Studying Gap between Irrigation Potential Created and Utilized in India

Final Report

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SAMAR K. DATTA (FACULTY COORDINATOR)
MILINDO CHAKRABARTI
SAKTI P. PAL

S.K. DAS, FORMER CHAIRMAN, CENTRAL WATER COMMISSION (ADVISOR)

Indian Institute of Management
Vastrapur, Ahmedabad-380015

STUDY TEAM

Mr. S. K. Das (Advisor)

Prof. Samar K. Datta (Faculty Coordinator, IIMA)

Prof. Milindo Chakrabarti (Fellow, NISTADS, New Delhi and Visiting Faculty, IIMA)

Dr. S. P. Pal (Ex-Advisor, Planning Commission and Visiting Faculty, IIMA)

Dr. Bharat Dudhat

Mr. Animesh Sarkar

Mr. Subho Biswas

Mr. Pankaj Rathod

Mr. Sanjay B. Desai

Mr. Sumanta Sen

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Preface

The issue of widening gap between IPC and IPU is no doubt a very important one for the country because of its implied inefficiency connotations. However, this is not the first time that the Ministry tried to address this issue. This issue has been visited several times by scholarly personnel and experts, but apparently without much progress in terms of understanding and implementation of possible solutions to this problem. It is in this context the Ministry took a very bold and unprecedented step in approaching four premier Institutes of the country (namely, IIMA, IIMB, IIMC and IIML) for a thorough study, understanding and evolution of strategies for resolving this problem. From IIMA side, I would like to express my deep gratitude and thanks for reposing so much faith, confidence and responsibility on us. The Ministry provided a fairly liberal budget, but allowed only eight months' time beginning end August 2007 to complete this task of huge data collection at secondary and primary level from as many as 9 states/UTs and processing the same for solution to the problems posed by the Ministry in the form of a set of five terms of reference.

It was no doubt a very interesting, admirable and challenging task, though in retrospect it appears we suffered two serious drawbacks, which could probably be avoided with better planning and coordination. First, the various state/UT governments were not prepared to provide the necessary data and support within the pressing time constraint – either because they don't have such organized data or because, for some reason they did not like to part with their data. This is a critical flaw – probably shameful of a federal democratic structure, but it is a fact that in good faith and full earnest we moved from almost pillar to post for most of these eight months and beyond to get a sensible amount of data, which is consistent and reliable. Our wild goose chase came to an end only when we realized that funds and time were running down rapidly, and other pre-scheduled institutional responsibilities knocking at our doors. Second, apparently because of frustration and uncertainty, a lot of research staff left half way, thus adding to our misery. In view of these constraints, we ended up getting delayed and delayed in spite of our best efforts, as we could find no way to shirk the fixed commitments to our Institute for pre-scheduled teaching, training and research. This is an unintended embarrassment and probably a lose-lose situation rather than a win-win one for all concerned.

In spite of the above stated downside, we must admit it was a glorious opportunity for us to learn and establish permanent bridges with a lot of excellent personnel directly or indirectly connected with the subject of irrigation and water resources. We are especially thankful to Secretary, MoWR, Commissioner, Director (R & D) - the nodal officer in Delhi, along with their team members, who have always been very patient, careful and nice towards us. I must also admit that they did not leave any stone unturned to facilitate matters, though the subsequent delays became almost unavoidable. Most of the state government officials were very kind and hospitable, who took good care of us, our research staff as well as the field investigators, in spite of all constraints. In fact, some of the state government officials went out of their way to help us and in fact, are still willing to help us if we want to pursue the matter further. This is a great achievement, I must admit. At our end, innumerable field investigators helped us. We owe our gratitude to all of them. We are especially thankful to Rahul Nilakantan and Saurabh Datta, two doctoral candidates from University of Southern California and Oregon State University, respectively, who provided free of cost an excellent support in analytical and econometric work in this connection, without which we could not reach the current status even at this belated stage. Ms. Ramany, my Secretary provided her usual admirable support not only in typing but also in managing this highly complex project. Mr. S.K. Das, the national expert for the IIMA study team is a gem of a personality who impressed us all not only by his expertise, but also by his human qualities. It was indeed a God's grace that we came across several such personalities in course of this assignment.

In spite of all constraints, we feel we have been able to achieve quite a lot by providing a strong analytical framework, a rigorous sampling design, a fairly detailed MIS format, a rigorous analytical exercise and above all, a great deal of learning for ourselves, so much so that we can never shy away from any issue relating to irrigation and water resources in any intellectual forum. We would like to express our hearty debts to all, who ingrained a perpetual love for 'Irrigation and Water Resources' in the heart of our hearts. We hope this modest exercise will add a little bit to the future of irrigation and water resources. We would be extremely grateful to receive constructive comments and suggestions to facilitate the future part of progress on this subject.

IIM Ahmedabad Prof. Samar K. Datta

December 5, 2008 Coordinator, IIMA Study Team

Foreword

The agriculture sector in India holds a place of pride in its national consciousness as it employs the maximum number of people possessing various levels of skills and has been feeding the teeming millions of population of this country since time immemorial. We have reached a position in the last decade where the agricultural output annually is just able to sustain the food grain requirement of the country. If the past is any indication for the future, the incremental increase in food production would be outstripped by the regular increase in the size of population in the country. To meet this challenge the productivity of the land has to grow, more areas need to be brought under the plough and efficiency of the irrigation system, which is quite low in this country, has to increase.

Within the matrix of a situation where food production has to match the requirement of a steadily increasing population, it is natural for the government to find ways and means for obtaining the maximum utilization from the inputs for food production. Attention has therefore been drawn to land and water, which are the primary inputs of irrigated agriculture. While we have come a long way supplementing rain-fed agriculture through the various irrigation systems since time immemorial, a close look at the irrigation system reveal, that since last four decades, the gap between the irrigation potential created and that utilized has been increasing. This is a fact that has been recognized by one and all, and numerous efforts have been made in the past to examine this matter purely from the technical viewpoints and recommendations have been made to bridge the gap from time to time. That the reasons for this gap are not only on account of technical issue, was known to all concerned, but no serious efforts appear to have been made in the past to probe into all the factors, viz technical, social, economical and political that contribute to the existence of this gap and its progressive increase over time.

The Ministry of Water Resources in the second half of the year 2007 took the lead by commissioning a study through the four IIMs in the country to study the factors contributing to the gap between irrigation potential created and utilized in a holistic manner, and to suggest the measures for reducing this gap. The several IIMs were allotted the states based on the geographical location of the IIMs, and IIM-A was allotted the states of Gujarat, Rajasthan, Punjab, Haryana, Jammu and Kashmir, Himachal Pradesh and the Union Territories of Delhi, Chandigarh, Dadra and Nagar Haveli.

The study by IIM-Ahmedabad commenced in late August 2007 through a process of data collection from the state governments, from selected primary sources like villages and households to estimate the supply side gap and the demand side gap. Several brain storming sessions were held in between, as also visit to the states by the IIM-A study team for discussion with the state government officers of the Irrigation Departments. Unfortunately, the data was very slow to come by and its reliability and consistency left much to be desired. Sorting out the data into a logical format was a large time taking exercise which the IIM study team was compelled to do and which compelled IIM-A team to request the Ministry for time extension and added cost.

Within the constraints of the availability of data provided by the states duly rationalized to the extent possible by the IIM team, factors affecting the gap between irrigation potential created and utilized have been identified and conclusions drawn for undertaking remedial action to reduce this gap. Recommendations have also been suggested to improve the data management aspects on Irrigation and other inputs for reducing this gap. It is hoped that agencies concerned would find the study useful and act on the recommendations made in this report.

New Delhi S. K. Das,

August 31, 2008 National Expert and Advisor to the IIMA Study Team

and former Chairman, Central Water Commission.

Chapter 1

Introduction

"At the end of the twentieth century, the world faces a number of challenges affecting the availability, accessibility, use and sustainability of its fresh water resources. These could have serious implications for the present and future generations of humanity as also for natural ecosystems. India, which was 16% of the world's population, has roughly four percent of world's water resources and 2.45 percent of world's land area. The distribution of water resources in the country is highly uneven over space and time. Over 80 to 90 percent of the runoff in Indian rivers occurs in four months of the year and there are regions of harmful abundance and acute scarcity. Vast populations live in latter areas. The country has to grope with several critical issues in dealing with water resource development and management…"

–MoWR, Report of the National Commission for Integrated Water Resources Development, Volume-I, Sept 1999: p.i.

1.1 Identification of existence of a gap between supply of irrigation water and its demand in a particular year, and looking for the factors responsible for, if such a gap really exists, are fraught with several difficulties. While some are conceptual, some result from lack of appropriate quantitative information that could have settled the issue. A simple rudimentary way to resolve the puzzle has been developed that compares the irrigation potential created (IPC) and irrigation potential utilized (IPU). The following diagram (Figure1.1)[1] based on the data available shows the increasing gap between these two parameters that are considered suitable proxies for supply of and demand for water for irrigation purposes. Obviously, the rising gap is a matter of concern for the planners who have to do a balancing act to allocate scarce resources across several important sectors of the economy. The rising gap raises questions about the need for public investments during the ongoing Five Year Plan in creating further irrigation potential in the country, if the existing potential created remains under-

[1] *This diagram will be referred to as MoWR diagram and serve as our reference point throughout this report.*

utilized. However, one is not very sure if the observed gap between these two parameters truly portrays the gap between supply of and demand for irrigation water in reality. Assuming that it is a true portrayal of reality, it is imperative to identify the factors that influence the movement of these two curves over time, such that necessary corrective measures may be initiated to minimize the gap.

1.2 As per the MoU signed with MoWR, the objective of the present study is to examine various issues related to the gap between irrigation potential created and utilized and suggest measures for reducing the gap. The precise terms of reference are:

a) Scope:

i) To examine the various issues associated with irrigation potential creation, irrigation potential utilization, gross irrigation and net irrigation including the definition, the reporting practices and consistencies in data etc.

ii) To suggest procedure for collection of related data to be applied uniformly throughout the country.

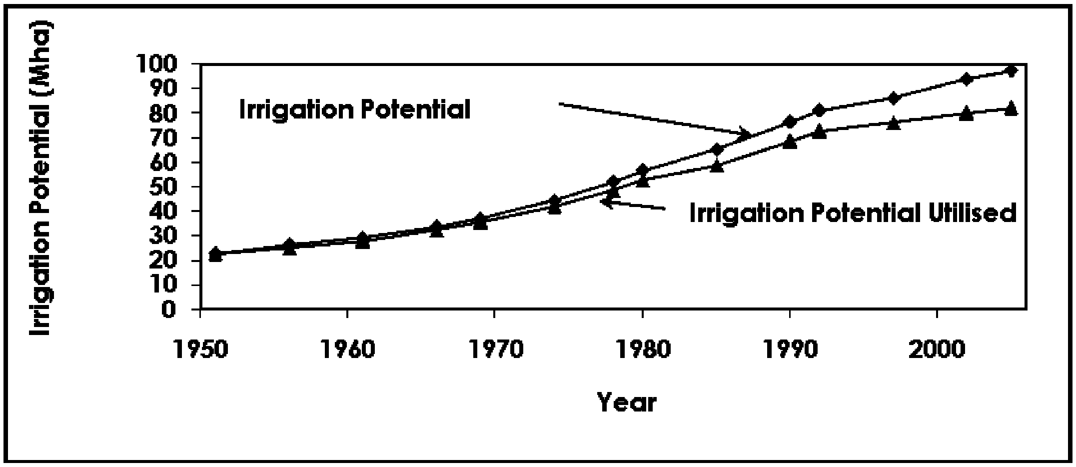
iii) To clearly identify the irrigation potential which has been created but:

- has never been utilized,
- has not been utilized regularly and
- has gone into disuse due to various reasons.

iv) To identify the reasons for gap in the irrigation potential created, irrigation potential utilized and gross irrigated area

v) To suggest measures for minimizing the gap between irrigation potential created and irrigation potential utilized.

Figure 1.1: Inter-temporal gap between IPC & IPU in India (Surface and Ground Water)



Source: Ministry of Water Resources, Govt. of India: 2007

b) Coverage: The following States / Union Territories will be covered in the study.

1. Gujarat
2. Haryana
3. Himachal Pradesh
4. Jammu & Kashmir
5. Punjab
6. Rajasthan
7. Delhi
8. Chandigarh
9. Dadra and Nagar Haveli

c) The sample size for the study will be taken as per the following:

- Major projects – 2 nos. in each state
- Medium Projects – Minimum 4 no. of projects in each state covering different regions
- Minor Projects – A cluster of minor irrigation projects in each State.

The sample size may however be varied depending upon the requirement of the study.

1.3 In tune with the scope specified by the terms of reference, the present study intends to

(a) identify the factors that influence the movement of IPC and IPU curves over time,

(b) quantify the extent of influence of the identified factors on IPC and IPU, and

(c) come up with suitable remedial measures with a road map, so that the real need for investment in creating further irrigation potential during the ongoing Five Year Plan can be correctly ascertained.

1.4 The study commenced on and from August 27th 2007. The draft report was submitted around 15th of August, 2008 – i.e., nearly a year later, much beyond the time period, within which it was intended to completed. Though the Study was launched on time and no stone was left unturned to get the necessary secondary data from the concerned states/UTs, it turned out to be a wild goose chase to get them, in spite of repeated appeals and reminders from MoWR and the Study Team. Even now one state is yet to provide any secondary data, and data provided by other states/UTs can at best be described as incomplete, far below any standard of completeness and consistency. As a result, primary data collection got awfully delayed, and at that stage too, although the necessary farmer-level and some village-level data too could be collected fairly satisfactorily from the states/UTs as per sampling design followed[2], other relevant data about the irrigation supply system in different layers couldn't be obtained[3]. As a result, analysis of supply-side bottlenecks got severely constrained, while authentically connecting demand-side (i.e., farmer side) data to supply-side data to get meaningful results became an impossible proposition. The IIMA Study Team got Ministry's comments on the draft report on 18th of September – i.e., far beyond the budgeted time as far as IIMA system could afford. As faculty has to strictly adhere to other student-related time schedules, further delay couldn't be avoided in spite of best efforts.

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[2] *State of Jammu & Kashmir turned out to be an area impossible to visit beyond the preliminary stage, in spite of several attempts by the Study Team and willingness to provide necessary cooperation by the officials.*

[3] *The sole exception is the state of Gujarat, which provided these data, though at a very belated stage to permit their use for this Study.*

1.5 In spite of the above-stated hurdles and limitations, the Study contains invaluable data and insights. Probably much more mileage could be obtained from the same data set if Ministry could foresee the difficulties and allowed some time flexibility from the very early stage. Hopefully, the Ministry or the same Study Team would be in a position to make fuller use of the data set created in the near future and revisit the Study Report for further refinement of results, conclusions and recommendations.

1.6 The Study is divided into ten chapters. The initial chapter is concerned with the statement of purpose. The second chapter elaborates the conceptual framework. Next chapter is concerned with operational structure of the study. Instruments used to collect information relevant for the study and the sampling framework developed to facilitate primary survey have been discussed therein. The fourth chapter reports findings from analysis of published secondary data at the national level. Fifth chapter throws light on the identification of the relevant factors contributing to the gaps and their respective contributions as are revealed from secondary surveys in selected major and medium irrigation projects. Next chapter concentrates on estimates of contribution of the identified factors derived out of data collected through primary surveys of some selected major and medium projects. Seventh chapter concentrates on the results derived out of relevant data collected in respect of minor irrigation systems dependent on ground water. Next chapter elaborates the findings related to minor irrigation systems using surface water. It should, however, be clarified that in the absence of primary data to be received on the supply parameters from project authorities estimates of gaps for major and medium irrigation systems are based on the perception of the farmers surveyed about the quality of supply of irrigation services provided to them by the canal authorities. Hence they are liable to be overestimated. Those for minor irrigation systems are more robust as there is an almost overlap between supplier and user of the service in question. Ninth chapter provides the concluding remarks, whereas the final chapter is devoted to recommendations emanating from the study.

Chapter 2

Conceptual Foundations of the Study

2.1 On the conceptual front, it is extremely important to differentiate the 'engineering' concept of irrigation capacity (either in terms of water flow or in terms of net irrigated area in ha.) from the economic concept of a supply curve of irrigation water to a farmer's field, on the one hand, and also to from the underlying concept of effective demand for irrigation water from the farmer side, which is the ultimate deciding factor for utilization or under-utilization of capacity created, on the other. From the way the matter is posed, it appears that the 'engineering' is a horizontal average or marginal cost curve[4] unless it hits the capacity point and becomes vertical, as shown figure below. The vertical part may however shift to the right or left depending on weather (e.g. rainfall) and factors (including political) beyond the engineering design.

2.2 For any irrigation project, there are fixed costs involved in its construction at a given capacity level, which makes the 'engineering' supply curve a vertical line. However, the average cost of irrigation will be relatively small as compared to medium or small irrigation projects but, what is useful for our purpose is the economic supply curve (S_{econ}=SS in Figure 2.1) rather than the engineering supply curve (S_{eng}). In other words, an engineering supply curve has to be converted into an economic supply curve by adding the cost of institutions and delivering mechanisms to make water physically available to the farmer at his doorsteps. The vertical distance between the economic supply curve (S_{econ}=SS) and the horizontal axix is the cost of organizing supply inclusive of the cost of irrigation delivery system and establishing suitable property rights to the users. Obviously, if this cost is higher for larger irrigation projects than for smaller ones, in spite of scale advantage of the farmer, the farmers are likely to prefer the latter rather than the former. Moreover, this cost has to be covered – that is, the users

[4] *One can make this curve rising as well, without loss of generality.*

must be willing to pay for it and the suppliers must be in a position to realize it to maintain supply. In other words, for supply of irrigation water to be meaningful to a farmer, it has to conform to his requirements of prior assurance about timeliness, the right quantity and the right quality at an affordable price. This means the supplier - just like good corporations do - has to maintain regular contacts with the demanders and conduct regular market surveys to adjust supply to the requirements of the demanders. It seems a very important lacuna of our existing irrigation supply system is the lack of effective interface between the supply side and the demand side, in spite of CADA, and it appears this interface is weaker, the larger the irrigation project. Obviously, a host of factors are responsible for not converting created irrigation potential in engineering terms into a usable economic resource. Through interaction with the supplying agencies, we need to identify the various possible loopholes including those due to faulty designs, political intervention, etc., besides being able to lay our fingers on some data on this subject to explain the gap in utilization of created irrigation potential for policy analysis.

