the ratio of the cultivated area to the geographical area is taken as an index of the categorization of the Study area.

4.1.2 Categorization from Socio-Economy Conditions

The following parameters are used in categorization of socio-economic conditions of the study area.

(1) Farm Economy Condition

(a) Farm Income

The main crops in the study area are wheat, paddy and sugar cane, but the crop intensity differs much with locations. Since cropping systems are closely related to farm income, the gross income of these three main crops is used to evaluate farm economic conditions.

(b) Farm holdings

The average operational holding in the study area is less than 1 ha, except in the upstream areas of the Hardoi Branch. Marginal operational holdings of less than 1 ha tended to increase in all districts during the 5 years from 1980/81 to 1985/86, at rates of 2% to 12%. The average holding and rate of increase of marginal operational holdings are used as another index for evaluation of farm economic conditions.

(2) Agricultural Support Service Conditions

The fertilizer supply service is an important agricultural support service. To evaluate the present development condition of this service, the capacity of the fertilizer storage provided in the area and fertilizer use actually introduced are employed.

(3) Social Infrastructure Development Conditions

The social infrastructure development conditions are evaluated by the parameters of :

(a) Rural electrification by means of the rate of electrified villages to the total numbers of villages.

(b) Rural water supply facility by means of the numbers of wells and taps.

4.2 Selection Criteria

(1) Selection procedure

The priority ranking for selection of the representative areas is determined by means of a scoring system on the basis of the results of the categorization.

(a) to determine the parameters for selection on the basis of the categorization of the study area,

(b) to calculate the scores for respective parameters and to determine the priority ranking according to the calculation formula with weighing to each parameter

(c) To check the items such as CAD work progress, environmental impacts through a screening method

(d) to select the representative area on the canal system basis with a view to making possible efficient water management

(2) Selection Criteria

Development of the representative CAD areas is aimed to sufficiently and effectively promote the Sharda Canal CAD Project. The following basic factors that the representative areas to be selected should meet as a model development are established :

(a) Strong development wish in terms of development strategy of the Government of India and Uttar Pradesh State Government and farmers

(b) No existence of on-going works of CAD program

(c) Representative model area for implementation of Sharda Canal CAD Project

(d) Area requiring modernization of the existing irrigation facilities to ensure efficient operation and maintenance

(e) No adverse environmental effect upon implementation

(f) Urgency of the development

(g) High economic effect of the development

(h) Strong development impact with a view of social and economic aspects

4.3 Scoring and Screening

(1) Scoring

The scores of the areas for selection of the representative areas are determined by the following calculation formula: The relative weight of the selection parameters is determined on the basis of the relationship between the basic factors and selection parameters as shown in Table 4.1.

Formula for scoring:

$$PR = 50\%TS + 50\%SE$$

where, PR : Total marks for selection
TS : Marks for technical aspects
These marks are determined for irrigation condition, poor drainage condition an alkalinity/salinity conditions
SE : Marks for socio-economic aspects

(a) parameters and marks of technical aspects

i) Irrigation condition

$$TSi = 35\%AI + 35\%FC + 15\%GC + 15\%DG$$

where, TSi : Total marks to be determined from irrigation conditions
AI : Actual irrigation rate
FC : Facilities condition
GC : Irrigation rate by government canals
DG : Dependency of ground water in irrigation

ii) Poor drainage condition

$$TSd = 35\%DI + 35\%PD + 30\%DC$$

where, TSd : Total marks to be determined from poor drainage condition
DI : Drainability index
PD : Poor drainage area rate
DC : Drainage canal density

$$TSs = 60\%SA + 20\%CS + 20\%CA$$

where, TSs : Total marks to be determined from salinity/alkalinity condition
SA : Salt affected soil rate
CS : Coarse soil rate
CA : Cultivated area rate

(b) Parameters and marks for socio-economic aspects

$$SE = 40\%FE + 30\%AS + 30\%SI$$

where, SE : Total marks to be determined from socio-economic aspect
FE : Farm economy index
AS : Agricultural support service condition
SI : Social infrastructure development condition

The results of the scoring of each block are as presented in ANNEX-I.

(2) Screening

The progress of CAD and adverse environmental effect upon implementation are used as the parameters for selection of the representative areas by means of screening method.

(a) Progress of CAD works

The CAD works of Sharda Canal Command are being executed, and some areas were completed as mentioned in the preceding section. In accordance with the result of the Minutes of Meeting of the Steering Committee held on October 16, 1990, the on-going areas of CAD works are excluded from selection of the representative areas through the screening procedure.

(b) Adverse environmental effect upon implementation

The adverse environmental effects upon implementation are preliminarily assessed in terms of the physical, ecological and human activity aspects.

The prediction of effects of the influence of the physical condition is related to the impacts of drainage, and the water quality of the marshy areas and their surroundings. The marshy areas and their surroundings which are located far from the main drainage streams and topographically depressed are difficult to sufficiently drain and are, therefore, susceptible to expansion of water logging and water contamination with introduction of advanced irrigation farming.

The impacts of the ecological aspect is assessed with respect to the effect on the ground water regime. The parameter used in the ground water regime is the recovery of the ground water tables. The ground water tables of post monsoon in the driest year 1987 in some areas did not recover up to the levels of the preceding pre-monsoon. To avoid an adverse effect on the ground water regime in extremely less recovered areas, groundwater development in such areas as conjunctive use will be avoided.

No significant adverse effect on human activity is predicted under the present study.