2.3 In a developmental perspective, a supplier cannot afford to ignore the factors determining the economic demand curve for irrigation water. Obviously, irrigation demand being an input demand, it has to be a derived demand – derived from the prices of outputs the farmer produces, and the prices of various inputs the farmer uses, and the markets thereof. The stronger the markets for the farmer's outputs, the higher will be the demand for irrigation water. It will also depend positively on availability of complementary inputs in production and negatively on the prices of such inputs. Generally speaking, demand for irrigation water will also depend positively on the prices of substitutes (say, for example, prices of underground water, lift irrigation etc.). The greater the risk the farmer faces in his economic environment, including those affecting his family, the farmer's demand for irrigation water from any project will suffer. This is what follows from economic theory. So, a sensible supplier has to understand the mechanisms or factors which underlie the demand for irrigation water, and like good corporations or a development entrepreneur, the supplying agency must undertake pro-active steps to boost up the demand curve (DD). If the supplier government agencies, or even the consumers of irrigation water – i.e., the farmers become interested, they can even organize the users of water such that the latter can easily resolve their conflicts from within and have a much healthier interface with the suppliers. This means when water users' associations (WUAs) are in place, we need to examine them and judge their efficiency. If they are not in place, the vacuum has to be understood and filled in. Although examining the efficacy of WUAs is not the subject of this study, it appears from the literature that not enough has been done to boost up demand. The lower the height of the demand curve DD, the greater are the problems of underutilization of irrigation in both economic and engineering terms.

2.4 In order to explain the gap between IPC and IPU, the IIMA Study Team conceptualized the problem in terms of a simple supply-demand diagram for irrigation services, irrespective of whether it is a case of major/medium or minor irrigation. In Figure 2.1 there is an investment in irrigation capacity, which may be termed as supply in potential (or even engineering sense) sense, Seng a vertical line in the diagram. This is different from the economic concept of regular supply and demand curves, SS and DD, respectively, which aren't independent of price of irrigation, as costs need to be incurred to make potential irrigation to be available to farmers at his doorsteps through development of canals, channels and a delivery system (represented by a typical upward–sloping supply curve, SS), and an effective demand curve of the usual shape (DD), wherein farmers display their willingness to pay. If regular demand and supply curves, DD and SS, are considered, equilibrium takes place at point X at price P_0. The equilibrium quantity decided by economic logic is nothing but IPU, which differs from the potential, IPC, as given by the vertical supply curve, Seng. At this price, unfortunately, there is a gap between IPC and IPU, i.e., there is excess capacity, on the one hand, and deficient demand, on the other – a typical situation often encountered in reality. For both demand and supply gaps to disappear, not only the price of irrigation must rise to P_1, but also the farmers must be willing to pay the same – i.e., there must be enough boost in the demand curve, to say D_1D_1, such that that the demand curve for irrigation also passes through the same point Y, where the rising economic supply curve meets the potential supply curve, thus making full utilization of created irrigation potential. In summary form, this is the story of gap between IPC and IPU, which the IIMA

Study Team has been trying to analyze in operational terms. It may be highlighted in this context that when developmental investments are made to create irrigation potential, suitable intervention measures are needed to push down costs of supply and/or to boost up demand, so that the farmers are willing to pay the right price for full utilization of potential created. In other words, the lesson is that merely leaving everything to the whims of an often ill-functioning market in water is likely to generate puzzling demand-supply gaps, as we are observing between IPC and IPU over the years. The story of milk, popularly known as the AMUL story becomes relevant in this context, where visionary leadership didn't remain content with investment in capacity, but undertook pro-active steps to play with supply of milk and milk products, but also to boost up demand for the same. In recent times, a Hyderabad based organization called BASIX has started doing the same thing in the context of credit. One can extract the necessary lessons out of these examples to develop a healthy irrigation system in this country, thereby getting rid of the age-old under-utilization problem. Probably this is what is missing in the context of irrigation! Administered pricing of irrigation water together with administered allocation of water across conflicting uses, sometimes in response to the demands of the spot political market, seem to have further compounded the problem, thus raising serious doubts about sustainability of livelihoods, food safety and ecological safety – all revolving around wise use of water.

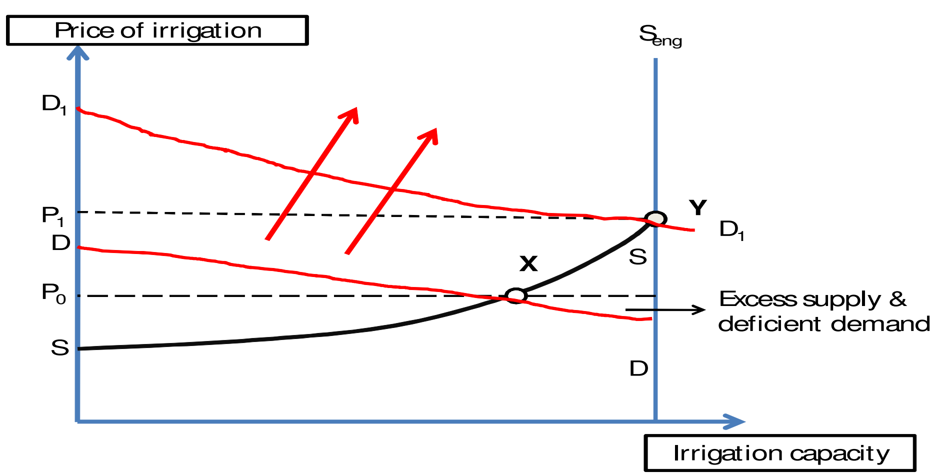
2.5 To formalize the issues conceptually, we begin with the premise that water is demanded for several purposes.

1. For drinking purposes;
2. For agriculture (~70%);
3. For industrial production, and for economic development, in general;
4. For cleaning environmental pollutions.

While water from drinking purposes is dependent on population growth of humans and animals, which may be considered a direct demand, the rest are derived demands. Derived demands arise from demands for agricultural and industrial products and the emerging demand for pollution free life. Thus, demand for irrigation water is influenced by factors operating in agricultural product markets as well as the input markets, specifically the complementary ones in the present context. An increased demand for an agricultural crop will increase the demand for water and vice versa. Similarly, an increased and cheap supply of credit, fertilizers, and/ or improved variety of seeds will also increase the demand for water. On the other hand, rapid industrialization, urbanization and increased requirement of water to cleanse the environment of accumulating pollutants may increase the relative price of water for irrigation and reduces its demand. The relative priorities assigned by our socio-economic-political system to the various sources of demand for water will obviously influence not only irrigation demand, but also its supply. In the simplest possible manner we propose to formulate a demand curve for irrigation water as a function of cropping pattern, i.e.,

DWATER = function of (Cropping pattern among other factors).

Figure 2.1: A Conceptual Framework to understand (IPC-IPU) Gap



2.6 Several factors like crop water requirement for the crops being grown, prices of agricultural products, input prices, urbanization, industrialization, environmental pollution, relative price of water for irrigation, climatic variations will influence the cropping pattern in a certain region. A change in cropping pattern will in turn change the demand for water. An increase in area under cultivation of wheat at the expense of reduction in those under winter paddy will reduce the demand for water, as crop water requirement for paddy is much higher than that for wheat. An above-normal monsoon rain may also influence a reduction in demand for water for irrigation. On the other hand, an increase in the market price of paddy relative to that of wheat may increase the demand for water. We present below a schematic diagram (Figure 2.2) from Chapagain and Hoekstra (2004) [Water Footprints of Nations: Vol:1: published by Institute of Water Education: UNESCO-IHE: The Netherlands: p. 16], that may be used to estimate the water footprints at a state level. Incidentally Chapagain and Hoekstra estimated the water footprint of India at an average of 980 m^3 per capita per year between 1997 and 2001 for an estimated population of 1,007,369,125. Out of this 38 m^3 per capita per year is required for domestic consumption, 907 m^3 per capita per year for domestic agricultural production and another 19 m^3 per capita per year for domestic industrial production. The rest of the water consumed is obtained through the water content of agricultural and industrial products imported. Some portion of the water consumed domestically to produce agricultural and industrial products is also virtually exported through the exports of commodities. We it is thus possible to estimate the demand for irrigation water by using the methodology proposed by Chapagain and Hoekstra (2004) even at the level of the states/UTs. However, given the time constraints, values of a good number of important determining factors will be picked up from Chapagain and Hoekstra (2004) assuming that they are uniform across the country. We may also, for the sake of simplifying the issue at hand and at the cost of precise estimates, assume away the impact of trade in agricultural products among the states. We propose to formulate a supply curve of water as function of supply curve of irrigation water as function of delivery efficiency of the irrigation system, i.e.,

S_{WATER} = *function of (delivery efficiency of the irrigation syste among other factors).*

2.7 Delivery efficiency of an irrigation system will depend on factors like design (which may include political influence as well), maintenance expenditure, natural wear and tear of the system, variations in climatic parameters – rainfall, rate of evaporation etc., efficiency of farm level water delivery management system, like Water Users' Association (WUA), cost of irrigation and the price of irrigation recovered from the users, the extent of conjunctive use of irrigation water, possible over-exploitation of ground water reserve etc. It should be clarified that while the major and medium irrigation schemes are solely owned and managed by the State, the minor irrigation systems, composed of dug wells, shallow tube wells, deep tube wells, surface flow schemes and surface flow schemes, are not necessarily always state-owned and state-managed. Rather they are predominantly owned and managed privately. The nature of distribution of the sources of minor irrigation according to ownership is given in Table 2.1 below. The underlying causes behind inefficiency of minor irrigation schemes are thus bound to be different from those affecting the performance of major and medium irrigation schemes.

2.8 The 3rd Minor Irrigation Census lists the following reasons behind the supply inefficiency of minor irrigation schemes:

- Inadequate power supply, mechanical breakdown and less water discharge appear to be the important factors affecting supply of irrigation water from dug wells, shallow tube-wells, deep tube-wells and surface lift irrigation systems.
- In addition, surface lift irrigation systems are also affected by storage siltation and channel breakdown-problems i.e. affect proper functioning of surface flow irrigation system as well. Surface flow systems also suffer from an additional problem of non-filling up of storage capacity.

Figure 2.2: Steps in Estimation of Demand for Water through Water Foot Print Method

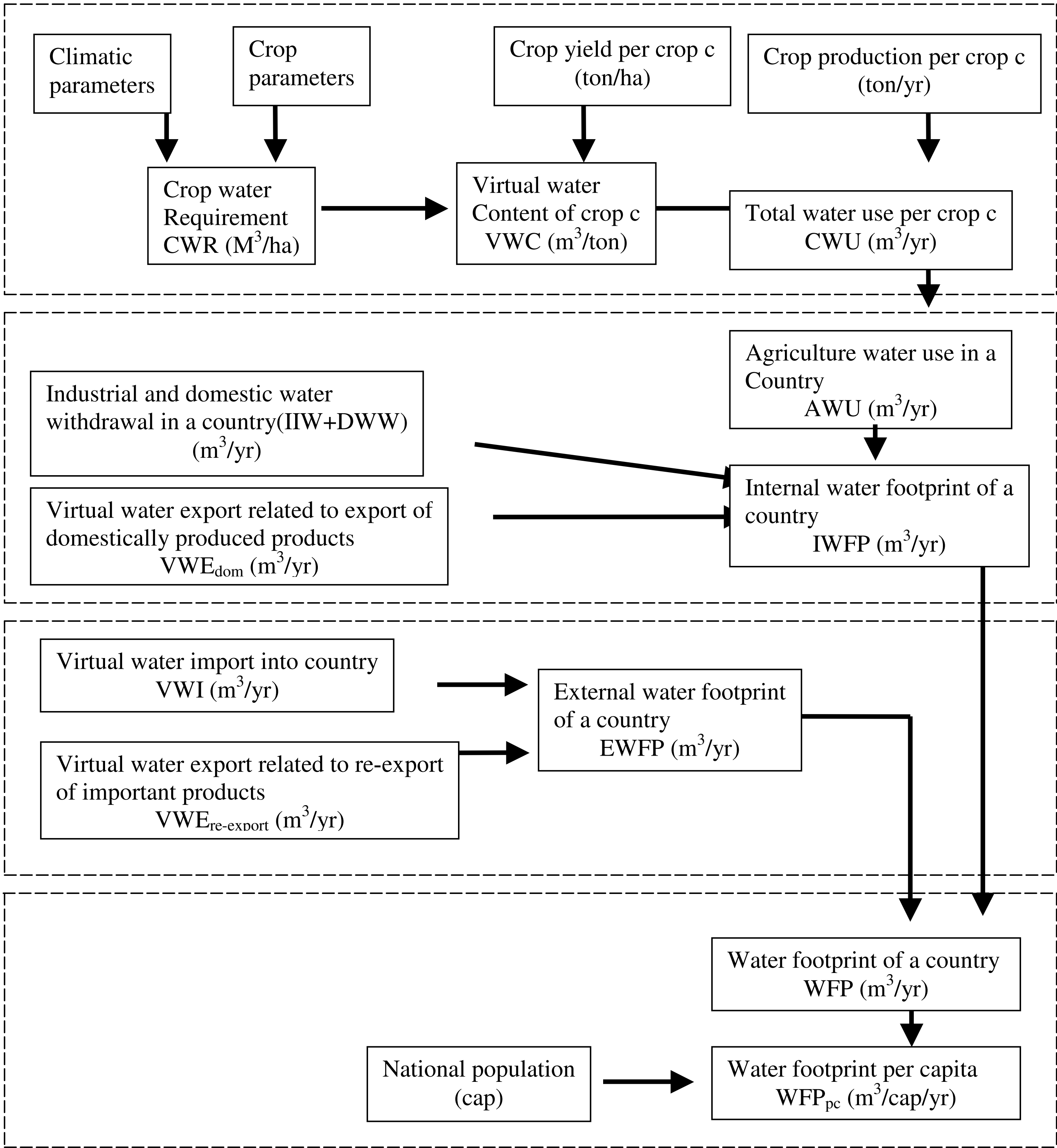


Table: 2.1 Ownership Pattern of Sources (in percentage terms) of Minor Irrigation

Source	Govt.	Cooperative	*Panchayat*	Farmer group	Individual farmers	Others	Total
Dug well	1.79	0.10	0.15	16.76	80.94	0.26	100.00
Shallow tube well	0.57	0.09	0.23	4.01	94.57	0.54	100.00
Deep tube well	9.49	0.36	0.66	27.64	0.00	61.86	100.00
Surface flow	41.24	0.38	7.11	15.29	33.80	2.17	100.00
Surface lift	9.05	0.49	0.55	10.48	77.63	1.80	100.00

Source: 3rd Census of Minor Irrigation Schemes (2000-01)

2.9 Data from the latest minor irrigation census coupled with data collected through selective sample studies will help identify the factors influencing delivery efficiency of minor irrigation systems at the level of the states and help estimate the supply of water function in minor irrigation.

2.10 The supply curve of major and medium irrigation seems to be shaped mainly by

- Engineering design of the irrigation system – reservoir, main canals, distributaries and field channels;
- Political influence in altering the design of the irrigation system – changed location and size or length of reservoir, main canals, distributaries and field channels during or after the designing exercise or reduction/enlargement in the size of the irrigation system due to financial resource constraint/surplus, thus deviating from optimal design;
- Maintenance structure of the irrigation system – reservoir, main canals, distributaries and field channels – to ensure the designed level of water flow;
- Climatological uncertainties – variations in precipitation (influencing availability of water) and temperature (influencing leakage);

- Geographical uncertainties – land slides at the source of the watercourse, if the river originates from mountains and change in the course of the main source of water.

2.11 A good number of studies have been commissioned by the Central Water Commission to study the water use efficiency of some selected major irrigation projects across the country. Clues and methods may be picked up from these studies to estimate the supply function of water for major and medium irrigation systems. Obviously, a detailed sample study is necessary to plug in the existing data gaps in secondary source materials. Thus, the overall supply curve of irrigation water will have two distinct components:

S_{WATER} = *s(delivery efficiency of the major and medium irrigation system) + s'(delivery efficiency of the minor irrigation system).*

2.12 We now summarize some methodological issues that emerged prominently during several brain-storming sessions conducted by the IIMA study team and through separate discussions with officers from relevant state/UT departments and well known NGO's/authorities on this subject.

2.13 Logically the widening absolute gap between irrigation potential created and utilized in this country since 1950, may be a normal one like a percentage buffer, or due to overstatement of potential created or understatement of potential utilized or both. Suitable methodological tools are necessary to be developed and applied to distinguish between the contributions of over-estimated IPC and underestimated IPU. The factors influencing supply of and demand are to be clearly identified to distinctly estimate their respective contributions in over-estimation of supply and/or under-estimation of demand.

2.14 We must mention in this context that interaction with relevant officials at state, central and NGO levels provided the following clues:

- The estimates of ultimate irrigation potential is relevant for a particular point of time since the estimate is derived on the basis of a number of assumptions about cropping pattern and water allowance, which undoubtedly vary over time, leading to changes in the estimated value of ultimate irrigation potential over time;
- The estimate of gross irrigated area is a possible under-estimate as areas under two-seasonal and perennial crops are counted only once. On the other hand, it may be over-estimated if areas under other projects from the new command area are added;
- Estimates of CCA are often arbitrarily arrived at without carrying out any survey;
- IPC of a new project is the aggregate of all areas at the end of watercourses where water could be delivered from the project and IPU is the total gross area actually irrigated during the year under consideration. There is often a possibility that the water-courses – to be developed by the farmers – are not in place;
- IPC and IPU are parameters developed by the Planning Commission for monitoring a project and are to be compared in a project specific manner. They, perhaps, cannot be aggregated at a regional level and compared;
- Estimates of IPC and IPU being dependent on a number of parameters that change over time, this aggregation over time is also methodologically unsound;
- There are possibilities in variations in estimates of IPC and IPU as different organizations compute them with different objectives;
- The gap should be tried to be bridged through micro level infrastructure development and efficient farm-level water management practices.

2.15 A question is thus raised about the wisdom of innocently adding up the potential created over the years without adjusting for the possible natural wear and tear that might have affected the potential supply of irrigation water from an older irrigation system. So, one may like to estimate a suitable 'discount rate' that would help estimate the net present potential of older irrigation systems. Such discount rates will obviously vary over space, if not over time as well. A positive value of such an estimated discount rate will effectively capture the nature of over-estimation of IPC.