4.4 Selection of Representative Areas

Based on the results of the priority ranking and screening, the following three areas are selected as the representative CAD areas:

1) Representative area for improvement of irrigation condition

District	:	Lucknow
Block	:	Sarojini Nagar
Canal system	:	Lucknow Branch Amausi Distributary
CCA	:	14,862 ha

2) Representative area for improvement of poor drainage condition

District	:	Hardoi
Block	:	Sursa
Canal system	:	Hardoi Branch Badaicha Distributary
CCA	:	17,313 ha

3) Representative area for salinity and alkalinity affected area

District	:	Unnao
Block	:	Purwa
Canal system	:	Purwa Branch Purwa Distributary and others
CCA	:	12,252 ha

In addition to the above-mentioned three areas, Sataon area having CCA of 12,874 ha was included as the other representative area for irrigation improvement as the result of discussion in the Steering Committee held prior to the field works of Stage II.

Formulation of an agricultural development plan and preparation of project implementation programme are carried out for those four representative CAD areas with CCA of 57,301 ha..

CHAPTER V PRESENT CONDITIONS OF THE REPRESENTATIVE CAD AREAS

5.1 Natural Conditions

5.1.1 Location and Topography

(1) Sarojini Nagar Area

The Sarojini Nagar area is located just in the south of Lucknow city which is the capital of Uttar Pradesh State. The Amausi Distributary is a principal irrigation system, which is diverted from Lucknow Branch at 106.8 miles. The area extends over 4 administrative blocks, i.e., Sarojini Nagar, Mohanlalganj, Asoha and Nawabganj Blocks. The geographical area is 33,488 ha within which a CCA of 14,862 lies. The Sarojini Nagar area lies with the latitude of the north 26°48' to 26°32' and the longitude of the east 80°50' to 81°02'. The elevation in the area varies from 114 m to 121 m above MSL. The topography is observed to be flat and no major depression is seen.

(2) Sataon Area

The Sataon area is located in the tailend of Asiwan Branch and Maurawan Distributary in Rae Bareli District. The area extends over 3 administrative blocks, i.e., Sataon, Kheero and Hilauli Blocks with a total geographical extent of 25,763 ha and CCA of 12,874 ha. The main irrigation system is Maurawan Distributary. The Sataon area lies with the latitude of the north 26°14' to 26°24 and the longitude of the east 85°58' to 86°07'. The elevation of the area varies from 107 m to 117 m. Swamps formed along river trails are scattered in the area.

(3) Sursa Area

The Sursa area is located in the southeast of Hardoi city in Hardoi district. The Badaicha Distributary is a principal irrigation system which is diverted from Hardoi Branch at about 100 miles from the head. The area extends over 2 administrative blocks, i.e., Sursa and Ahirori Blocks with the geographical extent of 32,269 ha and total CCA of 17,313 ha. The location of the area is expressed by the latitude of the north 27°12' to 27°22' and the longitude of the east 80°02' to 80°17'. The elevation of the area varies from 143 m in the upstream part to 134 m at the downstream part. Undulating topography is visible in the area.

(4) Purwa Area

The Purwa area is located in the south of Purwa town in Unnao District. The main irrigation system in the area are Purwa Distributary and Tikar Distributary which are taken off from Purwa Branch at 23 miles and 25.5 miles, respectively. The area extended over 4 administrative blocks,i.e., Purwa, Sumerpur, Hilauli and Kheero Blocks with the total geographical extent of 20,828 ha and CCA of 12,252 ha. The area lies with the latitude of the north of 80°44' to 80°52' and the longitude of the north 26°20' to 26°30'. The elevation of the area varies from 120 m to 113 m above MSL. Ponds and small lakes are formed along river trails.

5.1.2 Climate and Hydrology

There is no significant difference in the climatic characteristics among 4 representative areas. The coldest month is January when minimum temperature goes down to 8 degree centigrade. The hottest month is May when maximum temperature goes up to 40 degree centigrade.

The daily sunshine duration shows the longest in April and May which leads to the highest temperature in the year. The calculated reference evapotranspiration by modified Penman method shows 1,400 mm to 1,800 mm per year which are 1.5 to 2 times of the annual rainfall.

The annual rainfall in 4 areas ranges from 300 mm to 1,400 mm. About 75% of the annual rainfall occurs in three months from July to September.

5.1.3 Geology and Geo-hydrology

(1) Present Use of Ground Water

Shallow ground water at depths of up to about 50 m is being drawn through dug wells, private tubewells and pump set wells for drinking, domestic and irrigation purposes. Irrigation water is supplied mainly from private tubewells made with the assistance of Minor Irrigation Departments (MID), and the number of those tubewells is by far greater than that of other types of wells. Deep ground water at depths of about 100-200 m is being developed using the government tubewells of the Irrigation Department (ID), but the number of these wells is less than that of private tubewells. Other wells for groundwater use include Pucca wells and Rahat wells.

The density of tubewells is high in areas with far distance from a canal or at its tailend. The fact that there are many private tubewells in Sarojini Nagar, Mohanlalganj, Sataon and Kheero Blocks reflects the shortage of irrigation water supplied through canals. The number of shallow tubewells has been continuing to grow, indicating a tendency of excess development.

(2) Ground Water Table Fluctuation

Ground water level varies with from season to season or from place to place. The ground water levels of the four representative areas in the pre-monsoon and post-monsoon are about 4-6.5 m and 2.5-5 m from the ground surface, respectively, and the annual variation is about 1.5 m. However, there is also considerable seasonal variation depending on precipitation.

(a) Sarojini Nagar Area

Ground water level in Sarojini Nagar, Mohanlalganj, Nawabganj and Asoha Blocks mostly falls within the depths of 5-10 m below ground surface. However, there are some areas along Amausi Distributary where ground water level is at depths of 5 m or less. On the contrary, there are also semi-critical zones with respect to excess development at depths of 10 m or more. The annual drawdown rate of wells constructed during the last five years is as high as 0.38 m/year. If this tendency continues, ground water level could reach the critical zone for development with respect to excess development in near future.

(b) Sataon Area

The ground water level in this area ranges to 5-10 m but there are some areas where ground water level is at depths 10 m or more. The lowering tendency of ground water level in Sataon is even more pronounced than in Sarojini Nagar. The probability of excess development in this area is higher than that in the other areas.

(c) Sursa Area

Ground water level in this area mostly falls within the range of 2-5 m. However, there are also considerable areas where ground water level is at depths of 2 m or less, indicating a rather high risk of water logging. Those high water level areas lie along distributaries of Hardoi, Badaicha and other areas, suggesting the possible leakage

from canals. Ground water level in Sursa does not show a pronounced lowering tendency.

(d) Purwa Area

The contour lines of ground water level in this area indicate that the most common ground water level is at depths of 2-5 m. There are some areas where ground water level is at depths of 2 m or less, but the general tendency is close to the one in Sursa Area. The lowering tendencies of ground water level in four blocks in the four representative areas are shown below.

Name of Block	Present Ave. Water Level (m)	Ave. Annual Drawdown (m/year)	Drawdown in Last 5 Years (m/year)	Average Depth of Well (m)
Sarojini Nagar	6.81	-0.13	-0.38	19.19
Sataon	7.55	-0.18	-0.62	29.28
Sursa	2.83	-0.02	-0.04	24.74
Purwa	3.21	-0.01	-0.02	23.72

(3) Aquifer Characteristics

(a) Sarojini Nagar Area

Aquifers in Sarojini Nagar Area vary widely, and their thicknesses and depths are not uniform. Boring to the depth of 30 m revealed the existence of aquifers with thickness from 8 m to 18 m, but the results of the pumping tests only showed very low yields of 1.4-2.8 ℓ/sec. This is probably because the aquifers are layers of fine sand which clogs the strainers in the pumping wells. The Government tubewells are taking water from layers of medium grain sand at depths of about 30-90 m. Yields in Sarojini Nagar and Mohanlalganj of about 391 ℓ/sec and 351 ℓ/sec indicate the abundance of groundwater.

(b) Sataon Area

The geology of this area shows considerable variation, and the content of Kanker is high. Investigation at the pumping test well confirmed the existence of an aquifer of fine and medium-grain sand at depths of about 13-17 m. The yield of 4.7-22.4 ℓ/sec from this aquifer is higher than those from other pumping test wells. Deep ground

water at depths of about 30-70 m is being developed at the Government tubewell, which now yields 31 ℓ/sec. A 400m class deep well developed by CGWB yields 41 ℓ/sec.

(c) Sursa Area

This area is characterized by well developed sand layers of coarse grain sand. Strainer-type wells are suitable to this area, unlike the other areas. The results of pumping tests confirmed the yield of 6.3-10.4 ℓ/sec from an aquifer at depths of 15-20 m. The Government tubewell yields 44 ℓ/sec of water from a deep aquifer about 30-110 m from ground surface. CGWB's 450 m class deep well yields 61 ℓ/s, which is higher than the yields from similar wells in the other areas.

(d) Purwa Area

This area is characterized by thick layers of clay. In pumping tests, about 0.2-3.4 ℓ/sec was yielded from a fine sand layer at depths of 3-7 m. Since The Government tubewell yields about 43 ℓ/secs of deep ground water at the average depth of 185m and CGWD's 450 m class deep well yields 42 ℓ/sec, yields in this area is not much lower than those in the other areas though aquifers are not well developed.

5.1.4 Soils

A semi detailed soil survey was conducted in collaboration with the Department of Agriculture. The soils in the representative areas are classified in accordance with the standard of USDA, which is generally used in India.

The soils are classified into 5 categories; (a) upland, (b) midupland, (c) midland, (d) mid lowland, and (e) lowland, further sub-divided into 15 groups. Physico-chemical characteristics and suitable crops of these soils are briefly described below:

Upland soils are of sand to clay-loam in texture with high drainability and peameability. Soil pH shows almost neutral to weak alkaline. Although upland crops like maize, sorghum are main crops in these soils, paddy also is cultivated in some areas. The land suitability is ranked highest.

Mid-up land is of fine soil textures of silt to clay, and the drainability is moderate. Though strongly alkaline soils are partly seen with Kankar (consolidated body composed mainly of calcium carbonate), which limits the crop growth, the productivity is expected to be improved much through drainage improvement measures.

Midland is of clayey texture with imperfect drainability. Soil pH shows strongly alkaline. Paddy is mainly cultivated in this area at present. However, other crops can be grown after drainage condition is improved.

Mid-low land is of clayey, imperfectly drained and extremely alkaline. These soils are almost not suitable for crop cultivation, although paddy or wheat are cultivated partly by marginal farmers who do not have choice.

Lowland is characterized by heavy clay with poor drainage condition. It tends to be water-logged. Only paddy will be cultivated in Kharif in this land while wheat may be cultivated in areas where water is drained.

From the above consideration, except for a part of upland, Mid-low land and Lowland, any kind of crops will be cultivated though crop water requirement varies by soils.

The distribution of those soils in each Representative Area is as shown below:

Soils in CCA of Representative Areas

	Sarojini Nagar		Sataon		Sursa		Purwa	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)
Upland	3,174	21.4	4,815	37.4	1,734	10.0	2,638	21.4
Mid upland	8,696	58.5	7,252	56.3	10,658	61.6	7,050	57.5
Midland	2,204	14.8	-	-	1,745	10.1	1,098	9.0
Mid lowland	460	3.1	269	2.1	1,542	8.9	524	4.3
Lowland	328	2.2	538	4.2	1,634	9.4	952	7.8

5.2 Socio-Economic Conditions

5.2.1 Administration

Each of the representative areas consists of several administrative blocks to which many panchayat and villages belong. The number of those blocks and villages are as summarized and administrative boundaries are as shown in Figs. 5.1 to 5.4.