2.16 Another issue is concerned with the wisdom of comparing IPC with IPU at the same point in time estimate the gap. Experiences suggest that an irrigation potential created cannot be immediately utilized for want of fulfilling a host of conditions outside the purview of the effort that was put in to create the potential like construction of field channels, crafting the relevant institutional mechanisms at the user level, augmenting the demand for water through necessary changes in cropping pattern etc. Such realizations lead one to expect an operational lag existing between the creation and utilization of irrigation potential. The gap will obviously be larger in case of major and medium projects than that existing for minor irrigation projects. A rudimentary analysis (which needs further and more rigorous econometric testing) of a possible lagged behavior using data that are presently available (at the end of each plan period) seems to suggests that the gap is negative till 1990 (roughly with a five year lag)- result which apparently rejects the in-efficiency implications underline lag adjustment hypothesis. It is however important to report that this lag started becoming positive only from 1992, thus possibly raising a question whether demand for irrigation suffered as a result of opening up agriculture market to international discourses following liberalization of the country in the decade of 1990s. A further analysis, using annual figures disaggregated at the level of states and across major and minor schemes will help identify the extent of effective lag between creation and utilization of irrigation potential.

Chapter 3

Study Methodology and Sampling Design

3.1 The following framework has been developed to operationalize the conceptual framework discussed earlier. In this section we make an earnest attempt to identify quantitatively measurable factors that contribute to the gap we are keen to analyze. Once the factors contributing to the gap are identified tentatively, it is necessary to collect primary data from selected representative samples to probe the relationship between the gap and the responsible factors in a greater detail to arrive at a statistically significant quantitative estimation of the contribution of the identified factors to the gap. The methodological framework helps position the factors in a structural perspective.

3.2 As already mentioned in the MoU, the objectives of the study are to

1. measure the gap between IPC and IPU;
2. identify the factors contributing to the measured gap and
3. estimate the contributions of the identified factors to the measured gap.

We propose to disaggregate the gap into two components, namely, supply side gap and demand side gap. While the former emerges because of influences of factors that are in the supply side domain, some under the control of irrigation providers and some beyond human control, the latter happens as the factors in the demand side – mostly influenced by the farmers who demand water – become operative. To facilitate conceptualization, we define a few concepts beforehand:

IPC_{DESIGN}: Irrigation potential intended to be created at the design stage;

IPC: Irrigation potential created when the project was operationalized;

IPR: Irrigation potential as being realized now.

3.3 We begin on the premise that data generated at Planning Commission refer to IPC and not to IPC_{DESIGN}. Thus the job at hand is to estimate

IPC – IPU which can be expressed as

$$IPC - IPU = (IPC - IPR) + (IPR\text{-}IPU) = SG + DG, \quad (1)$$

where IPR refers to current period IPC, thus taking care of the dynamics of IPC between the completion stage and its status as reported by Irrigation Department at the stage of undertaking this Study. While the first component captures the supply side gap – SG, the second one takes care of the demand side gap, DG.

3.4 For major and medium irrigation system

$$(IPC - IPU)_{MAJOR} = (IPC - IPR)_{MAJOR} + (IPR\text{-}IPU)_{MAJOR} = SG_{MAJOR} + DG_{MAJOR} \quad (1a)$$

In order to identify the contributions of the components that have impact on SG_{MAJOR} we hypothesize that

$SG_{MAJOR} = S_{MAJOR}$ (Water availability, conveyance efficiency of irrigation system, diversion to other uses) (2a)

Water availability is dependent on natural – climatic factors beyond human control and land use changes in the catchment area of the system, also beyond the control of irrigation providers.

3.5 Conveyance efficiency of the irrigation system is measured by the wear and tear of irrigation system and the maintenance costs incurred in maintaining the systemic parameters to the desired level coupled with organizational structure crafted towards management of water supply, like availability of manpower etc. These factors are expectedly under control of irrigation providers.

3.6 Diversion of water meant for irrigation purposes to other uses like industrial purposes, drinking water as a result of urbanization in and around the command area of the project and cleansing of environmental pollution etc can effect a gap between IPC and IPR. These factors are again beyond the control of the irrigation providers. Schedules I through V (Annexures 2.1 to 2.5) have been used to generate the relevant primary data for the variables mentioned above.

3.7 We also define

$DG_{MAJOR} = D_{MAJOR}$ (attributes of supply as perceived by farmers, cropping pattern, land utilization pattern, alternative sources of irrigation, social capital) (3a)

We differentiate among the variables across head and tail ends of the system. While the attributes of supply, i.e., availability of water in right quantity as and when required will indicate the extent of coordination failure between farmers and irrigation providers, cropping pattern will capture the influence of input and output markets related to agri-crops, physical infrastructure and technology, land utilization pattern will capture the influence of land market, alternative source of irrigation will capture the extent of conjunctive irrigation in influencing demand for water for irrigation purposes. Primary data collection schedules VI through VII (Annexures 2.6 to 2.7), have been used to generate the relevant data for the variables mentioned above.

3.8 Coming to the issues pertaining minor irrigation system, we can simply put that

$$(IPC - IPU)_{MINOR} = (IPC - IPR)_{MINOR} + (IPR - IPU)_{MINOR} = SG_{MINOR} + DG_{MINOR} \quad (1b)$$

However, given the fact that all minor irrigation systems are not homogenous in terms of water source, we argue that SG for minor irrigation (SG_{MINOR}) can be further decomposed into two components, namely SG_{GROUND} and $SG_{SURFACE}$. Similarly DG_{MINOR} can be decomposed into DG_{GROUND} and $DG_{SURFACE}$. Understandably,

$SG_{MINOR} = SG_{GROUND} + SG_{SURFACE}$ and

$DG_{MINOR} = DG_{GROUND} + DG_{SURFACE}$

Since most of the surface water minor irrigation systems are similar in physical characteristics to major/medium projects, barring their size and are mostly owned and maintained by State, cooperatives, *panchayats* and groups of farmers, we use the same structural forms as defined for major and medium irrigation schemes. Thus

$SG_{SURFACE} = S_{SURFACE}$ (Water availability, conveyance efficiency of irrigation system, diversion to other uses) (2b)

and

$DG_{SURFACE} = D_{SURFACE}$ (attributes of supply as perceived by farmers, cropping pattern, land utilization pattern, alternative sources of irrigation, social capital) (3b)

3.9 However, for ground water systems, which are mostly owned by private individuals, we may use some other structural forms.

$SG_{GROUND} = S_{GROUND}$ (Ground water level, Availability of source of energy, Price of energy, Availability of technical support for repair and maintenance) (2c)

We hypothesize that the supply of ground water is dependent on the ground water level – the higher the level, the higher the supply. Availability and price of energy also influence SG_{GROUND} in opposing ways. An increase in availability reduces SG_{GROUND}, while an increase in price increases it.

3.10 The demand gap for ground water may be slightly reformulated as

$DG_{GROUND} = D_{GROUND}$ (cropping pattern, land utilization pattern, alternative sources of irrigation) (3c)

Attributes of supply as perceived by farmers and social capital are dropped from (3a), keeping in mind that ground water sources are mostly owned by individual farmers and hence these two variables do not play much role in influencing the demand gap.

3.11 We simultaneously determine the influence of minor irrigation system on the major and medium ones and vice versa. So when we estimate DG for major/medium projects, minor irrigation from surface and ground water sources will appear as alternative sources. As we estimate DG from minor ground water system, the independent variables related to alternative source will be major/medium projects and minor surface water schemes. When DG for minor surface water system is the dependent variable, the independent variables vis-à-vis alternate sources are major/medium projects and minor ground water schemes. Information collected through Schedules VI (both A & B) and VII (i.e., Annexures 2.6 & 2.7) were intended to be used to estimate both SG_{GROUND} and DG_{GROUND}.

3.12 Appropriate variables from the schedules are necessary to be identified to specify any quantitative relationship between the dependent and independent variables mentioned in equations (1) to (3). To begin with we link the variables to data collected using the secondary schedule. Water availability is measured by total release into main canal (pre-monsoon and post-monsoon added together) normed by (i) CCA and (ii) length of the canal system. Since no variables are available for conveyance efficiency we use O&M expenditure (work only) to be normed by (i) CCA and (ii) length of canal system. Diversion of water from irrigation is measured by the ratio of water released for non-irrigation purposes to (i) total water released (ii) CCA

3.13 Now we turn to spelling out the sampling framework necessary to identify the projects, villages and households that would be true representatives of their respective states, given wide variations existing in each of the states for which the gap between IPC and IPU is to be estimated and subsequently explained. Obviously the sampling framework to be followed for estimating the gap in respect of major and medium projects will be different from that to be followed in relation to minor projects.

3.14 First, we concentrate on the sampling framework followed for major/medium irrigation projects. The terms of reference of the present study spell out categorically that 6 projects in each state – 2 of them being major and the rest being of medium size – are to be studied in detail to help identify the factors contributing to the gap. In addition, one cluster of villages in each state is to be identified to look into the factors contributing to the gaps in minor irrigation. In order to facilitate the identification of the sample projects under major and medium irrigation system, we circulated a four page questionnaire to seek some details about each of such systems existing in a state/UT. The format of the questionnaire is given in the appendix.[5]. To distinguish it from the rest of the questionnaires designed to collect primary information at the sample project level[6] this questionnaire is assigned the nomenclature of secondary schedule.

3.15 The sampling framework is, therefore, designed so as to enable us to identify

- Representative projects – major and medium in a state (Secondary schedule and Schedule I of primary instruments);

[5] *Annexure 1*
[6] *Annexure 2*

- Representative main/branch canals in the selected project (Schedule II);
- Representative distributaries on the selected main/branch canal (Schedule III);
- Representative minors/sub-minors on the selected distributary (Schedule IV;
- Representative outlets on the selected minor/sub-minor (Schedule V) and
- Representative households receiving irrigation water from the selected outlet (Schedule VII).

Since the selected outlets identify the villages they are located in, no separate exercise is carried out to identify sample villages (Schedule IV used to collect data for the selected villages).

3.16 However, it should be mentioned, we did not receive filled in secondary schedules on time from most of the states so as to enable us to use the relevant information to identify the sample projects. So we used the list of major and medium irrigation projects supplied to us by most of the states that contained information about

- Name of the project;
- Location of the project and
- CCA of the project.

Irrigation projects across any particular state vary in terms of their culturable command areas (size) and location. In order to be able to be sensitive to these variations, the states are divided into different geographic regions following the patterns generally used by the respective states. The projects, on the other hand, are marked big and small, depending on their CCA. Projects with higher CCA than the average CCA of all the projects were identified as big, while the rest were tagged small. Two-way tables, separately for major (CCA > 10000 Ha) and medium (CCA>2000 Ha but <10000 Ha) projects have been constructed and the number of projects falling under each cell has been recorded. The cells with larger concentration in number across regions and two broad sizes are identified and projects are picked up randomly from each cell.

3.17 Once the projects are randomly identified, a simple logic is used to select the sample outlet. The main/branch canal with the highest CCA is picked up. Three distributaries – one each at the head, middle and tail end – are identified from the selected main/branch canal, criterion for selection again being the ones serving the highest CCA. Three minors, serving highest CCAs, are again picked up – one each at the head, middle and tail end – from each selected distributary located at its head, middle and tail ends. Finally, two outlets – located at the head and tail ends of the minor are identified, again using the largest CCA criterion, for deeper scrutiny. Four holdings out of the holdings served by the selected outlet are to be identified. The method used to identify these holdings will rather be a bit complicated. It will involve the following three distinct steps:

Step I: All the holdings covered by an outlet have been linked to the households owning them. A listing of holdings along with their owners' names, area of holding and whether conjunctive irrigation is practiced or not by the farmer have first been made. It is to be noted that need not always be a one-to-one correspondence between owner of a parcel and a household. In some cases a household may own more than one holdings falling within the CCA of a selected outlet.

Step II: The total ownership holding of the farmers who figure in the list is ascertained, irrespective of whether the rest of the ownership holdings are served by the selected outlet or not.

Step III: Farmers having a total ownership holding of 2 hectares or less has been termed small farmers and the rest as big farmers. A probability proportionate sample of 3 farmers is chosen at random with a rider that at least one of them would be a large farmer, if one such exists. The fourth farmer was chosen randomly out of those who practice conjunctive irrigation. In case no one among the farmers served by the particular outlet practices conjunctive irrigation, the fourth farmer was also chosen along with the first 3 farmers in a probability proportionate manner. The same principle was be applied in case a farmer practicing conjunctive irrigation is already identified among the first three samples.

3.18 It is imperative that some fixed norms are developed in locating the head and tail ends of a main/branch canal, distributary or minor. As a rule of thumb, the canal in question was divided into two equal parts across its total length. The first part is considered the head end, the second part is identified as the tail end. For example, if a distributary has a length of 2 kilometers, any minor off-taking from the first kilometer will be considered to be on the head end. The rest emanating from the stretch between 1st and 2nd kilometer belong to the tail end. Follows below the state-wise list of major and medium irrigation projects identified to draw representative samples for the respective states. For major projects (2 to be selected out of 20): given average CCA = 56918 Ha, the two selected projects are:

- *Ukai-Kakrapar – South Gujarat – Surat – CCA: 331559 Ha – Big*
- *Dantiwada – North Gujarat – Banaskantha – CCA: 45823 Ha – Small*

For medium projects (4 to be selected out of 55), given Average CCA = 4353 Ha, the selected projects are:

- *Und (Jivapur) – West Gujarat – Jamnagar – CCA: 9800 Ha – Big*
- *Jojwa Wadhwan – Central Gujarat – Vadodara – CCA: 8800 Ha – Big*
- *Umaria – Central Gujarat – Dahod – CCA: 2378 Ha – Small*

  Rudramata – West Gujarat – Kachchha – CCA: 2997 Ha – Small

Table 3.1: Distribution of major projects according to size and region in Gujarat

	TOTAL	BIG (>average CCA)	SMALL (<average CCA)
NORTH	6	1	**5**
CENTRAL	7	1	6
WEST	3	0	3
SOUTH	4	**2**	2

Table 3.2: Distribution of medium projects according to size and region in Gujarat

	TOTAL	BIG (>average CCA)	SMALL (<average CCA)
NORTH	2	2	0
CENTRAL	12	7	5
WEST	37	**12**	**25**
SOUTH	4	2	2

3.19 A similar exercise is done for the states of Rajasthan, Punjab, H & P and J & K in Tables 3.3 to 3.7.

Table 3.3: Distribution of major projects according to size and region in Rajasthan

	TOTAL	BIG (>average CCA)	SMALL (<average CCA)
NORTH	2	**2**	0
SOUTH	5	1	**4**
EAST	3	0	3
WEST	1	0	1

Major Projects (2 to be selected out of 11): Average CCA: 66319 Ha

Selected Projects:

- *Sidhmukh Nahar – North Rajasthan – Hanumannagar – CCA: 93000 Ha – Big*
- *Parwati – South Rajasthan – Kota – CCA: 11040 Ha -- Small*

Table 3.4: Distribution of medium projects according to size and region in Rajasthan

	TOTAL	BIG (>average CCA)	SMALL (<average CCA)
NORTH	0	0	0
SOUTH	35	**18**	**17**
EAST	18	6	**12**
WEST	4	**1**	3

Medium Projects (4 to be selected out of 57): Average CCA: 4989 Ha

Selected Projects:

- *Chappi – Southern Rajasthan – Jhalawar – CCA: 10000 Ha – Big*
- *Sardar Sammand – Western Rajasthan – Pali – CCa: 8560 Ha – Big*
- *Baretha Bund – Eastern Rajasthan – Bharatpur – CCA: 2830 Ha – Small*
- *West Banas – Southern Rajasthan – Sirohi – CCA: 4080 Ha – Small*

Table 3.5: Distribution of major projects according to size and region in Punjab

	TOTAL	BIG (>average CCA)	SMALL (<average CCA)
NORTH	4	**1**	**3**
SOUTH	0	0	0
EAST	0	0	0
WEST	2	0	**2**
SOUTH & EAST	1	0	**1**
SOUTH, EAST & WEST	1	**1**	0

Major Projects (6 to be selected out of 8 as there is no medium project): Average CCA: 434500 Ha.

Selected Projects:

- *Sir Hind Canal System – South, East & West Punjab – Ludhiana, Moga, Bhatinda, Sangroor – CCA: 1333000 Ha – Big*
- *UBDC System – North Punjab – Gurdaspur, Amritsar – CCA: 578000 Ha – Big*
- *Bist Doab System – North Punjab – Jullandhur – CCA: 199000 Ha – Small*
- *Eastern Canal System – West Punjab – Ferozpur – CCA: 216000 Ha – Small*
- *Sir Hind Feeder System – West Punjab – Faridkote – CCa: 380000 Ha – Small*
- *BML Canal System – East & South Punjab – Ropar, Patiala, Fatehgarh – CCA: 322000 Ha – Small*

Table 3.6: Distribution of major projects according to size and region in J & K

	TOTAL	BIG (>average CCA)	SMALL (<average CCA)
JAMMU	2	**1**	1
KATHUA	1	0	**1**

Major projects (2 to be selected out of 3): Average CCA: 34431 Ha

Selected Projects:

- *Ranbir Canal – Jammu – CCA: 74800 Ha – Big*
- *Kathua Canal – Kathua – CCA: 14386 Ha – Small*

Table 3.7: Distribution of medium projects according to size and region in J & K

	TOTAL	BIG (>average CCA)	SMALL (<average CCA)
JAMMU	2	1	**1**
BARAMULLA	1	**1**	0
DODA	1	0	**1**
PULWAMA	1	**1**	0

Medium Projects (4 To Be Selected Out Of 5): Average CCA: 3700 Ha

Selected Projects:

- *Xainoair Canal – Baramulla – CCA: 5100 Ha – Big*
- *Marval Lift Irrigation Scheme – Pulwama – CCA: 4858 Ha – Big*
- *Kandi Canal – Doda – CCA: 3229 Ha – Small*
- *Ranjan Canal – Jammu – CCA: 2600 Ha – Small*

3.20 For the state of Haryana, all the existing major projects – 6 in number – get automatically selected as there is no medium project:

- *Gurgaon Canal: Gurgaon : CCA: 123621.05 Ha*
- *Loharu Lift: Bhiwani – CCA: 3522.26 Ha*
- *Naggal Lift:*
- *Tail BML: Sirsa – CCA: 49856 Ha*
- *Western Jamuna Canal: Jind – CCA: 9985.82 Ha*
- *Jawahar Lal Nehru Irrigation Project: Rewari – CCA: 3522.26 Ha*

3.21 Similarly, for the state of Himachal Pradesh, all medium projects are selected as there is no major project.

- *Balh Valley Right Bank – Mandi – CCA: 2410 Ha*
- *Bhabour Sahib Phase Ii – Una – CCA: 2640 Ha*
- *Giri – Sirmohar – CCA: 5263 Ha*

3.22 For the UTs of Delhi and Chandigarh, there is no major, nor any medium project. For the UT of Dadra & Nagar Haveli, therefore, *Major Projects: Nil,*

Selected Projects: Nil,

Medium Projects: Daman Ganga Project: CCA: 4235 Ha: (Only One Exists).