Study Area	District	Block	Nyaya Panchayat	Gaon Sabha	Revenue Village
Sarojini Nagar	2	4	16	75	107
Sataon	2	3	9	30	43
Sursa	1	2	11	76	85
Purwa	2	4	12	63	84

5.2.2 Population

Recent population data at block level is available. They are shown below:

Population of Related Blocks of Representative Areas

Item	Sarojini Nagar		Sataon		Purwa	Sursa
	Sarojini Nagar	Mohanlal Ganj	Hilauli	Sataon	Purwa	Sursa
1. Total population	169027	135824	98771	94686	130500	121674
2. Nos. of families	32644	27436	19156	19892	16542	25636
3. Average family size	5.2	5.0	5.2	4.8	7.9	4.7
4. Population growth rate for last 10 years (%)	32.1	15.7	23.4	10.8	1.5	2.5
5. Population density per km^2	797	522	420	300	375	377
6. Total nos. of labors	51600	40200	29800	27900	36900	37100
7. Total nos. of farmers	30533	29650	19806	27660	19807	31232
8. Total nos. of agricultural Labors	8147	4546	5964	1955	2190	3401

Note: Data presented are as of 1987-88
Source: Statistics Patrika, U.P. State Planning Department.

Sarojini Nagar Block shows higher population density than other blocks and higher growth rate as well, which may reflect recent urbanization of Lucknow urban area, adjacent to the Lucknow city. In contrast, population growth of Purwa Block has been stagnant.

About 30% of total population have job. The rate of labors who are engaged in agriculture sector to total number of labors is the lowest in Sarojini Nagar Block with the value of about 75%, while other blocks are higher with the rate of between 85% and 96%. Almost all labors are engaged in agriculture sector.

5.2.3 Social and Economic Aspects

(1) General socio-economic condition

(a) Sarojini Nagar, Sataon and Purwa Areas

Three of the representative areas; Sarojini Nagar, Sataon and Purwa Areas; are largely located within a "triangle zone" which is formed by the roads connecting Lucknow, Rae Bareli and Unnao cities. Accessibility to these areas are generally good. Asphalted road network connects major cities and villages although some parts of the road are not passable by ordinal car. People usually use bicycle and animal-draft cart as means of transportation. In "Kharif" season, however, considerable part of these areas centering Purwa-Maurawan roads become inaccessible because of inundation in Purwa Study Area. Water stagnation make the quality of groundwater and hygiene condition inferior, which often causes water-born diseases.

Most farmers in these areas seems at subsistence level. Houses are mostly made of bricks. Usually they raise several heads of cows or buffalos as means of transportation and farm power or supplemental income source by milking. Very few public facilities like school and hospital are established although electricity has been provided in most towns and villages except those in Purwa and Asoha blocks. People depend largely on groundwater as domestic water source by digging wells.

Economy in these areas are not active. Main income source is by far agriculture although there is almost no market facilities. Farmers bring their products to open markets along a road in a town or a village which are held usually twice a week. On village level, only brick and brick-made goods market, and bicycle repair shop are seen. Even a town which function as a rural center, commercial zone is limited along the main street, and small stores selling mainly necessaries like kitchen goods and cloths, some agricultural inputs distributors, agro-machinery traders, canteens, and vegetable and fruits vendors are seen there. There are scarce industry activities like processing except brick making factories.

(b) Sursa Area

Being far from the urban centers like Lucknow, and also apart from the trunk national road No.28, connecting Lucknow and Delhi, which passes Sitapur and Shahjahanpur, this area remains in complete rural circumstances. Along the way to Hardoi from Lucknow with the distance of some 100 km, there is only one town, Sandila which seems to function as a rural center.

Accessibility in the Area is not so good. Pucca roads are not well established, and earth roads are rough. Animal drafting cart and/or bicycle are main means of transportation. Electrification has not been well-established. Domestic water supply entirely depends upon groundwater through open dug-well and hand pump. Public facilities have not well been established. Economic activity is hardly seen. There is no rural centers. Almost all income are generated from agricultural products.

(c) Inter-block Comparison

From Table 5.1, following inter-block comparison on social development situation may be pointed out:

- Purwa Block has less number of village development officers on the population basis;
- Literacy rate is relatively lower in Hilauli and Sursa Blocks which, however, do not necessarily reflect the number of junior basic schools;
- Health facilities are generally poorly established in Hilauli, Purwa and Sursa Blocks;
- Population based pucca road length is shorter in Hilauli and Sursa Blocks;
- Electrification rate is lower in Hilauli, Purwa and Sursa Blocks;

(2) Women's Status

Women in rural areas play a very important role. They manage not only household matters, but also farming, collecting firewood, animal care, making fuel rod by animal dung, etc. In spite of their important role in socio-economic activities, socio-cultural problems prevent them from improving their positions in the community. Low education, mal-nutrition, high infant mortality rates, less paid attention, etc. have caused many tragic histories on women. Considering the fact that about 60% of the farming activities are done by women, their training as well as other social education should be programmed.

5.2.4 Rural Institutions

The details of loans in the agricultural cooperatives in the respective Representative Areas are shown in Table 5.2. The relevant recovery rates at the block level could not be obtained, although a general feature can be stated that the rate of recovery is inversely proportional to the agro-economic development level.

5.3 Present Agricultural Setting

5.3.1 Land Use

According to the classification which is generally adopted in India, land use in 1989/1990 by Representative Areas and all Hardoi Branch Command are summarized below.