Selected Project: Daman Ganga Project

3.23 The framework for drawing a multi-stage sample for major/medium irrigation projects is displayed in Figure 3.The list of identified samples of

- Main/Branch Canal,
- Distributary,
- Minor and
- Outlets

for each of these projects following the sampling method detailed above are given in Annexure 3. The location maps of the sample projects are provided in Annexure 4.

3.24 Let us now concentrate on the sampling frame followed in respect of minor irrigation systems. The sampling process involved 3 steps.

Step I: For each state having both major/medium and minor irrigation systems as the source of irrigation, the districts falling in the least quartile in terms of share of major/medium sources have been identified. One out of them was randomly selected. Minor irrigation systems can be decomposed into five different categories as per the data from last Minor Irrigation Census. They are:

- Deep Tubewells (DEEPTW)
- Shallow Tubewells (STW)
- Dug Wells (DW)
- Surface Flow Irrigation Systems (SURFL) and
- Surface Lift Irrigation System (SURLFT).

The contributions of these five sources to the total irrigation potential created in each state/UT are not identical. Following tables have been generated from data obtained from the 3rd Minor Irrigation Census carried out by the Ministry of Water Resources, Government of India in 2001. While the first (Table 3.8) of them provides the absolute quantum of IPC out of several sources, the second one gives an idea about the share of different sources in the IPC in a particular state/UT. The second table (Table 3.9) identifies the three main sources of minor irrigation in each state/UT that covers more than 90% of their corresponding IPC. The third one (Table 3.10) identifies the three most important sources of minor irrigation in each state/UT.

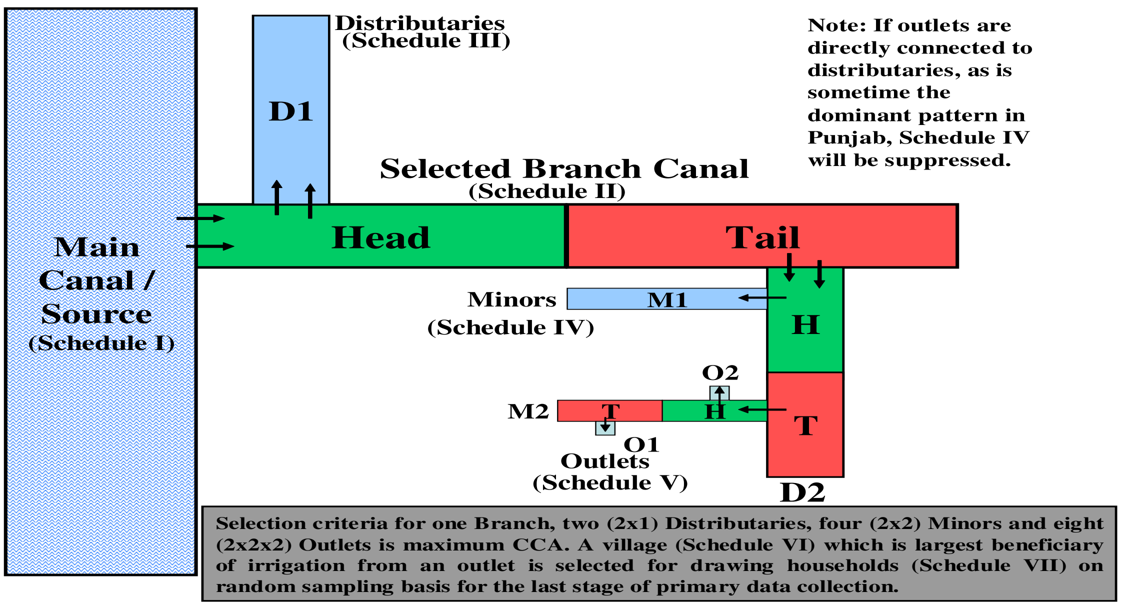


Figure 3.1: A schematic representation of a typical major/medium irrigation system

Table 3.9: Minor irrigation potential created across relevant states/UTs & sources

	IRRIGATION POTENTIAL CREATED (Hectares)					
STATE/UT	**Deep tube well**	**Shallow tube well**	**Dug well**	**Surface flow**	**Surface lift**	**TOTAL**
Gujarat	1101376	339028	2284782	435773	23839	4184798
Haryana	193218	2101481	70689	5208	3775	2374371
Himachal Pradesh	12864	9144	5775	155889	22747	206419
J&K	440	5537	22385	318427	31439	378228
Punjab	128423	6119083	13498	7257	10098	6278359
Rajasthan	539568	633641	3838899	123593	23876	5159577
Chandigarh	1415	515	0	0	0	1930
Dadra Nagar Haveli	0	0	1462	239	1349	3050
Delhi	6966	37837	0	244	456	45503
Total	1984270	9246266	6237490	1046630	117579	18632235

Table 3.9: % minor irrigation potential created across relevant states/UTs & sources

	% SHARE IN IRRIGATION POTENTIAL CREATED				
STATE/UT	**Deep tube well**	**Shallow tube well**	**Dug well**	**Surface flow**	**Surface lift**
Gujarat	26.32	8.10	54.60	10.41	0.57
Haryana	8.14	88.51	2.98	0.22	0.16
Himachal Pradesh	6.23	4.43	2.80	75.52	11.02
J&K	0.12	1.46	5.92	84.19	8.31
Punjab	2.05	97.46	0.21	0.12	0.16
Rajasthan	10.46	12.28	74.40	2.40	0.46
Chandigarh	73.32	26.68	0.00	0.00	0.00
Dadra Nagar Haveli	0.00	0.00	47.93	7.84	44.23
Delhi	15.31	83.15	0.00	0.54	1.00

Step II: Once the districts are identified, three villages are chosen from each of them. The criteria used to identify the villages are as under. Table 3.10 above identifies the three most dominant sources of minor irrigation in each state/UT. Villages in each district are arranged in descending order in terms of the number of units separately for each of the dominant sources. One village is selected at random from the first quintile under each category. Three sample villages from each state/UT are thus identified. In case the selected district does not have all the three dominant types of minor irrigation systems pertaining to the state the number of villages selected have been equal to the number of dominant systems located in the district.

Table 3.10: Three most dominant sources of minor irrigation in the relevant states/UTs

	3 MOST DOMINANT SOURCES OF MINOR IRRIGATION				
STATE/UT	**Deep tube well**	**Shallow tube well**	**Dug well**	**Surface flow**	**Surface lift**
Gujarat	√		√	√	
Haryana	√	√	√		
Himachal Pradesh	√			√	√
J&K			√	√	√
Punjab	√	√	√		
Rajasthan	√	√	√		
Chandigarh	√	√			
Dadra Nagar Haveli			√	√	√
Delhi	√	√			√

Step III: 48 minor irrigation systems are sampled out in each state. In case the identified district has all the three types of systems dominant in the state, 16 minor irrigation systems in proportion to the distribution of IPC of the three dominant systems in the identified village have been picked up randomly. In districts where only two villages have been picked up due to the absence of the third dominant system, the number of sample systems in each village has been 24. In case of individually owned and managed system, Schedules V and VII were administered to owner of each system. In case of a group-owned system, or If the system is owned by the state or *panchayat*, Schedule VII was administered to all the users of the system. Schedule V was also administered to the manager of the system. Schedule VI was filled up for each of the villages. Sample villages identified using the above procedure are given in Table 3.11.

Table 3.11: Selected Sample Villages for Studying Minor Irrigation Systems

State/UT	MIC Code	District	MIC Code[7]	Block	MIC Code	Village	MIC Code	Dominant system	Remarks
Chandigarh	30	Chandigarh	1	Nil	Nil	Nil	Nil	dug well	no dug well
	30	Chandigarh	1	Chandigarh	1	Maloya	16	shallow tube well	
	30	Chandigarh	1	Chandigarh	1	Malacca	2	deep tube well	
Delhi	33	Nangloi	5	Nangloi	5	Bakkarwala	12	surface lift	surface lift only at Nangloi
	33	Nazafgarh	1	Nazafgarh	1	Ghitorani	19	deep tube well	
	33	Nazafgarh	1	Nazafgarh	1	Chhawla	7	shallow tube well	
Gujarat	7	Gandhinagar	9	Kalol	3	Santej	61	surface flow	
	7	Gandhinagar	9	Gandhinagar	2	Karai	28	dug well	
	7	Gandhinagar	9	Gandhinagar	2	Limbadiya	36	deep tube well	
Haryana	8	Panchkula	19	Raipur rani	4	Barauna kalan	56	dug well	
	8	Panchkula	19	Raipur rani	4	Raipur rani	54	shallow tube well	
	8	Panchkula	19	Raipur rani	4	Tharwa	79	deep tube well	
HP	9	Una	4	Una	3	Up mahal uppar bhato	109	surface liftl	
	9	Una	4	Bahrwain(st)	5	Ghanghret	2	surface flow	
	9	Una	4	Una	3	Nagnoli haar	2	deep tube well	
Punjab	21	Kapurthala	9					dug well	no dug well in Kapurthala
	21	Kapurthala	9	Nadala	3	Nadara	88	shallow tube well	
	21	Kapurthala	9	Sultanpur	5	Kalru	80	deep tube well	
Rajasthan	22	Sikar	29	Sikar	5	Mandota	75	dug well	
	22	Sikar	29	Sikar	5	MunDug wellara	94	shallow tube well	
	22	Sikar	29	Sikar	5	Bhad kasli	114	deep tube well	
J & K	10	Doda	9	Paddar	9	Sohal	18	surface lift	
	10	Leh	5	Leh	4	Lagjung	52	Surface flow	
	10	Jammu	1	Akhnoor	1	Rakh kharan	165	dug well	
Dadra	31	Dadra	1	Dadra	2	Tighra	3	surface lift	
	31	Dadra	1	Kilavani	6	Silli	4	surface flow	
	31	Dadra	1	Dadra	2	Dadra	1	dug well	

[7] *MIC code refers to code numbers assigned in 3rd Minor Irrigation Census.*

Chapter 4

Findings from Published Secondary Data Sources

4.1 The present chapter focuses on relevant findings culled out by analyzing two aggregative datasets. The first dataset looks into the behavior of IPC and IPU along with that of Gross Irrigated Area (GIA) and Net Irrigated Area (NIA) over the plan period for the country as a whole. The second dataset consists of published data available from the last two minor irrigation censuses.

4.2 Incidentally, cumulative irrigation potential created through simple addition of capacity created over the years is not necessarily addition of homogenous items. A good amount of such potential has been created with large and medium irrigation – and often multipurpose — projects. The rest of the potential resulted out of minor – again distinguished between surface and ground water – irrigation schemes. The data for utilization also can be disaggregated along the same lines. It is, therefore, imperative to identify the gaps disaggregated in terms of the source of irrigation water. Aggregation across sources has the potential to mask some important factors that may give rise to this gap. A point that needs to be clarified at right here is that the gap identified as matter of concern for the country is an absolute one. It does not give much emphasis on the size of the gap in relation to the irrigation potential created. From the point of view of taking investment decisions, it is much more rational to consider a relative measure of the gap that captures the efficiency of an irrigation system to guide the future policies with respect to creation of creation of fresh irrigation potential in the years to come.

4.3 To begin with let us concentrate on the absolute measure of the gap between IPC and IPU. Table 4.1 below identifies the changing share of different sources in created irrigation potential over time. The interesting features to note are:

1. The share of major and medium irrigation systems in the total irrigation potential created has declined marginally between 1951 and 2002, having reached the peak around 1978.
2. The share of minor irrigation schemes, on the other hand, increased.
3. More importantly, the share of ground water as a source of irrigation potential created has increased significantly during the last 50 years. However, the share of ground water has been declining perceptibly, while that of surface water increased since 1992.

Table 4.1: Changing Share of Different Sources in Irrigation Potential Created

Year	Major and medium irrigation schemes	Minor irrigation schemes	Minor irrigation with surface water	Minor irrigation with ground water
1951	42.92	57.08	28.32	28.76
1956	46.46	53.54	24.49	29.06
1961	49.28	50.72	22.18	28.54
1966	49.36	50.64	19.30	31.34
1969	48.79	51.21	17.52	33.69
1974	46.83	53.17	15.84	37.33
1978	47.52	52.48	14.42	38.06
1980	47.01	52.99	14.13	38.86
1985	42.47	57.53	14.87	42.66
1990	39.10	60.90	14.36	46.54
1992	37.91	62.21	14.13	48.08
1997	38.20	61.80	14.50	47.30
2002	39.44	60.56	17.14	43.43

Source: Estimated with data available from the website of Ministry of Water Resources, Govt. of India: 2007

4.4 A look into Table 4.2, on the other hand, reveals the share of different sources in terms of irrigation potential utilized. It is evident that

- Share in utilization of irrigation potential from minor irrigation schemes is well over 60% with the lion's share provided by ground water based systems.
- Contribution of surface water based systems in utilization of irrigation capacity has been steadily declining, coupled with a steady increase in that of ground water based systems.

4.5 A comparison between respective columns of Tables 4.1 and 4.2 brings out further interesting features, as summarized below:

- Shares of major & medium as well as the same for minor surface irrigation seem to be lower when compared to potential utilized rather than potential created, thus apparently signaling agency problem in use of surface water.
- A comparison of shares of minor irrigation in general or minor ground water irrigation in IPU to their counterparts in IPC, on the other hand, displays an opposite pattern – that is, better performance in terms of potential utilized, probably reflecting lesser agency problem between supplier and user of irrigation water, especially with respect to ground water sources.

Table 4.2: Share of Different Sources in Irrigation Potential Utilized

Year	Major and medium irrigation schemes	Minor irrigation schemes	Minor irrigation with surface water	Minor irrigation with ground water
1951	42.92	57.08	28.32	28.76
1956	43.85	56.15	25.68	30.47
1961	46.94	53.06	23.20	29.86
1966	47.16	52.84	20.14	32.70
1969	46.85	53.15	18.18	34.97
1974	43.90	56.10	16.71	39.39
1978	43.66	56.34	15.48	40.86
1980	43.01	56.99	15.20	41.79
1985	40.07	59.93	15.32	44.61
1990	37.13	62.87	14.54	48.33
1992	36.12	63.88	14.12	49.76
1997	37.29	62.71	14.51	48.20
2002	38.73	61.27	15.35	45.92

Estimated with data available from the website of Ministry of Water Resources, Govt. of India: 2007

4.6 Table 4.3 displays absolute gap between IPC and IPU for different irrigation categories over the years. It is observed that the lion's share of the gap is accounted for by minor irrigation schemes, and more so by ground water based systems.

Table 4.3: Source-wise Break up of Absolute Gap between IPC and IPU (million hectares)

Year	Total Gap	Major & Medium Schemes	Minor Schemes	Surface Water Schemes	Ground Water Schemes
1951	0	0	0	0	0
1956	1.22	1.22(100)	0	0	0
1961	1.28	1.28(100)	0	0	0

1966	1.4	1.40(100)	0	0	0
1969	1.35	1.35(100)	0	0	0
1974	2.31	2.31(100)	0	0	0
1978	3.56	3.56(100)	0	0	0
1980	3.97	3.97(100)	0	0	0
1985	6.4	4.13(64.53)	2.27(35.47)	0.69(10.78)	1.58(24.69)
1990	7.94	4.45(56.05)	3.49(43.95)	1.02(12.85)	2.47(31.11)
1992	8.24	4.43(53.76)	3.91(47.45)	1.17(14.20)	2.74(33.25)
1997	9.99	4.51(45.15)	5.48(54.85)	1.44(14.41)	4.04(40.44)
2002	13.89	6.04(43.48)	7.85(56.52)	3.81(27.43)	4.04(29.09)

Figures in parentheses indicate % share in total gap; Source: Estimated with data available from the website of Ministry of Water Resources, Govt. of India: 2007

Table 4.4: Absolute Irrigation Gaps (in '000 hectares) across States (as on 31-3-04)

State	Irrigation Potential Created			Irrigation Potential Utilized			Irrigation Gap		
	Major & Medium	Minor	Total	Major & Medium	Minor	Total	Major & Medium	Minor	Total
Andhra Pradesh	3303.22	3019.46	6322.68	3051.59	2781.22	5832.81	251.63	238.24	489.87
Arunachal Pradesh	0	99.52	99.52	0	77.4	77.4	0	22.12	22.12
Assam	243.92	603.62	847.54	174.37	494.11	668.48	69.55	109.51	179.06
Bihar	2680	4716.44	7396.44	1714.83	3759.46	5474.29	965.17	956.98	1922.15
Chhattisgarh	922.5	487.7	1410.2	760.74	322.86	1083.6	161.76	164.84	326.6
Goa	21.17	19.14	40.31	15.33	20	35.33	5.84	-0.86	4.98
Gujarat	**1430.37**	**1998.92**	**3429.29**	**1300.83**	**1876.14**	**3176.97**	**129.54**	**122.78**	**252.32**
Haryana	**2099.49**	**1630.95**	**3730.44**	**1849.97**	**1578.12**	**3428.09**	**249.52**	**52.83**	**302.35**
Himachal Pradesh	**13.35**	**161**	**174.35**	**7.51**	**138.3**	**145.81**	**5.84**	**22.7**	**28.54**
Jharkhand	354.47	588.87	943.34	230.45	471.09	701.54	124.02	117.78	241.8
Jammu & Kashmir	**179.69**	**382.45**	**562.14**	**168.75**	**366.77**	**535.52**	**10.94**	**15.68**	**26.62**
Karanataka	2121.12	1585.4	3706.52	1844.82	1541.74	3386.56	276.3	43.66	319.96
Kerala	609.49	640.02	1249.51	558.87	603.76	1162.63	50.62	36.26	86.88
Madhya Pradesh	1386.9	2256.13	3643.03	875.63	2149.48	3025.11	511.27	106.65	617.92
Mizoram	0	16.69	16.69	0	14.08	14.08	0	2.61	2.61
Maharashtra	3239	2942.6	6181.6	2147.24	2557.72	4704.96	1091.76	384.88	1476.64
Manipur	156	75.49	231.49	111	62.34	173.34	45	13.15	58.15
Meghalaya	0	50.97	50.97	0	47.31	47.31	0	3.66	3.66
Nagaland	0	76.56	76.56	0	65.63	65.63	0	10.93	10.93
Orissa	1826.56	1474.12	3300.68	1794.17	1337.55	3131.72	32.39	136.57	168.96
Punjab	**2542.48**	**3427.56**	**5970.04**	**2485**	**3367.82**	**5852.82**	**57.48**	**59.74**	**117.22**

Rajasthan	**2482.15**	**2447.1**	**4929.25**	**2313.87**	**2361.8**	**4675.67**	**168.28**	**85.3**	**253.58**
Sikkim	0	29.67	29.67	0	23.61	23.61	0	6.06	6.06
Tamil Nadu	1549.31	2123.38	3672.69	1549.29	2119.52	3668.81	0.02	3.86	3.88
Tripura	4.9	109.65	114.55	4.5	96.09	100.59	0.4	13.56	13.96
Uttar Pradesh	7910.09	21599.4	29509.49	5334	17279.62	22613.62	2576.09	4319.78	6895.87
Uttaranchal	280.3	500.98	781.28	185.41	400.8	586.21	94.89	100.18	195.07
West Bengal	1683.29	3792.52	5475.81	1527.12	3098.12	4625.24	156.17	694.4	850.57
Total States	37039.77	56856.31	93896.08	31006.28	49012.46	80018.74	6033.49	7843.85	13877.34
Total Uts	6.51	43.71	50.22	3.94	35.41	39.35	2.57	8.3	10.87
Grand Total	37046.28	56900.02	93946.3	31010.22	49047.87	80058.09	6036.06	7852.15	13888.21

Source: Estimated with data available from the website of Ministry of Water Resources, Govt. of India: 2007

4.7 Table 4.4 above looks into the situation prevailing in the 9 regions being specifically studied by IIMA study team in comparison with the rest of the states and union territories of the country. The states covered in the present study are marked in bold. No disaggregated information is available yet in respect of the union territories – Delhi, Chandigarh, Dadra and Nagar Haveli. The gap is found to be the highest in Haryana, followed by those observed in Rajasthan and Gujarat. As we develop state-specific tables comparable to Table 4.4 (in terms of IPU as % of IPC in Table 4.5 and in terms of % contribution of two sources of irrigation to the gap in Table 4.6) below, some variations across the states are visible. The stylized features emerging from these two tables are:

- A comparison of all India average figure (in last row) with those of each relevant state in Table 4.5 shows that the utilization index is higher (indicated by double or single upward arrow – i.e., ↑↑ or ↑) in all relevant states except in HP, thus signifying strong demand forces for utilization are prevalent in the former category of states. This is true of both major/medium and minor categories of irrigation. The opposite seems to be true for the UTs as a whole.
- A similar pattern is observed in Table 4.6, though the % figures in this table also indicate the degree of dependence on the two broad types of irrigation.

4.8 A little effort to construct a relative measure of gap [(IPC-IPU)/IPC*100], however, introduces some puzzling observation. If we construct relative measures of gap, Table 4.7 identifies a reversal of role of major-medium and minor irrigation systems in terms of their respective contributions. We observe that the gap in major and medium irrigation systems relative to the potential created is 16.30%, as compared to 13.80% observed in the minor systems. The relative gap is alarmingly high for surface minor irrigation system and considerably low for the ground water based minor irrigation systems. However, the relative gaps have been increasing continuously over time.

4.9 Table 4.8, based on the estimates of relative gap, redirects our attention to Himachal Pradesh and also convinces us about the necessity to look more into the functioning of the major-medium irrigation systems to identify the proximate causes of the increasing gap between IPC and IPU. The relative gaps are much higher across the states considered in the present study in respect of major and medium irrigation systems than that found for the minor irrigation ones.

4.10 Thus, the reality is that the available data is undoubtedly pointing towards an increasing gap between IPC and IPU, irrespective of whether it is measured in absolute or in relative terms. However, the share of major-medium and minor irrigation systems to this increasing gap gets altered as we shift from an absolute measure to a relative one. The conceptual and methodological issues we develop in the following paragraphs have to be sensitive to this puzzle.

Table 4.5: State-wise % utilization of created potential (as on 31st March 2004)

State/UTs/all India	Major & Medium	Minor	Total
Andhra Pradesh	↑↑ 92.38	↑↑ 92.11	↑↑ 92.25
Arunachal Pradesh	.	↓↓ 77.77	↓↓ 77.77
Assam	↓↓ 71.49	↓ 81.86	↓↓ 78.87
Bihar	↓↓ 63.99	↓↓ 79.71	↓↓ 74.01
Chhattisgarh	↓ 82.47	↓↓ 66.2	↓↓ 76.84
Goa	↓↓ 72.41	↑↑ 104.5	↑ 87.65
Gujarat	**↑↑ 90.94**	**↑↑ 93.86**	**↑↑ 92.64**
Haryana	**↑ 88.12**	**↑↑ 96.76**	**↑↑ 91.9**
Himachal Pradesh	**↓↓ 56.25**	**↓85.9**	**↓ 83.63**
Jharkhand	↓↓ 65.01	↓↓ 80	↓↓ 74.37
Jammu & Kashmir	**↑↑ 93.91**	**↑↑ 95.9**	**↑↑ 95.26**
Karanataka	↑ 86.97	↑↑ 97.25	↑↑ 91.37
Kerala	↑↑ 91.69	↑↑ 94.33	↑↑ 93.05
Madhya Pradesh	↓↓ 63.14	↑↑ 95.27	↓ 83.04
Mizoram	.	↓ 84.36	↓ 84.36
Maharashtra	↓↓ 66.29	↑ 86.92	↓↓ 76.11
Manipur	↓↓ 71.15	↓ 82.58	↓↓ 74.88
Meghalaya	.	↑↑ 92.82	↑↑ 92.82
Nagaland	.	↓ 85.72	↑ 85.72
Orissa	↑↑ 98.23	↑↑ 90.74	↑↑ 94.88
Punjab	**↑↑ 97.74**	**↑↑ 98.26**	**↑↑ 98.04**
Rajasthan	**↑↑ 93.22**	**↑↑ 96.51**	**↑↑ 94.86**
Sikkim	.	↓↓ 79.58	↓↓ 79.58
Tamil Nadu	↑↑ 100	↑↑ 99.82	↑↑ 99.89
Tripura	↑↑ 91.84	↑ 87.63	↑ 87.81
Uttar Pradesh	↓↓ 67.43	↓↓ 80	↓↓ 76.63
Uttaranchal	↓↓ 66.15	↓↓ 80	↓↓ 75.03
West Bengal	↑↑ 90.72	↓ 81.69	↓ 84.47
Total States	83.71	86.2	85.22
Total UTs	↓↓ 60.52	↓ 81.01	↓↓ 78.36
Grand Total	83.71	86.2	85.22

Table 4.6: Source-wise Share of Absolute Gap between IPC and IPU (percentage)

States and UTs	Major & Medium	Minor
Andhra Pradesh	↑↑ 51.37	48.63
Arunachal Pradesh	↓↓ 0.00	100.00
Assam	↓↓ 38.84	61.16
Bihar	↑↑ 50.21	49.79
Chhattisgarh	↑ 49.53	50.47
Goa	↑↑ 117.27	-17.27
Gujarat	**↑↑ 51.34**	**48.66**
Haryana	**↑↑ 82.53**	**17.47**
Himachal Pradesh	**↓↓20.46**	**79.54**
Jharkhand	↑↑ 51.29	48.71
Jammu & Kashmir	**↓ 41.10**	**58.90**
Karanataka	↑↑ 86.35	13.65
Kerala	↑↑ 58.26	41.74
Madhya Pradesh	↑↑ 82.74	17.26
Mizoram	↓↓ 0.00	100.00
Maharashtra	↑↑ 73.94	26.06
Manipur	↑↑ 77.39	22.61
Meghalaya	↓↓ 0.00	100.00
Nagaland	↓↓ 0.00	100.00
Orissa	↓↓ 19.17	80.83
Punjab	**↑ 49.04**	**50.96**
Rajasthan	**↑↑ 66.36**	**33.64**
Sikkim	↓↓ 0.00	100.00
Tamil Nadu	↓↓ 0.52	99.48
Tripura	↓↓ 2.87	97.13
Uttar Pradesh	↓↓ 37.36	62.64
Uttaranchal	↑ 48.64	51.36
West Bengal	↓↓ 18.36	81.64
Total States	↑ 43.48	56.52
Total UTs	↓↓ 23.64	76.36
Grand Total	43.46	56.54

4.11 The discussions above clearly suggest that instead of looking at the situation vis-à-vis the country as a whole the way MoWR posed it, it will be prudent to have a relook at the issue from a different perspective. The need for a relook is necessitated by the following reasons:

- The diagram prepared by MoWR that constitutes the background of the present study considered the cumulative aggregates of IPC and IPU, and used an ocular visualization of distance between the two curves that has been apparently increasing at an increasing rate to set the alarm bell ringing. We rather would like to have a look the movement of the gap between IPC and IPU – as a distinct variable in itself – over time to identify the inter-temporal movement of the gap in question.

Table 4.7: Source-wise Break up of Relative Gap between IPC and IPU (in %)

	Total	Major & Medium	Minor	Minor Surface	Minor Ground
1951	0.00	0.00	0.00	0.00	0.00
1956	4.65	10.00	0.00	0.00	0.00
1961	4.40	8.93	0.00	0.00	0.00
1966	4.17	8.45	0.00	0.00	0.00
1969	3.64	7.46	0.00	0.00	0.00
1974	5.23	11.16	0.00	0.00	0.00
1978	6.84	14.40	0.00	0.00	0.00
1980	7.01	14.92	0.00	0.00	0.00
1985	9.81	14.91	6.05	7.11	5.68
1990	10.38	14.87	7.49	9.28	6.93
1992	10.16	14.41	7.75	10.21	7.03
1997	11.58	13.69	10.28	11.51	9.90
2002	14.78	16.30	13.80	23.66	9.90

Source: Estimated with data available from the website of Ministry of Water Resources, Govt. of India: 2007

- The diagram also does not distinguish between sources of irrigation, i.e., major & medium, and minor. Further, the minor irrigation sources can also be categorized depending on source of water, i.e., surface and ground. In view of the fact that these different categories of irrigation sources are fundamentally different in terms of several characteristics – life of projects, source of water, property rights of the systems, initial investments, operation and maintenance expenditures etc. – we argue that it will be conceptually erroneous to pose the problem without disaggregating the different components of the irrigation system in the country and looking at them separately.
- Further, addition of created irrigation potentials of projects across years irrespective of their year of inception without discounting them to accommodate the possibilities of systemic wear and tear over time can, in all likelihood, introduce an over-estimation bias to the estimated IPC at any point of time. For

example, while studying the irrigation systems in Punjab, we came across projects that are more than 100 years old. IPC of a project, as the study team has been made to understand, is sacrosanct and does not change in course of time, even though the actual realization of potential after a passage of time may be well below the IPC because of natural wear and tear, changes in land use pattern in the command area, changes in cropping pattern etc. Simple addition of IPC of projects created over a century thus lead to a possible overestimation of the cumulative value of IPC reported for today[1].

Table 4.8: Relative Irrigation Gaps (in %) across the States of India (as on 31st March 2004)

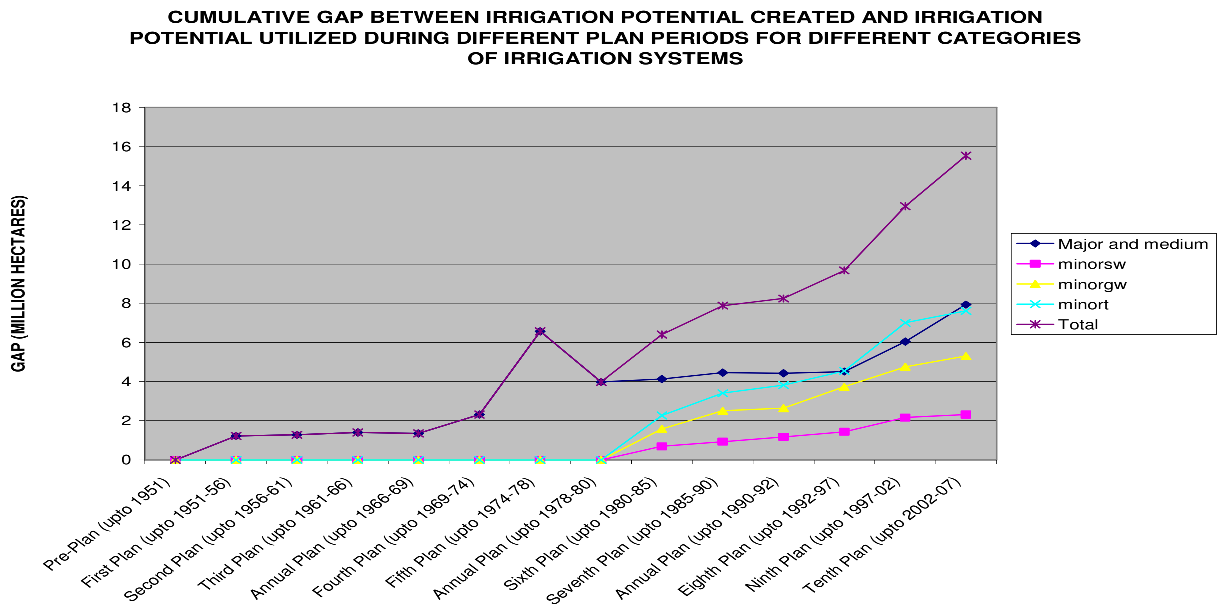
State	Major & Medium	Minor	Total
Andhra Pradesh	7.62	7.89	7.75
Arunachal Pradesh	0.00	22.23	22.23
Assam	28.51	18.14	21.13
Bihar	36.01	20.29	25.99
Chhattisgarh	17.53	33.80	23.16
Goa	27.59	-4.49	12.35
Gujarat	**9.06**	**6.14**	**7.36**
Haryana	**11.88**	**3.24**	**8.10**
Himachal Pradesh	**43.75**	**14.10**	**16.37**
Jharkhand	34.99	20.00	25.63
Jammu & Kashmir	**6.09**	**4.10**	**4.74**
Karanataka	13.03	2.75	8.63
Kerala	8.31	5.67	6.95
Madhya Pradesh	36.86	4.73	16.96
Mizoram	0.00	15.64	15.64
Maharashtra	33.71	13.08	23.89
Manipur	28.85	17.42	25.12
Meghalaya	0.00	7.18	7.18
Nagaland	0.00	14.28	14.28
Orissa	1.77	9.26	5.12
Punjab	**2.26**	**1.74**	**1.96**
Rajasthan	**6.78**	**3.49**	**5.14**
Sikkim	0.00	20.42	20.42
Tamil Nadu	0.00	0.18	0.11

[1] *If a project has a life span of 100 years, as often mentioned by irrigation engineers, it will mean an annual depreciation rate of 12.9%, a figure close to what is assumed by neighboring countries, while evaluating their projects, as we shall show in the concluding chapter 9.*

Tripura	8.16	12.37	12.19
Uttar Pradesh	32.57	20.00	23.37
Uttaranchal	33.85	20.00	24.97
West Bengal	9.28	18.31	15.53
Total States	16.29	13.80	14.78
Total UTs	39.48	18.99	21.64
Grand Total	16.29	13.80	14.78

Source: Estimated with data available from the website of Ministry of Water Resources, Govt. of India: 2007

4.12 The diagrams that follow, therefore, try to pose the problem at hand in tune with the conceptual difficulties mentioned above. While the diagram prepared by MoWR (Figure 1.1) gives us a feeling of a continuous steady increase in the gap between cumulative IPC and cumulative IPU over the plan periods, a look at the diagram given below (Figure 4.1) does not suggest such a continuous increase all along. Rather it locates a decline in the total gap measured on a cumulative basis between the fifth and the sixth plan. Incidentally, this period characterizes the rapid onset of green revolution in some parts of the country. It is well-known that a necessary condition, though not a sufficient one for the spread of Green Revolution was assured supply of water for irrigation. Further, as we disaggregate the total gap into components according to source, we observe that the trend growth features are not identical across the sources. While the growth in gap for minor irrigation sources has been substantial between 1979-80 and the last Five Year Plan (2002-07), the gap in respect of major and medium irrigation systems did not grow phenomenally till the beginning of the 9th plan period. Interestingly, the magnitude of gap for minor irrigation systems overtook the gap witnessed in respect of major and medium systems by the beginning of the 9th Plan. By the end of the 10th Plan, both these two sources are observed to contribute somehow equally to the total gap between potential created and utilized across the irrigation system of the country.



Note: minorsw stands for minor surface water, minorgw for minor ground water and minort for minor total. **Figure 4.1: Cumulative gap between IPC and IPU for different categories of irrigation**

4.13 A cumulative measure of IPC, as argued in an earlier paragraph, however, does not capture the possible changes in the values of project parameters over a substantial period of time. To rule out the impact of such long term changes on the potential of an irrigation system realized, we concentrate on the gaps between incremental values of IPC and IPU across different plan periods. To elaborate, each plan period has witnessed changes in IPC and IPU. We look into the gap between the increment in IPC and that in IPU observed during a particular plan period. The observed information is plotted in the diagram below (Figure 4.2). The nature of movements of the curves, contrary to the perception created through MoWR diagram, suggests a larger incidence of cyclical movement, than a time trend. More significantly, as we disaggregate between major & medium sources, on the one hand, and minor sources, on the other, the nature of the cyclical movements also appear not to be identical. While the cyclical fluctuations are happening over a larger period of time for the former, the corresponding cycles for minor irrigation systems are rather shorter. These observations are quite in keeping with our expectations, given that the minor irrigation systems have a shorter life span vis-à-vis their counterparts in major and medium irrigation systems. A disaggregation of minor irrigation system into ground and surface water scheme substantiates our argument further. It is found that ground water systems characterized by relatively shorter life time experience a shorter cycle than that experienced by the surface water systems with a relatively larger life span. A cyclical fluctuation is also characterized by the amplitude of the cycle. In case of major and medium systems, the amplitude is smaller, perhaps signifying the longer gestation period and lower rate of depreciation. In contrast, the amplitude in respect of minor irrigation schemes is higher in tune with their shorter gestation period and higher rate of depreciation. On decomposition, surface water minor irrigation systems show a smaller amplitude – even smaller than that observed for major & medium systems – capturing the reality that they exhibit a shorter gestation period coupled with a lower rate of depreciation. The lack of property rights on ground water and its uncontrolled extraction aided by subsidized supply of energy may also partially explain the larger amplitude and shorter cycle experienced by the ground water minor irrigation systems[2].