Present Land Use of Representative Areas

Land Use	Sarojini Nagar		Sataon		Sursa		Purwa		All Hardoi Branch	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(100ha)	(%)
Net cultivated	18,807	55.8	14,591	57.1	20,255	65.1	12,753	64.9	10,229	64.2
Irrigated	(13,117)	(38.1)	(9,934)	(38.9)	(15,313)	(49.2)	(10,355)	(52.7)	(7,790)	(48.9)
Non-irrigated	(5,740)	(17.1)	(4,657)	(18.2)	(5,171)	(16.6)	(2,321)	(11.8)	(2,435)	(15.3)
Current fallow	4,532	13.4	4,142	16.2	3,482	11.2	2,171	11.1	1,459	9.2
Other fallow	760	2.3	486	1.9	273	0.9	717	3.9	724	4.5
Barren but arable land	1,286	3.8	1,311	5.1	2,144	6.9	794	4.0	616	3.9
Horticulture price	773	2.3	627	2.4	227	0.7	320	1.6	322	2.0
Permanent pasture	297	0.9	244	1.0	150	0.5	65	0.3	129	0.8
Usar/uncultivable	992	2.9	635	2.5	817	2.6	603	3.1	573	3.6
Forest	2,192	6.5	73	0.3	1,313	4.2	17	0.1	597	3.8
Miscellaneous	4,021	11.9	3,446	13.5	2,441	7.9	2,207	11.2	1,276	8.0
Total	33,660	100.0	25,555	100.0	31,107	100.0	19,646	100.0	15,926	100.0

Source: Milan Khasra published by Tehsil Office

In general, 60% of total land is cultivated of which 60% to 80% are irrigated. A rate of irrigated land is low in Sataon and Sarojini Nagar Representative Areas. Comparing to all of Hardoi Branch Command, a rate of current fallow land is higher in these areas.

Although usar itself does not occupy wide area, the areas where usar is predominant are, middle reaches of Amausi Distributary in Sarojini Nagar Area, northern part of Sataon Area, southern part along Marsa Distributary in Sursa Area and eastern part of Purwa Area,

that is; in/around Basaha Depression. A rate of forest land is extremely low in Sataon and Purwa Areas.

5.3.2 Land Holding Size and Tenure System

Land holding sizes of Uttar Pradesh are generally very small irrespective of land tenure status, although most farmers are wholly owned and self-operated. Of the total number of holdings, about 50% or 94 lakh are in the 0.02-0.5 ha bracket. This holdings account only for 22 lakh hectares or 12.5% of the total holding area. Marginal farmers having less than 1.0 ha are 134 lakh in number and 50 lakh hectares. This accounts for 72% in number and only 28% in holding size. Small farmers holding 1.0 to 2.0 hectares of land are 30 lakh in number or 16% of the total land holdings and share about 41 lakh hectares or 23% of the total holding area. Marginal and small farmers account for as many as 88% of the total holdings and share 51% of the land.

The number of holdings becomes less with the increase of holding size as below:

Distribution of Operational Holdings in UP

Holding Size (ha)	Total Holdings			
	Number	(%)	Area in ha	(%)
< 1.0 (marginal)	13,372,740	72.0	4,987,275	28.3
1.0-2.0 (small)	2,964,348	16.0	4,114,922	23.3
2.0-4.0 (semi-small)	1,581,694	8.5	4,313,121	24.4
4.0-10.0 (semi-large)	602,108	3.2	3,377,431	19.1
> 10.0 (large)	55,255	0.3	849,470	4.8
Total	18,576,145	100.0	17,642,219	100.0

Source: Board of Revenue, Govt. of U.P. 1990

5.3.3 Farming Practice and Cropping Pattern

Important crops in each Representative Area by cropping season are summarized as below:

Crop Intensity in Representative Areas

Crops	Sarojini Nagar	Sataon	Sursa	Purwa
Kharif	11,340ha	7,980ha	13,700ha	7,300ha
Paddy	60%	54%	40%	73%
Sorghum	22%	29%	14%	16%
Millet	-	1%	-	-
Maize	3%	-	24%	2%
Araha	-	5%	-	-
Black gram/green gram	7%	2%	7%	4%
Groundnut	-	2%	3%	-
Vegetables	3%	1%	2%	1%
Other crops	5%	6%	10%	4%
Rabi	14,200ha	10,330ha	16,500ha	7,500ha
Wheat	78%	70%	81%	81%
Gram	6%	7%	8%	2%
Barley	3%	6%	3%	9%
Peas	2%	3%	1%	1%
Millet	4%	5%	2%	3%
Potatoes	2%	2%	2%	3%
Berseem	1%	1%	-	-
Other Crops	4%	6%	3%	1%
Perennial				
Sugarcane	7 ha	279 ha	1117 ha	168 ha
Tree crops	250 ha	-	236 ha	46 ha

Main Kharif and Rabi crops in Representative Areas are paddy for Kharif, and wheat for Rabi, respectively. Cultivated crops are well diversified in Sursa Area while paddy and wheat are dominant crops in Purwa. Sorghum is second important crop in Sarojini Nagar, Sataon and Purwa Areas while maize is rather important in Sursa Area, maybe reflecting its higher land conditions.

Zaid crops are planted in a minimal scale, not more than 2% of the total Rabi cropping area. Crops cultivated in this season are: vegetables, musk melon, pulses, etc.

For perennial crops, sugarcane is commonly cultivated in Sursa Area. Some orchard or horticultural crops like mango and guava are planted in Sarojini Nagar and Sursa Areas.

Kharif season crops are planted from June to July while Rabi crops are started to cultivation from late October to December. Water condition may be a decisive factor on transplanting or sowing times for paddy and wheat. For example, in Purwa Area farmers

transplant paddy in June while mainly in July in Sataon. Reflecting smaller farming size, i.e. insufficient capital, most farmers depend cultivation on animal power such works as ploughing and harrowing.