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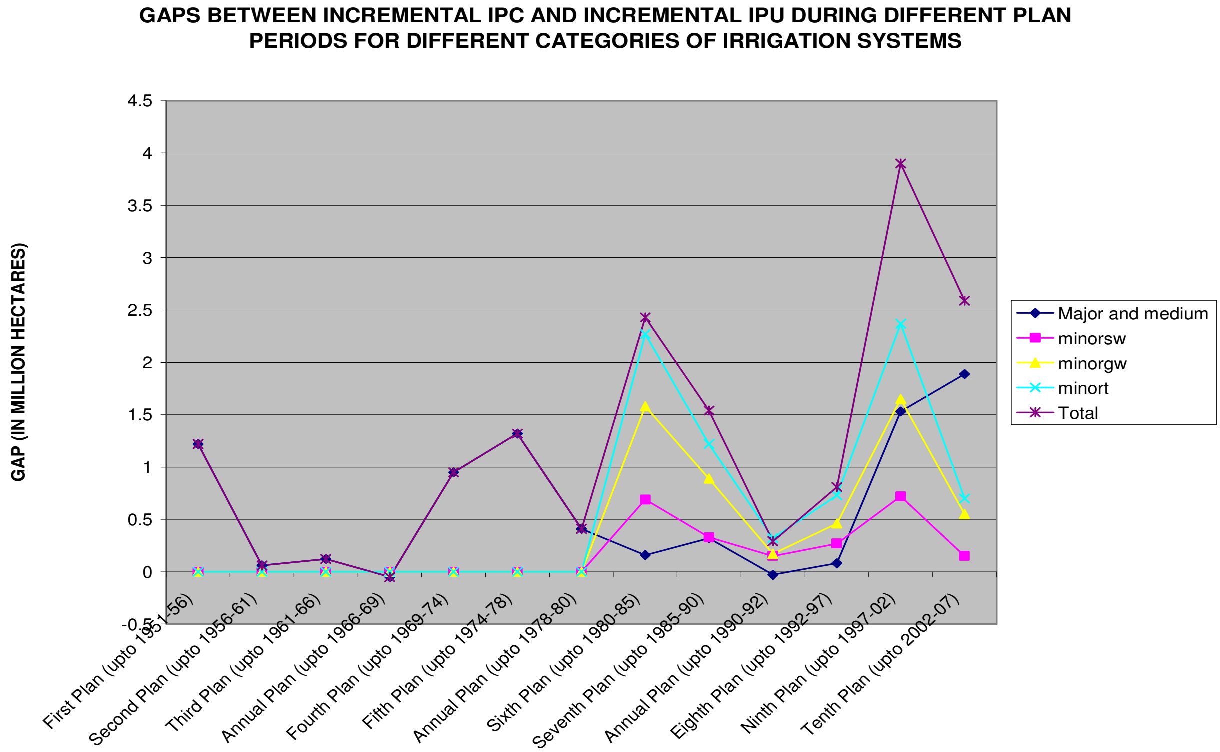
[2] *There are two dimensions of a property rights system – (i) whether there is clearly assigned ownership and control rights, or it is open access, as in case of ground water; (ii) whether the owner of the source of irrigation is different from the user – if yes, then there is an agency problem, leading to possible mismatch between the interests of the owner and the user.*



Note: minorsw stands for minor surface water, minorgw for minor ground water and minort for minor total.

Figure 4.2: Gaps between incremental IPC and incremental IPU

4.14 To summarize, we may argue that instead of showing a pure increasing trend, the gap between incremental IPC and incremental IPU across the various plan periods exhibits a highly cyclical fluctuating tendency with a somewhat moderate increasing trend over time. Statistical analysis suggests that the time trend accounts for a meager

- 37.21% of inter-temporal variation for the combined irrigation system
- 7.86% of inter-temporal variation in major and medium irrigation system
- 37.36% of inter-temporal variation in minor irrigation system
- 37.26% of inter-temporal variation in minor irrigation system using ground water, and
- 36.91% of inter-temporal variation in minor irrigation system using surface water.

4.15 A further consideration of the variations in length and amplitude of the cyclical movements across different categories of irrigation system helps develop a 2x2 contingency table (Table 4.9) as follows. The tentative factors determining the location of an irrigation system in a particular cell may be classified based on our discussion with Irrigation Department personnel and experts, as per Table 4.10 below.

Table 4.9: Distribution of irrigation systems according to length and amplitude of cycles

Amplitude of cycle	Length of cycle	
	Large	Small
Large	--	Ground water Minor Irrigation System
Small	Major and medium systems	Surface water Minor Irrigation System

Table 4.10: Tentative factors determining location in a particular cell

Amplitude of cycle	**Length of cycle**	
	Large	Small
Large	• Larger life span, • Larger gestation period, • Lower depreciation rate, • Ambiguous to less property right over water	• Shorter life span, • Larger gestation period, • Generally lower depreciation rate, • Ambiguous property right over water
Small	• Larger life span, • Lower gestation period, • Lower depreciation rate, • Public good characteristic of water	• Shorter life span, • Lower gestation period, • Generally lower depreciation rate, • Unambiguous to public good characteristic of water

4.16 In order to better understand the simultaneous inter-temporal movements of incremental IPC and IPU, we introduce a series of diagrams (Figures 4.3 to 4.7) that plots these two variables separately for total irrigation system, major & medium irrigation system, and minor irrigation system which has been further disaggregated between ground water and surface water systems. The plots reveal a somewhat uniform pattern of movement of incremental IPC and IPU across all these systems. The salient features of all these figures are:

- Both the curves appear to be moving together in respect of all types of irrigation systems under our consideration, indicating a possible co-integration between the two.
- The gap between incremental IPC and IPU increases while the curves are on their upswing and decreases as they start heading southwards. At the minimum of the cycles, the gap almost vanishes and again starts increasing as both the curves head northwards. On the other hand, the gaps are maximized while both the curves reach their peak.
- This general pattern gets somehow disturbed from 1992 onwards. The gap remained virtually non-existent in respect of major and medium projects during the tenure of 8th Five Year Plan, even though both the curves are on their upswing. The curves followed the general trend mentioned above from the next period.
- All types of minor irrigation systems exhibit a shift away from general pattern of moving together since the 9th Five Year Plan, with incremental utilization of potential not catching up with the incremental creation of irrigation potential in the same cycle. The former reached a trough while the latter simultaneously achieved its peak.

4.17 The salient features mentioned above probably make one argue that demand for irrigation follows the creation of irrigation potential. Initially, while the potential gets created, the gap gets larger as the users take time to adjust to the new flow of irrigation water. Once such adjustments are made the gap narrows down, sometimes even vanishes, to initiate newer irrigation projects for creation of further potential. Thus there appears a definite time lag between creation of potential and its utilization – a feature quite natural to expect during a stage of potential creation. As incremental capacity creation drops, the gap between incremental IPC and incremental IPU also tends to narrow down, as evidenced in these diagrams, except in most recent years for minor surface irrigation system.

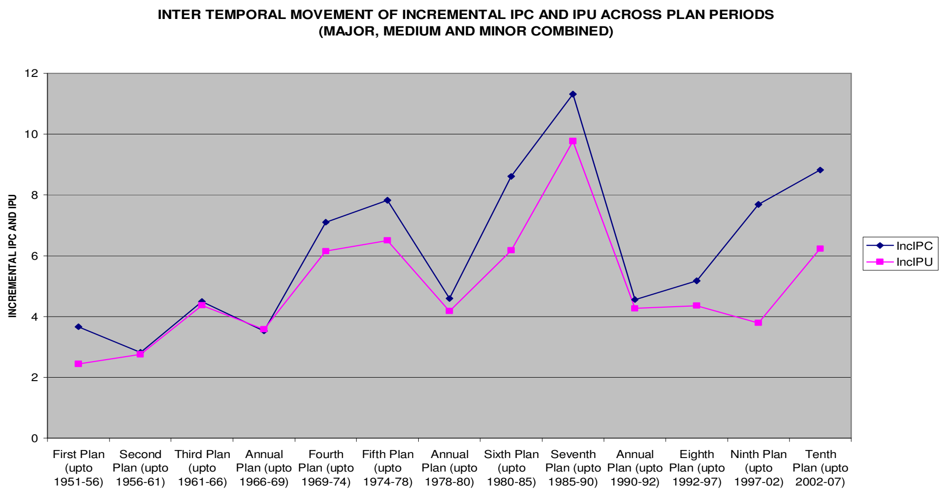


Figure 4.3: Inter-temporal movement of incremental IPC and IPU for total irrigation system

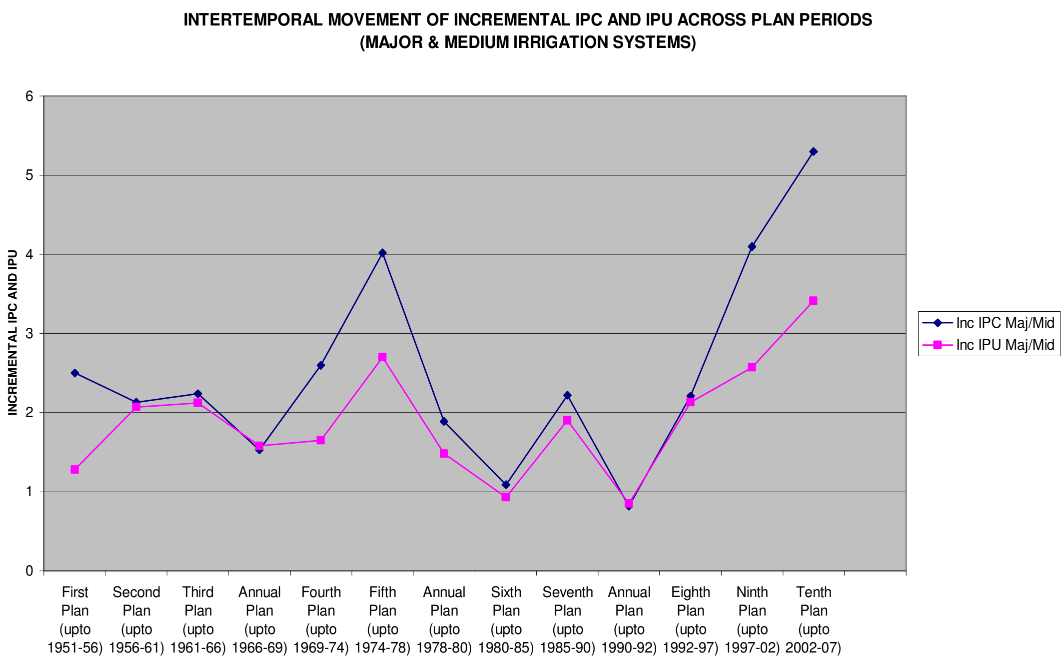


Figure 4.4: Inter-temporal movement of incremental IPC and IPU for major & medium system

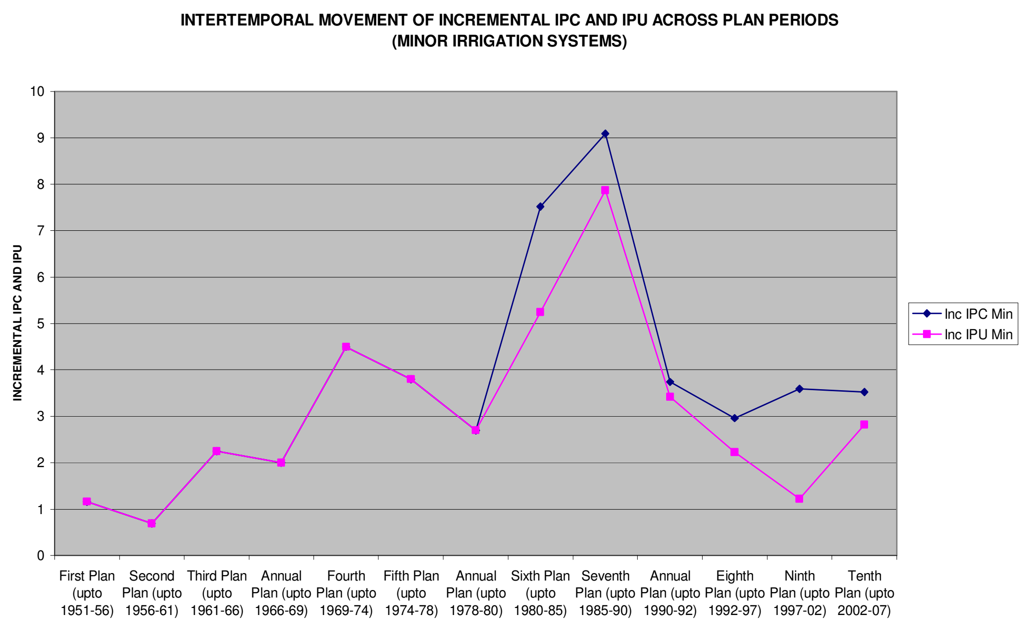


Figure 4.5: Inter-temporal movement of incremental IPC and IPU for minor irrigation system

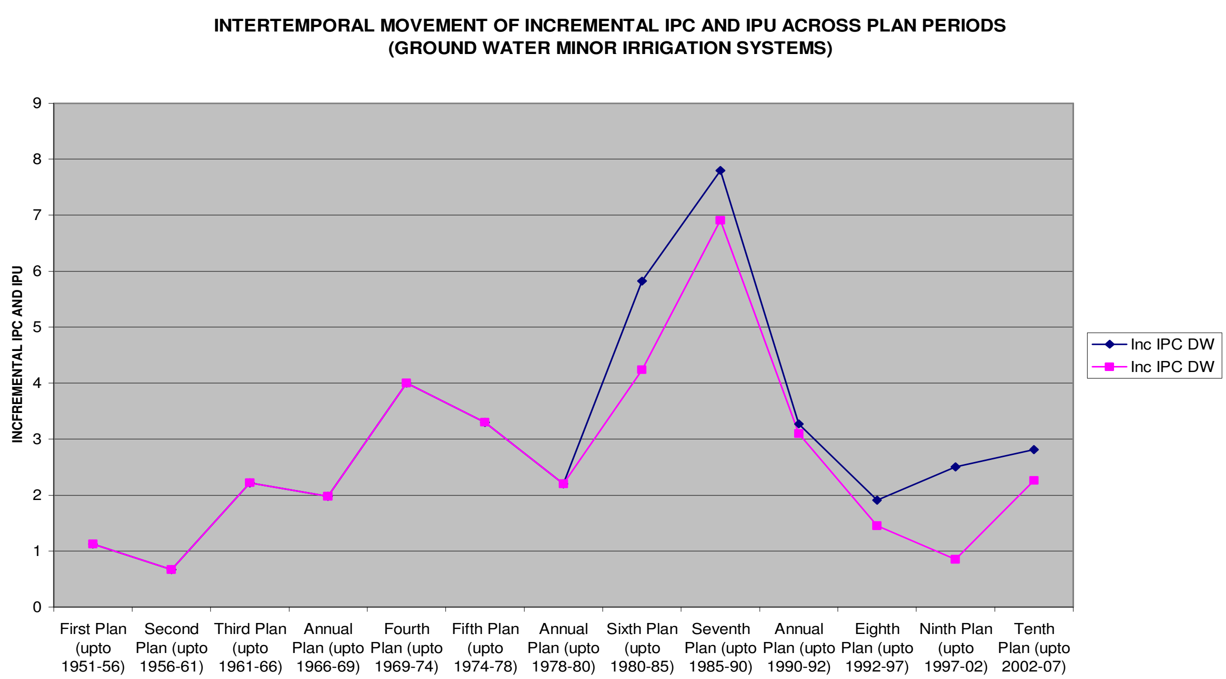


Figure 4.6: Inter-temporal movement of incremental IPC and IPU for minor ground water system

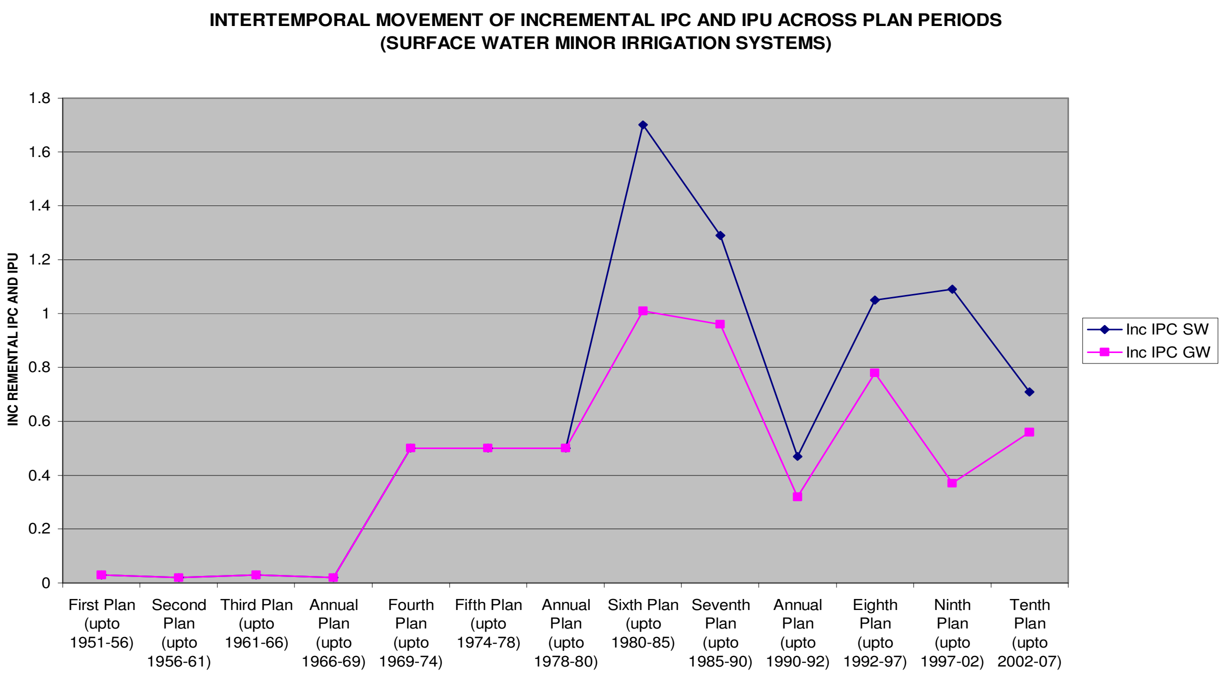


Figure 4.7: Inter-temporal movement of incremental IPC and IPU for minor surface water system

4.18 However, there is an issue of concern worth taking note of. A look at the source wise irrigation pattern of the country since Independence unearths a disturbing feature vis-à-vis the management of irrigation capability of India. An exercise to assess the gap between estimates of irrigation potential utilized (IPU) and gross irrigated area (GIA) reveals interesting insights into the present situation. The diagram below (Figure 4.8) has been generated by comparing data available from the Ministry of Agriculture (MoA), Government of India on GIA according to sources of irrigation and data maintained by Ministry of Water Resources (MoWR), Government of India on IPU. While the data on GIA is available on a yearly basis, data on IPU is available at certain points of time (end of a plan period). To make the datasets comparable, cumulative figures for IPU have been plotted along with the data on source-wise GIA for the years that marked the end of a particular plan period. Further, as data from both the sources provide source-wise disaggregation, comparisons have been made at disaggregated levels. However, pattern of disaggregation in data available with two Ministries are not identical. While MoWR data distinguishes between major and medium projects on the one hand and minor projects on the other, the MoA data are available separately for canals – government and privately owned – and tanks as surface sources of water for irrigation, with tube wells and other wells as underground sources. MoA data also reports a component called "other" source, that is not covered under the sources already mentioned (govt. canals, private canals, tanks, tube wells and other wells). To render compatibility to data across these two sources we define the following variables:

GIASW= Area irrigated by Govt. and private canals plus area irrigated by tanks
GIADW= Area irrigated by Tube wells and Other Wells
GIA= GIASW+GIADW+ Area irrigated by other sources
GIAKNOWN= GIASW+GIAGW [irrigation from specific sources] or GIA-Area irrigated by other sources
IPUSW= IPU from surface water – major, medium and minor (surface) projects
IPUGW= IPU from groundwater – minor (ground water) projects
GAP: (IPU-GIA)/IPU*100
GAP1: (IPU-GIAKNOWN)/IPU*100

Ideally, IPU should be equal to GIA, i.e., GAP should be equal to zero. However, as is evident from Figure 4.8:

- GAP was negative during the decade of fifties and then turned and remained positive till date, coming almost close to zero in 1968-69 and again during 1996-97. However, there has been ups and down in the movement, with the maximum gap recorded during 1989-90 – close to 10%. A positive value of GAP indicates an overestimation of IPU vis-à-vis GIA.

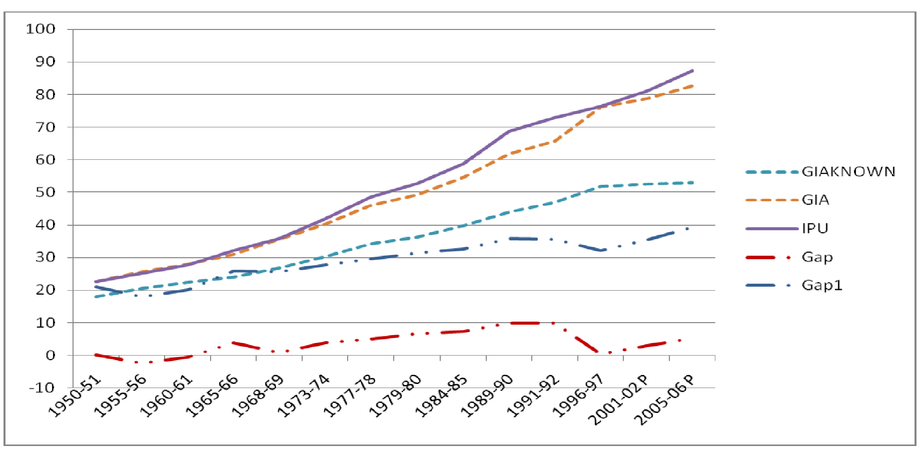
- Another alternative estimate GAP1 is constructed leaving out from GIA the area that was irrigated from unspecified sources. The gap between IPU and GIA appears to be extended further as a result.

From the diagram, it will be prudent to argue that IPU reported by MoWR captures the area irrigated by water available from other unspecified sources as well and it is higher than GIA reported by MoA.

4.19 Figure 4.9 provides a disaggregated perspective of IPU and GIA in terms of source of water. It is found that from 1984-85 onwards GIA from ground water sources are higher than that from surface water sources. However, no such crossing over of the curves is observed in case of IPU. IPUSW and IPUGW came close to each other in 1991-92 only to diverge away from one another since then. Incidentally, IPUSW has been higher than IPCGW over the entire period under review. Thus, it appears that IPU and GIA have more or less followed the same trend, with IPU being slightly higher than GIA. The gap was relatively higher between 1969 and 1991 and has been showing a tendency of divergence since 1996-97. This phenomenon may be due to

- Either an over reporting of IPU
- Or, an under reporting of GIA
- Or, a combination of both of them

Figure 4.9: Percentage Gap between Gross Irrigated area and Irrigation Potential Utilized in India between 1950-51 and 2005-06 {area measured in million hectares}



4.20 Figure 4.10 captures the estimates of gap between two different sources of water, namely, surface water and ground water (Figure 4.11 displays the gap in % terms). It reveals that while GAPSW has been increasing consistently since the beginning of the second five year plan period, GAPGW has been showing a declining trend since 1990.

4.21 Two proximate factors that may affect the gap between IPC and IPU are:

- Changes in cropping pattern and
- Change in area under cultivation

To test these hypotheses, a detailed district level analysis of change in cropping pattern and change in area under cultivation between 1999-00 and 2004-05 was undertaken. The salient features coming out of the analysis are given in Table 4.11 below. A change in cropping pattern in favor of crops that are relatively more water-intensive will increase water requirement per hectare, while a shift of land away from agriculture to non-agricultural uses will contribute to reduction in area under cultivation. This table reveals that the changes are not uniform across the major states studied under the present study.

Figure 4.10: Gross Irrigated area and Irrigation Potential Utilized in India from surface and ground water [in million hectares] between 1950-51 and 2005-06

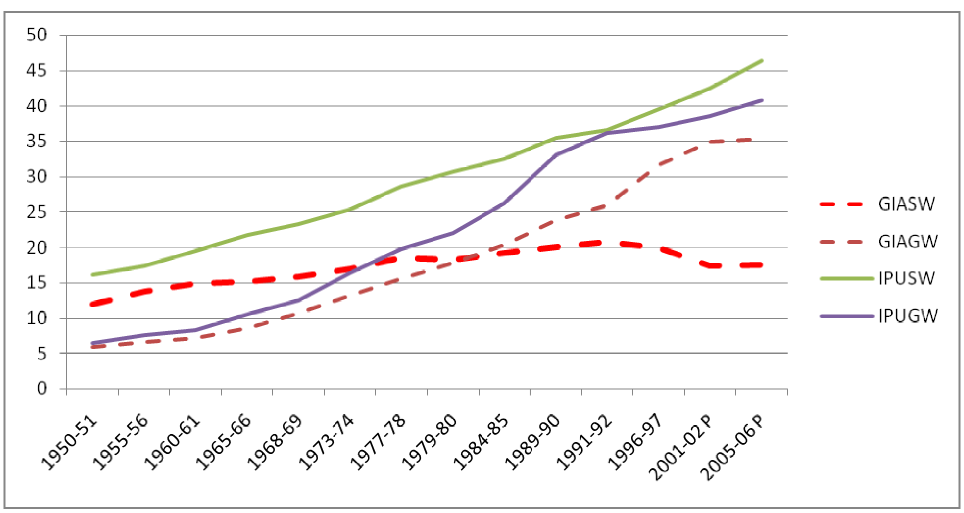


Figure 4.11: Percentage Gap between Gross Irrigated area and Irrigation Potential Utilized in India from surface and ground water between 1950-51 and 2005-06

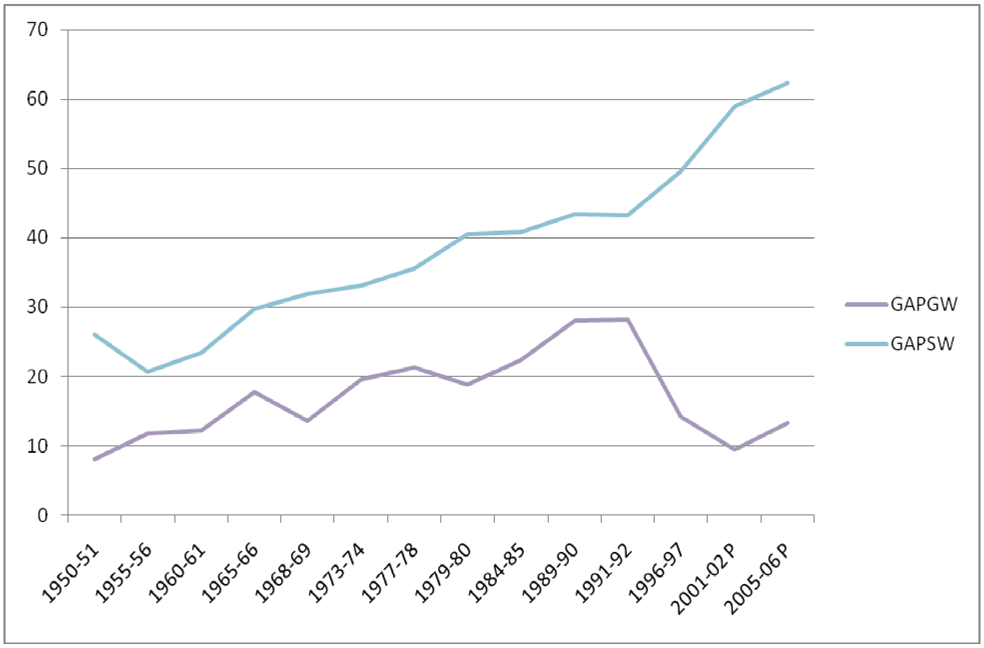


Table 4.11: States Classified in terms of Changes in Cropping Pattern and Area Cultivated between 1999-00 and 2004-05

Water requirement for cultivation per hectare	Area cultivated	
	Increased	Decreased
Increased	Punjab	Rajasthan
Decreased	Gujarat, Haryana, Jammu & Kashmir	Himachal Pradesh

4.22 We now turn to analysis of published secondary data on minor irrigation system. Some interesting insight obtains from an analysis of data provided by 2nd and 3rd Minor Irrigation Census. These reports provide state-wise data not only on IPC and IPU of ground water and surface water systems, but also the potential of the systems that are in use. Using the concepts described in the conceptual framework, the potential of those systems currently in use may be termed as irrigation potential realized (IPR). Appendices 4.1 to 4.6 below provide an idea about the state-specific supply and demand-side gaps (SG and DG, respectively) and their changes between 1993-94 and 2000-01. Some of the salient features emerging from these tables are worth noting.

- There has been a steady increase in IPC under ground water schemes between 1994 and 2001 in most of the states, notable exceptions being Punjab and Delhi which recorded decline. Jammu & Kashmir recorded the highest increase.
- However, the increase in IPU observed in most of the states did not keep pace with the increase in IPC, the gap being considerably higher in Rajasthan.
- Punjab and Delhi recorded decline in IPC under surface water schemes between the two census periods.
- Further, the increase in IPU in most of the states failed to keep pace with that in IPC.

However, there being no data available in respect of Gujarat and Chandigarh, the estimates of SG and DG could not be obtained in respect of them for the year 1993-94. Further, the reasons behind the changes in SG and DG could not be identified as relevant information is not available from the Census Reports. Analysis of primary data collected alone can help identify the reasons and their respective contributions. However, interesting features emerge as we classify the states in terms of the changes in the value of SG_{MINOR} and DG_{MINOR}. The classification table (Table 4.12) provides some clues to possible changes in the relative efficiency of the minor irrigation system vis-à-vis its IPC. An increase in SG_{MINOR} obviously signifies a fall in absolute efficiency of minor irrigation system – a phenomenon observed in Haryana, Jammu & Kashmir and Rajasthan. Interestingly, of these three, Jammu & Kashmir and Rajasthan recorded a simultaneous increase in DG_{MINOR}, perhaps signaling any or a combination of these following possibilities:

- a shift away from minor sources to major and medium sources of irrigation,
- a shift of land away from cultivation to non-cultivation
- a shift away from more water-intensive crop to less water-intensive crop.

Himachal Pradesh, Dadra & Nagar Haveli on the other hand, recorded a decline in SG_{MINOR} coupled with a simultaneous increase in DG_{MINOR} implying an increase in efficiency as well as a reduced demand for water from minor irrigation systems. The cases of Haryana and Punjab are a little different. In case of Haryana, a decline in irrigation efficiency is accompanied by a fall in demand gap, implying a more prudent use of water available from minor irrigation sources. Punjab registers a situation of increased irrigation efficiency, coupled with a judicious use of water – a phenomenon to be expected from any region acutely dependent on water for agriculture.

Table 4.12: States Classified in terms of Changes in SG_{MINOR} and DG_{MINOR} between 1993-94 and 2000-01

DG_{MINOR}	**SG_{MINOR}**	
	Increased	Decreased
Increased	Jammu & Kashmir, Rajasthan	Himachal Pradesh, Dadra & Nagar Haveli, Delhi
Decreased	Haryana,	Punjab

Appendix 4.1: IPC, IPR and IPU as per 2nd and 3rd Minor Irrigation Census Report (Groundwater schemes, in 000' Ha.)

Sl. No	State/ UTs	2000-01			(IPC01 /IPC94) *100	(IPR01 /IPC94) *100	(IPU01 /IPC94) *100	1993-94			(IPC94 /IPC94) *100	(IPR94 /IPC94) *100	(IPU94 /IPC94)*100
		IPC	IPR	IPU				IPC	IPR	IPU			
1	Gujarat	4364.2	3725.19	2712.9	N.A	N.A	N.A	N.A	N.A.	N.A	N.A	N.A	N.A
2	Haryana	2424.13	2365.39	2267.17	106.82	104.24	99.91	2269.28	2269.15	2152.92	100	99.99	94.87
3	HP	28.26	27.78	23.8	134.64	132.35	113.39	20.99	20.67	18.64	100	98.48	88.8
4	J&K	29.81	28.36	26.89	354.88	337.62	320.12	8.4	8.39	8.15	100	99.88	97.02
5	Punjab	6287.15	6261.01	5747.62	93.08	92.69	85.09	6754.64	6697.55	6138.01	100	99.15	90.87
6	Rajasthan	5840.33	5012.11	3844.34	146.75	125.94	96.6	3979.81	3843.94	3499.97	100	96.59	87.94
7	Chandigarh	2.01	1.93	1.88	N.A	N.A	N.A	N.A	N.A.	N.A	N.A	N.A	N.A
8	D&NH	1.46	1.46	1.04	171.76	171.76	122.35	0.85	0.85	0.74	100	100	87.06
9	Delhi	44.99	44.8	43.77	87.7	87.33	85.32	51.3	51.04	49.48	100	99.49	96.45
10	India	62408.09	57829.61	44982.23	167.4	155.12	120.66	37281.58	36126.4	30133.58	100	96.9	80.83

Appendix 4.2: SG and DG as per 2nd and 3rd Minor Irrigation Census Report (Groundwater schemes, in 000' Ha.)

Sl. No.		2000-01				1993-94			
	State/UTs	SG	DG	% SG	% DG	SG	DG	% SG	% DG
1	Gujarat	639.01	1012.29	38.70	61.30	N.A	N.A.	N.A.	N.A.
2	Haryana	58.74	98.22	37.42	62.58	0.13	116.23	0.11	99.90
3	HP	0.48	3.98	10.76	89.24	0.32	2.03	13.62	12.97
4	J&K	1.45	1.47	49.66	50.34	0.01	0.24	4.00	5.66
5	Punjab	26.14	513.39	4.84	95.16	57.09	559.54	9.26	98.37
6	Rajasthan	828.22	1167.77	41.49	58.51	135.87	343.97	28.32	92.39
7	Chandigarh	0.08	0.05	61.54	38.46	N.A	N.A.	N.A.	N.A.
8	D&NH	0	0.42	0.00	100.0	0	0.11	0.00	100.00
9	Delhi	0.19	1.03	15.57	84.43	0.26	1.56	14.29	9.84
10	India	4578.5	12847.4	26.27	73.73	1155.2	5992.82	16.16	99.73

Appendix 4.3: IPC, IPR and IPU as per 2nd and 3rd Minor Irrigation Census Report (Surface water schemes, in 000' Ha.)

Sl. No.	State/UTs	2000-01			(IPC01 /IPC94) *100	(IPR01 /IPC94) *100	(IPU01 /IPC94) *100	1993-94			(IPC94 /IPC94) *100	(IPR94 /IPC94) *100	(IPU94 /IPC94) *100
		IPC	IPR	IPU				IPC	IPR	IPU			
1	Gujarat	520.03	459.61	48.78	NA	NA	NA	N. A.	N. A.	N. A.	NA	NA	NA
2	Haryana	9.3	8.98	8.19	188.26	181.78	165.79	4.94	4.94	4.89	100	100	98.99
3	HP	182.63	178.64	155.02	105.91	103.60	89.90	172.44	167.4	150.96	100	97.08	87.54
4	J&K	370.06	349.87	313.05	106.54	100.73	90.13	347.35	347.35	327.02	100	100	94.15
5	Punjab	17.99	17.36	16.61	80.56	77.74	74.38	22.33	18.83	12.98	100	84.33	58.13
6	Rajasthan	213.6	147.47	80.47	139.80	96.52	52.67	152.79	136.41	114.38	100	89.28	74.86
7	Chandigarh	0	0	0	NA	NA	NA	N.A	N.A.	N.A	NA	NA	NA
8	D&NH	1.59	1.59	0.91	230.43	230.43	131.88	0.69	0.68	0.62	100	98.55	89.86
9	Delhi	0.7	0.7	0.68	10.69	10.69	10.38	6.55	6.5	6.43	100	99.24	98.17
10	India	11939.24	10374.35	6987.7	146.27	127.10	85.61	8162.43	7197.26	5264.98	100	88.18	64.50

Appendix 4.4: SG and DG as per 2nd and 3rd Minor Irrigation Census Report (Surface schemes, in 000' Ha.)