As far as main crops of paddy, wheat and sugarcane are concerned, farmers usually use sufficient amount of chemical fertilizer to attain better yield although the use of agro-chemicals is still not popular. Despite sufficient application of chemical fertilizer, however, yield levels of those crops generally remain low. Yield response to nitrogen fertilizer dosage is not clear, which suggests that the yield of these crops are limited by other factors; i.e. low farming technology, water condition, micro-nutrient deficiencies, etc.

Farm economy survey reveals farmers' feeling on major reasons of low yields of paddy and wheat as follows:

- Water shortage
- Soil salinity/alkalinity
- Pest and diseases
- Lack of knowledge

The extension directorate of Chandra Azad University of Agriculture and Technology pointed out some constraints on agricultural production in the Lucknow division. They are enumerated by crop as shown in Table 5.3.

5.3.4 Post-harvest and Marketing System

Post-harvest facilities like warehouse, godown, mills, etc. have been established by the Central and State Warehouse Corporations. Every farmer keeps some part of their products for their domestic consumption. Godowns of grains, especially for paddy usually have rice-mills.

Marketing channel from farm to marketing places or storage facilities is connected by either private sector or public sector. The results of the farm economy show different bodies bear marketing activities from area to area. For example a private sector dominates marketing in Sataon Area while government channel mainly in Sursa Area.

The existing institutional marketing net-work functioning in the respective Areas as well as other parts of the state is primarily contributed by (a) Krishi Utpadan Mandi Parishad (public market), (b) private marketing group in addition to cooperative marketing societies usually located at tehsil level (one society per tehsil on an average).

The following shows the mandis located in and around the respective Representative Areas:

Marketing Systems in Districts related to Representative Areas

District	Main Mandis	Sub-Mandis
Lucknow	Banthara	Mohanlal Ganj, Gosain Ganj
Rae Bareli	Rae Bareli	Gurbakhshganj, Harchandpur, Munsiganj, and Kandaura
	Lalganj	Kheero, Unchahar, Sareni, Laxmanpur, Dinganj, Mahrajganj
Hardoi	Hardoi	Baghauli
	Madhoganj	Bilgram, Mallanwa
Unnao	Purwa	Maurawan

Many of the small and marginal farmers are unable to take advantage of these systems, not only because of very meagre marketable surplus but also because of geographical distance and transportation bottle-necks involved in their access to the physical systems. It is generally said that establishment of infrastructures like roads, and private sector's participation are the key factors for successful implementation of marketing projects.

5.3.5 Farm Economy

Smaller farmers tend to keep their harvested grains for domestic consumption. The farm economy survey shows more than 70% of paddy and more than 80% of wheat produced by marginal farmers are consumed by themselves. Marginal farmers naturally have minimal income. The following are the results of crop budget analysis for paddy and wheat.

Budget Analysis of Main Crops

Holding Size	Average cultiv.area (ha)	Yield (ton/ha)	Gross V. (Rs.)	Marketed V. (Rs.)	Prod. cost (Rs.)	Net income (Rs.)
Paddy						
Marginal	0.36	2.20	1,462	357	870	0
Small	0.67	2.27	2,774	865	1,486	0
Semi-medium	1.26	2.30	5,538	2,005	2,263	0
Medium and Large	1.64	2.58	7,760	3,281	2,801	480
Wheat						
Marginal	0.42	2.01	1,776	300	1,380	0
Small	0.72	2.18	3,376	1,198	1,660	0
Semi-medium	1.27	2.18	5,869	2,018	2,192	0
Medium and Large	2.52	2.30	12,332	6,552	2,694	3,858

Source: Farm Economy Survey by JICA Study Team.

Marginal, small and semi-medium farmers show deficits on crop budgets for paddy and wheat. The larger the farm size, the more the number of hired labor. Based on the above tables, smaller scale farmers seem not be able to live only on agriculture.

5.3.6 Farmers' Organization

There is almost no farmers' organization in any of Representative Areas except cooperatives related to credit, input supply and marketing as described in sub-section 5.3.4.

With the formulation of Command Area Development (CAD) Programmes sponsored by the Government of India, formation of water users association was planned to be revitalized, initiated and encouraged, in order to complement the proposed activities of the government organizations especially under the Irrigation and Area Development Department.

Such associations, however, have not been established so far not only in any of the four Representative Areas but also in the Study Area (Hardoi Branch Command). There may be two major reasons why water users' association has not been established: (1) unstable and/or unreliable water supply from the canal; and (2) unproper implementation for foundation associations.

Water management can be operated properly only when irrigation water is supplied as scheduled in terms of both quantity and time. Under such present condition that water distribution is uneven (head-end farmers tend to draw more water than scheduled, which results in less water supply to tail-end farmers) and that canal irrigation water is not supplied timely, successful function to water management societies will not much be expected.

Another aspect is that water management generally requires broad knowledge on engineering hydrology, agronomy, agricultural economy, socio-economy, management, etc. Without careful and steady guidance, both state officials and farmers, a said association will not be able to be managed property. The CAD Authority is expected to play a very important role in this regards.

5.3.7 Support Services

(1) Extension

Agricultural extension seems not so active. According to the result of the farm economy survey, about 80% of respondents do not know about training. In Sataon Area only

25% of respondents have got training. As seen in Table 5.1 (PHYSICAL INFRASTRUCTURE 17), village level extension officers are not enough to extend farming technology to all farmers.

(2) Research works

In Lucknow, the Usar Development Institute has made study on usar improvement. Drainage and soil amendment experiments have been done. One trial project is now on-going in Purwa, and its evaluation is being undertaken. The linkage between extension and research work seems almost none.

(3) Credit

According to the Farm Economy Survey, about 30% of respondents do not avail of credit. Main credit sources are acquaintances, followed by commercial banks or cooperatives.

(4) Farm input supply

There exists a proper supply system of chemical fertilizer. About 50% of respondents do not know about seed quality, and only 30% of respondents use certified seeds. While many Sataon farmers (60% of respondents) use insecticides while Purwa farmers (only 6%) less use them. Other chemicals such as fungicides and herbicides available among cooperatives as well as private stores are not commonly used.

5.4 Irrigation and Drainage

5.4.1 Irrigation

(1) Irrigation Canal System

Four Representative Areas lie in the Hardoi Branch Command area. The parent canals commanding four Representative Areas are the Hardoi Branch for the Sursa and Lucknow Branch for the Sarojini Nagar, Asiwan Branch for the Sataon and Purwa Branch for the Purwa. The parent Canal System and the locations of the Representative Areas are as shown in Fig. 5.5.

The Hardoi Branch is bifurcated from the tail end of the Sharda Main Canal with a flow capacity of 5,400 cusec, a total length of 249.63 km, and the C.C.A. of 757,771 ha. The Hardoi Branch diverts four (4) branch canals.

Branch Canals of Hardoi Branch Canal System

Branch Canal	Diverting on H.B.C.	Discharge (cusec)	Length (km)	C.C.A. (ha)
Lucknow Branch	55 miles	2,200	188.6	281,443
Asiwan Branch	142 miles	600	41.8	85,511
Unnao Branch	tail end	400	63.5	77,814
Purwa Branch	tail end	800	93.8	74,565

The branch canals divert directly into numbers of the distributary canals and minor canals through the offtake structures, and then the distributary canals divert into some numbers of minor canals. Most of the head regulators are not provided with gates, and the control of the water supply is made by use of the wooden planks.

Outlets, so-called Kulaba, are provided on the minor and distributary canals even on the branch canals to supply the water to the fields. The structure of the outlets is of steel pipe with 3 to 6 inches in diameter and no gate is provided. Operation of the outlets is being made by use of muddy soil at their inlets. After the outlets, earthen field channels are constructed to lead the irrigation water to the field.

The existing irrigation canal system in each Representative Area is described below:

(a) Sarojini Nagar Area

The Sarojini Nagar Area is served by the Amausi distributary canal system, which is diverted on the right bank of the Lucknow Branch canal at about 108 miles from the head. The Amausi distributary canal takes off 1 distributary and 11 minors canals with a head discharge of 125 cusec, a total canal length of 109.53 km and a C.C.A. of 14,862 ha. Number of outlets total 434 with the average command area of 34 ha.

(b) Sataon Area

The Sataon Area is served by the Maurawan distributary canal system, starting from the Asiwan Branch Canal at the tail end, and running for 28 miles with a head capacity

of 34 cusec and 1 distributary canal and 8 minor canals. The Sataon Area has a C.C.A. of 12,874 ha with a total canal length of 67.5 km. Number of outlet total 212 having an average command area of 61 ha.

(c) Sursa Area

The Sursa Area is served by two canal systems, namely, the Badaicha distributary canal system with a canal capacity of 124 cusec and Marsa minor canal system of 12.4 cusec, both of which are directly branched from the Hardoi Branch Canal. The Sursa Area has a C.C.A. of 17,313 ha. Both systems consist of nine (9) minor canals and two (2) minor canals, respectively. The total canal length is 99.66 km. Number of Kulaba in total are 323 with an average command area of 54 ha.

(d) Purwa Area

The Purwa Area is supplied by four (4) canal systems, namely Purwa distributary, Chimyani minor, Pakra minor and Tikar distributary canals, which are directly diverted from the Purwa Branch Canal. The Purwa Area has a C.C.A. of 12,252 ha. These canals have ten (10) off-taking canals and total canal length is 81.38 km. Number of Kulaba in total are 290 having the average command area of 42 ha.

(2) Irrigation Area

Three kinds of data on the irrigation area are available in the Representative Area, i.e., (a) Canal-wise irrigation area for last five years (the Irrigation Department, U.P.), (b) Outlet-wise irrigation area of each canal for the last five years (the Irrigation Department, U.P.) and (c) Village-wise irrigation area by Milan Khasra (the Tehsil Head Quarters concerned) (detail: see ANNEX-F).

(a) Canal-wise Irrigation Area

Irrigation intensities for 6 years from 1985 to 1990 for Kharif and for 5 years from 1985/86 to 1989/90 for four Representative Areas are as shown below:

Irrigation Intensities for Representative Areas

Unit: ha

Study Area	C.C.A.	P.I.A.		Actual Irrigated Area			
		Kharif	Rabi	Kharif	% of CCA	Rabi	% of CCA
1) Sarojini Nagar	14,862	3,567	3,716	1,342	9.0%	1,821	12.3%
2) Sataon	12,874	3,090	3,219	259	2.0%	404	3.1%
3) Sursa	17,313	4,155	4,328	2,595	15.0%	4,827	27.9%
4) Purwa	12,252	2,941	3,063	2,908	23.7%	3,103	25.3%
Total	57,301	13,753	14,326	7,104	12.4%	10,155	17.7%

Source : Circle VI, Irrigation Department, U.P.
Remarks : P.I.A. means Proposed Irrigation Area with crop intensities of 24% and 25% in respective Kharif and Rabi.

Irrigation intensities in Sataon and Sarojini Nagar Areas are extremely low compared with the other Representative Areas in both Kharif and Rabi cropping due to its tailend location. Equitable distribution of the irrigation water is not being made and tail end area is always suffering from scarce irrigation water. The canal wise irrigation conditions are summarized below.

- The irrigation areas of offtaking canals decrease toward downstream of the parent canal. The tail end problems occur even within the distribution systems in the Representative Areas.

- A large amount of irrigation water is taken by the canals directly diverted from the branch canals. It is judged that less control of water delivery from offtake canals is made.

(b) Outlet-wise Irrigation Area

Many outlets are provided directly on the parent canals of the Area. Much water is illegally taken from direct outlets by making bunds in distributary canals on by remodeling, since direct outlets can easily be controlled by farmers. In order to prevent the illegal diversion and to ensure the even distribution to the tailend of a distributary canal, such direct outlet should be avoided and be shifted to minor canals to be additionally provided along the distributary canal.

(c) Village-wise Irrigation Area

Village-wise irrigation information for four Representative Areas is made available from, so called Milan Khasra, from the Tehsil Head Quarters concerned, which indicates the present irrigation conditions by source as well as the land classification etc. The irrigation areas by sources are as shown below.

Source-Wise Irrigation Area of Four Representative Areas

Unit: ha

Study Area	Geograph-ical Area	Cultivated Area		Irrigated Area*1	Source-wise Irrigation Area							
		Total Area	w/o D.C.		By Canal Area*1		By Tube-Well		By Dug Well		By Others	
Sarojini Nagar	33,488	27,765	18,807	13,117	4,200	32%	8,230	63%	118	1%	569	4%
Sataon	25,763	19,500	14,591	9,934	1,624	16%	7,543	76%	10	0%	757	8%
Sursa	32,269	26,949	26,116	16,976	8,300	49%	6,701	39%	1,696	10%	279	2%
Purwa	26,828	17,165	12,753	10,432	8,369	80%	1,457	14%	16	0%	542	5%

Source : Milan Khasra obtained from tehsil concerned
Remarks : *1 .Double cropped areas are excluded.

As seen from the above, the Purwa Area is largely dependent on the canal water, because the canals for Purwa Areas are located near its parent canal, i.e. Purwa Branch canals, then water is easily taken. On the other hand, the irrigation area by canal for both Sarojini Nagar and Sataon Areas are small, whereas the tubewell irrigation areas are large. Both Areas are largely dependent on the groundwater.

(3) Water Supply

The irrigation water supply schedule for respective Representative Area, so-called roster, is prepared by Executive Engineer Office on the weekly basis for every six months. However, the roster is prepared only for the canals directly diverted from the Branch canals, but not for the offtaking canals diverted from those canals.

Comparison of diversion volumes of water between the roster and actual supplies at the major canal system of each Area is tabled on a crop season basis in 1989 and 1990.

Comparison of Diversion Volumes between Schedule and Actual Supply

Unit: MCM

Representative Area	Canal System	89/90 Rabi			90 Kharif		
		Schedule	Actual		Schedule	Actual	
1) Sarojini Nagar	Amausi Dy.	12.3	16.4	133%	18.5	15.8	85%
2) Sataon	Maurawan Dy.	45.2	26.6	59%	65.7	37.5	57%
3) Sursa	Badaicha Dy.	7.5	24.4	324%	16.6	28.0	169%
4) Purwa	Purwa Dy.	7.8	5.3	68%	10.7	8.3	77%

Source: Circle VI, Irrigation Department, U.P.

Similarly to the extent of the irrigation area, the water delivery much differs in the Representative Areas. Water delivery to the Sataon Area located in the most downstream is the lowest and that to the Sursa Area is the highest.

According to the result of Comparison of the weekly discharges between the schedule and actual ones, the timing of supply is also much different from the schedule. The reliable supply is not made in the every Representative Area.

(4) Operation and Maintenance

(a) O&M Organization

The operation and maintenance of Sharda canal system is executed by the State Irrigation Department with three Irrigation Work Circles (I.W.C.), i.e., I.W.C.-V, I.W.C.Sitapur and I.W.C.-VI under the administration of the Chief Engineer for Sharda Canal System. The operation and maintenance in the four Representative Areas is executed under the administration of I.W.C.-VI.

The jurisdiction of I.W.C.-VI consists of such four divisions as Sharda Canal Hardoi, Division-II (Lucknow), Sharda Canal Unnao Division, and Irrigation Division Unnao, all of which are headed by the Executive Engineers.

The O&M activities of the existing irrigation canal and drainage systems related to the four Representative Areas are executed by the following Divisional Offices and their Sub-divisional Offices:

O&M Offices of Irrigation and Drainage Systems in Four Representative Area

Sarojini Nagar Area	:	Divisional Office-II - III-Sub-division
Sataon Area	:	Irrigation Division Unnao - V-Sub-division
Sursa Area	:	Sharda Canal Hardoi Division - II-Sub-division
Purwa Area	:	Sharda Canal Unnao Division - III-Sub-division

The Executive Engineers as the heads of the Divisional Offices, are assisted by 3 to 4 assistant engineers and one deputy revenue officer. The assistant engineers as the heads of Sub-divisional Offices, are supported by three to four junior engineers who supervise tendals. This group is executing operation and maintenance works of irrigation systems such as gate opening or closing, recording of diversion discharges, repair and maintenance works. The deputy revenue officers are supported by ziledar, who is assisted by amins who control patrols. This group is carried out the recording and reporting of actual irrigation areas by the canal system, which are submitted to the revenue office for collecting irrigation fees.

(b) Operation and Maintenance

The control of diversion discharges from the parent canal to the distributaries is basically used to be executed by means of on-off of head regulators. Most of offtaking regulators for the minor canal and some of the distributaries are not provided with control gates. Whenever the parent canal runs, the water is easily taken from offtakes located in the upstream. Outlets are also not provided with diversion control facilities.

The maintenance works consist of routine maintenance and repair. The desilting works of minor canals are regularly executed in the off-season after Kharif irrigation operation. Desilting works of most distributaries, however, are executed once in five years or more, depending on the available fund. The desilting works or minor repairs are conducted on the contact basis.