Sl. No.	State/UTs	2000-01 SG	2000-01 DG	2000-01 % SG	2000-01 % DG	1993-94 SG	1993-94 DG	1993-94 % SG	1993-94 % DG
1	Gujarat	60.42	410.83	12.82	87.18	NA	NA	NA	NA
2	Haryana	0.32	0.79	28.83	71.17	0	0.05	0	100
3	HP	3.99	23.62	14.45	85.55	5.04	16.44	23.46	76.54
4	J&K	20.19	36.82	35.41	64.59	0	20.33	0	100
5	Punjab	0.63	0.75	45.65	54.35	3.5	5.85	37.43	62.57
6	Rajasthan	66.13	67	49.67	50.33	16.38	22.03	42.65	57.35
7	Chandigarh	0	0	NA	NA	NA	NA	NA	NA
8	D&NH	0	0.68	0.00	100.00	0.01	0.06	14.29	85.71
9	Delhi	0	0.02	0.00	100.00	0.05	0.07	41.67	58.33
10	India	1564.89	3386.65	31.60	68.40	965.17	1932.28	33.31	66.69

Appendix 4.5: IPC, IPR and IPU as per 2nd and 3rd Minor Irrigation Census Report (Total, in 000' Ha.)

Sl. No	State/Uts	2000-01			(IPC01 /IPC94) *100	(IPR01 /IPC94) *100	(IPU01 /IPC94)*100	1993-94			(IPC94 /IPC94) *100	(IPR94 /IPC94) *100	(IPU94 /IPC94) *100
		IPC	IPR	IPU				IPC	IPR	IPU			
1	Gujarat	4884.23	4184.8	2761.68	NA	NA	NA	N.A	N.A.	N.A	NA	NA	NA
2	Haryana	2433.43	2374.37	2275.36	107.00	104.40	100.05	2274.22	2274.09	2157.81	100	99.99	94.88
3	HP	210.89	206.42	178.82	109.03	106.72	92.45	193.43	188.06	169.6	100	97.22	87.68
4	J&K	399.87	378.23	339.94	112.40	106.32	95.56	355.75	355.74	335.17	100	100.00	94.22
5	Punjab	6305.14	6278.37	5764.23	93.04	92.64	85.06	6776.97	6716.38	6150.99	100	99.11	90.76
6	Rajasthan	6053.93	5159.58	3924.81	146.49	124.85	94.97	4132.6	3980.35	3614.35	100	96.32	87.46
7	Chandigarh	2.01	1.93	1.88	NA	NA	NA	N.A	N.A.	N.A	NA	NA	NA
8	D&NH	3.05	3.05	1.95	198.05	198.05	126.62	1.54	1.53	1.36	100	99.35	88.31
9	Delhi	45.69	45.5	44.45	78.98	78.65	76.84	57.85	57.54	55.91	100	99.46	96.65
10	India	74347.33	68203.96	51969.93	163.60	150.08	114.36	45444.01	43323.66	35398.56	100	95.33	77.89

Appendix 4.6: SG and DG as per 2nd and 3rd Minor Irrigation Census Report (Total, in 000' Ha.)

Sl. No.	State/UTs	2000-01 SG	2000-01 DG	2000-01 % SG	2000-01 % DG	1993-94 SG	1993-94 DG	1993-94 % SG	1993-94 % DG
1	Gujarat	699.43	1423.12	32.95	67.05	N.A	N.A.	N.A.	N.A.
2	Haryana	59.06	99.01	37.36	62.64	0.13	116.28	0.11	99.89
3	HP	4.47	27.6	13.94	86.06	5.37	18.46	22.53	77.47
4	J&K	21.64	38.29	36.11	63.89	0.01	20.57	0.05	99.95
5	Punjab	26.77	514.14	4.95	95.05	60.59	565.39	9.68	90.32
6	Rajasthan	894.35	1234.77	42.01	57.99	152.25	366	29.38	70.62
7	Chandigarh	0.08	0.05	61.54	38.46	NA	NA	N.A.	N.A.
8	D&NH	0	1.1	0.00	100.00	0.01	0.17	5.56	94.44
9	Delhi	0.19	1.05	15.32	84.68	0.31	1.63	15.98	84.02
10	India	6143.37	16234.03	27.45	72.55	2120.35	7925.1	21.11	78.89

Chapter 5

Findings from Collected Secondary Data on Major and Medium Irrigation Projects

5.1 The present chapter analyses the secondary data made available to the study team by Irrigation Departments of respective states with regard to the major and medium projects managed by them. To ensure cross checking similar information for the corresponding projects have been collected from CWC sources as well as far as they are available in the public domain. To begin with, we report the results obtained from a tabular analysis of the data. Later, we present the results obtained from rigorous Tobit regression that identifies the factors contributing significantly to the gap and their percentage contributions. Using data made available to the Study Team till 31st August, 2008 through project level secondary schedule, some tentative estimates of IPC, IPR and IPU could be made[1].

5.2 Table 5.1 shows the percentage of irrigation potential created (IPC) from major and medium projects[2] for each state, as well as for all the UTs under the jurisdiction of IIM Ahmedabad study team, for which we have data about projects as submitted by the state governments. Our sample covers approximately 48.6% of IPC in the states as a whole, and can hence be treated a fairly representative sample. Coverage of IPC for each state except Rajasthan and Haryana is in excess of 50%. Note that the team did not receive any data whatsoever from the Haryana government in spite of repeated requests. In all, data from 169 major and medium projects were received by the study team. However, as we put this data to estimate the gaps, we had to drop a good number of projects for want of all relevant project level information. The number of projects that were considered for the analysis came down to 99 depending on the variables under consideration. In respect of estimating the gaps, it came down further to 75 as all the relevant information required to estimate the gaps were available only for these 75

[1] *The status of data through secondary schedules received from the states so far is given in Annexure 5.*

[2] *The entire analysis in this section is based only on major and medium projects*

observations. The coverage of these projects in terms of the aggregate IPC of the states also came down consequently.

5.3 As already mentioned in the earlier section, the gap between IPC and IPR is called the supply side gap, and the gap between IPR and IPU is called the demand side gap. There are two measures of each gap – one calculated based on data supplied by the CWC, and the other calculated from data supplied by the state governments. Although the IPU data supplied by the CWC is for the year 2004, that supplied by the state governments is averaged over a 10 year period (1996-96 to 2005-06), there should not be any major differences between the two figures. Thus, one set of figures can serve as a check on the other. The IPC figures supplied by each both the CWC and the state governments should be identical since they both refer to a historical figure generated at the point of completion of the irrigation project.

Table 5.1: Representativeness of sample for major and medium projects

State	IPC[3] as of 2003-04 (000 ha)	IPC covered by sample (000 ha)	%age coverage
Chandigarh	na	na	na
Dadra & Nagar Haveli	na	na	na
Delhi	na	na	na
Gujarat	1599	1107.68	86.90%
Haryana	2139	0	0%
Himachal Pradesh	14	10.01	121.40%
Jammu & Kashmir	187	69.97	65.20%
Punjab	2571	5.74	85.80%
Rajasthan	2579	91.69	26.40%
TOTAL	9089	4414	48.60%

5.4 Table 5.2 lists the variables used in the analysis, as well as their definitions. The sample size consists of projects spread across 5 states (Gujarat, Rajasthan, Himachal Pradesh, Jammu and Kashmir, and Punjab). Data sources are the CWC as well as the state governments. No data at the state level could be received from Haryana, hence no efforts could be made to estimate the relevant parameters in respect of the concerned state. Project-wise values of IPRSTATE have been estimated from the data provided by the respective state departments.

[3] *Source: Central Water Commission*

5.5 Tables 5.3 provides estimates of IPC, IPR and IPU obtained using the different definitions mentioned above. Consistency checks on the data revealed a few inconsistencies. While the estimates of CCACWC and CCASTATE are almost close – the former being a shade smaller than the latter, there appears a huge gap between IPUCWC and IPUAVGSTATE. Taking into consideration 75 projects (out of 169 projects) spread over the states of Gujarat, Rajasthan, Himachal Pradesh and Jammu & Kashmir for which all relevant information were available with the study team to estimate IPC, IPR and IPU using the different definitions mentioned above, IPUCWC has been estimated at 14856.40 hectares per project. Estimated IPUAVGSTATE has been obtained as 8550.09 hectares, implying the former to be 174% of the latter. The variation between IPCCWC and IPCSTATE is also considerable, although the degree of variation is much lower than that observed for IPU. Average IPCCWC per project is estimated to be about 90% of average estimated IPCSTATE. Such inconsistencies between figures returned by the state departments and the data available from CWC publications add further to the confusion about the nature of the gap existing between IPC and IPU.

Table 5.2: List and Definition of Variables Used in the Analysis.

Variable	Description
CCACWC	Culturable Command Area of a Project as Mentioned in the CWC Document
CCASTATE	Culturable Command Area of a Project as Informed by the State Department
IPCCWC	Irrigation Potential Created of a Project as Mentioned in the CWC Document
IPCSTATE	Irrigation Potential Created of a Project as Informed by the State Department
IPUCWC	Irrigation Potential Utilized of a Project as Mentioned in the CWC Document
IPRSTATE	Irrigation Potential Realized of a Project as Informed by the State Department
IPUAVGSTATE	Irrigation Potential Utilized of a Project as Informed by the State Department
GAPCWC	IPCCWC-IPUCWC
GAPSTATE	IPCSTATE – IPUAVGSTATE
SGAPSTATE	IPCSTATE-IPRSTATE
DGAPSTATE	IPRSTATE- IPUAVGSTATE

5.6 Table 5.4 deals with the estimated gaps. For the projects falling within the study area covered by IIMA team, average estimated SGAPSTATE came out to be negative, while DGAPSTATE emerged positive. A negative SGAPSTATE indicates that the irrigation potential realized today is higher than the irrigation potential created at the inception of the project. Coupled with the fact that GAPSTATE is estimated to be positive, the implication by default is quite alarming. There is a significant demand side gap that points to slackening demand for water for irrigation purposes. As we get into state-wise breakup of the estimates (Table 5.5), the same trend is observed for all the four states for which data are available. SGAPSTATE is either negative or zero, indicating the observed gap to be completely a demand side phenomenon, with a significantly high positive value of GAPSTATE. Significant variation is also evident as one compares the estimates of GAPSTATE and GAPCWC, with former being more than 12 times of the latter. Inconsistency between the estimates of GAP using information from two different sources is a delicate issue that requires pointed attention for scrutiny. As one goes into a disaggregated level and compare the estimates of gap using information from two sources, the variations across states are much higher in Rajasthan and Jammu & Kashmir. We shall argue later that an effective management information system (MIS) is absolutely necessary to settle the inconsistency of information managed by different agencies linked with the utilization of water resources in India. Project specific estimates of IPC, IPR and IPU using data obtained from different sources – State and CWC – are provided in Appendix 5.1 for necessary scrutiny.

Table 5.3: Differences (in ha) in estimates of CCA, IPC, IPU

Variable	N	Mean	Median	Sum
CCACWC	75	17384.92	5670.00	1303869.00
CCASTATE	75	17733.32	5887.00	1329999.00
IPCCWC	75	15580.04	4300.00	1168503.00
IPCSTATE	75	17363.95	5180.00	1302296.30
IPRSTATE	75	17724.01	5259.00	1329300.76
IPUCWC	75	14856.40	3780.00	1114230.00
IPUAVGSTATE	75	8550.09	1869.30	641256.78

Note: IPR stands for IPC realized as of today, whereas IPUAVG average is yearly average of IPU, as reported by states/UTs.

Table 5.4: Estimation of (IPC-IPU) gaps

Variables (in ha)	N	Mean	Median	Sum
Gap as per CWC	75	723.64	420.00	54273.00
Gap as per state	75	8813.86	3095.15	661039.52
Supply side gap as per state	75	-360.06	0	-27004.46
Demand side gap as per state	75	9173.92	3228.59	688043.98

Table 5.5: Estimation of (IPC-IPU) gaps across states

Variables (in ha)	N	Mean	Median	Sum
(a) State=Gujarat				
Gap as per CWC	59	803.2711864	470.0000000	47393.00
Gap as per state	59	10082.69	3095.15	594878.54
Supply side gap as per state	59	-445.4315254	3228.59	-26280.46
Demand side gap as per state	59	10528.12		621159.00
(b) State=HP				
Gap as per CWC	2	1920.00	1920.00	3840.00
Gap as per state	2	4577.83	4577.83	9155.66
Supply side gap as per state	2	0	0	0
Demand side gap as per state	2	4577.83	4577.83	9155.66
(c) State=J & K				
Gap as per CWC	3	0	0	0
Gap as per state	3	3912.83	5483.90	11738.50
Supply side gap as per state	3	0	0	0
Demand side gap as per state	3	3912.83	5483.90	11738.50
(d) Rajasthan				
Gap as per CWC	11	276.36	70.00	3040.00
Gap as per state	11	4115.17	2793.70	45266.82
Supply side gap as per state	11	-65.82	0	-724.00
Demand side gap as per state	11	4180.98	2793.70	45990.82

5.7 To facilitate a rigorous identification of the factors that contribute to the gaps and their relative contribution to the gaps we use Tobit models[4]. To ensure that the estimates are

[4] *The **Tobit Model** is an econometric, biometric model proposed by James Tobin (1958) to describe the relationship between a non-negative dependent variable y_i and an independent variable (or vector) x_i. The model supposes that there is a latent (i.e. unobservable) variable y_i^*. This variable linearly depends on x_i via a parameter (vector) β which determines the relationship between the independent variable (or vector) x_i and the latent variable y_i^* (just as in a linear model). In addition, there is a normally distributed error term u_i to capture random influences on this relationship. The observable variable y_i is defined to be equal to the latent variable whenever the latent variable is above zero and zero otherwise.*

independent of the size of the projects, we normalize the gaps by the respective IPCs. Thus GAPNORM is defined as (IPC-IPU)/IPC, whereas SGAPNORM = (IPC-IPR)/IPC and DGAPNORM= (IPR-IPU)/IPC. For construction of all the variables, IPC considered refer to the values given by the state departments. GAPNORM, DGAPNORM and SGAPNORM are considered dependent variables for the three models estimated. The results are reported below.

5.8 Estimating Tobit Model involves two fundamental steps. First we identify the outliers and remove them from the data set. Figure 5.1 provides a typical example of the probability distribution with the entire dataset and helps identify the outliers. They are deleted from the dataset. The new probability distributions on deletion are presented as Figures 5.2-5.4 for GAPNORM, DGAPNORM and SGAPNORM and it is found that the distributions are much closer to normal distribution that gives a better fit.

5.9 Once the data set has been cleaned of the outliers, we fit three Tobit models to the data to identify the independent variables influencing GAPNORM, SGAPNORM and DGAPNORM. Description of different variables used in these analyses is given in Appendix 5.2. The results are given below in Tables 5.6 to 5.8. Justification of use of a Tobit model lies in the fact that unlike OLS estimates, it doesn't give too much weight on extreme values and thus provide more reliable estimates.

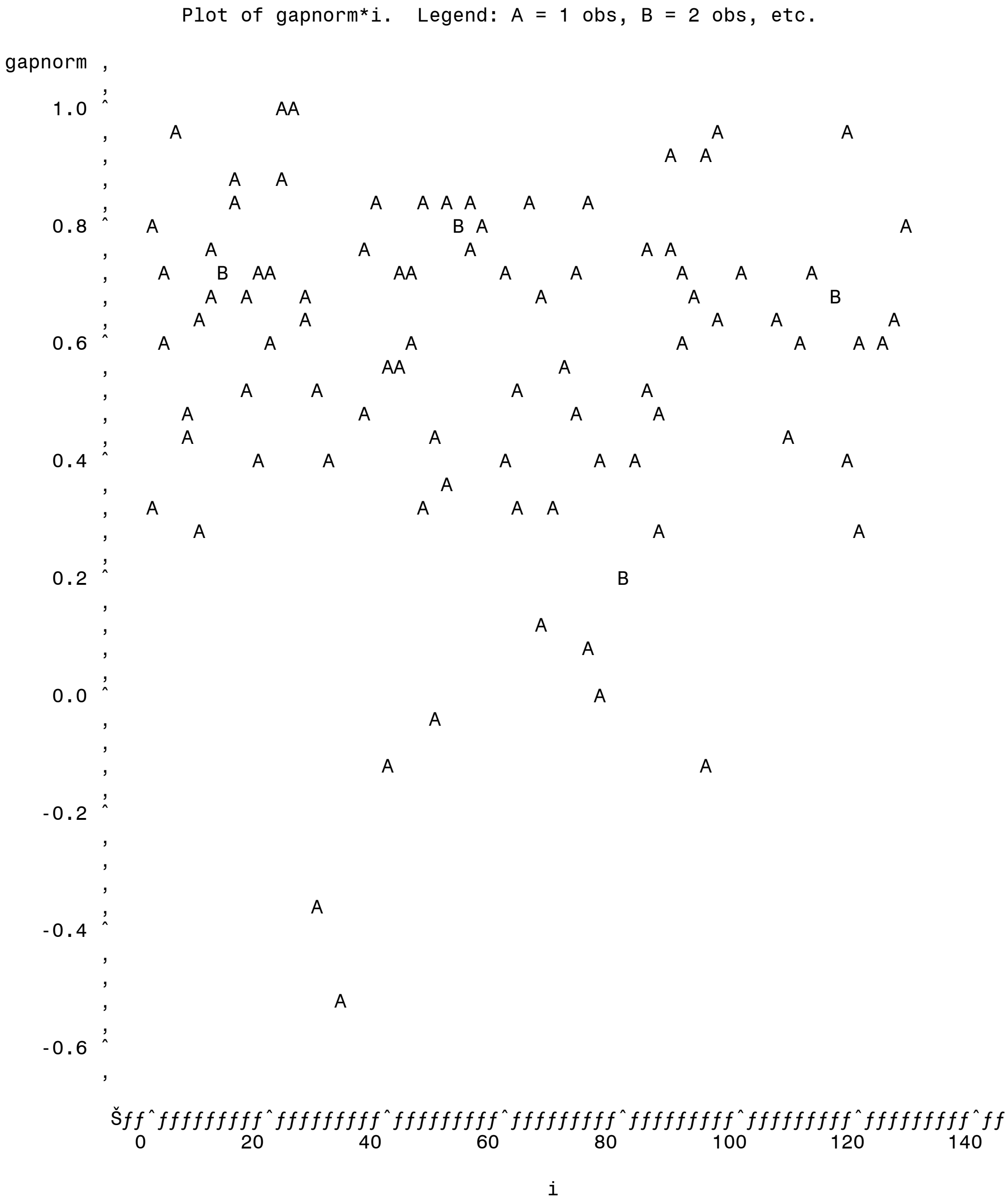
$$y_i = \begin{cases} y_i^* & \text{if } y_i^* > 0 \\ 0 & \text{if } y_i^* \leq 0 \end{cases}$$

where y_i^* *is a latent variable:*

$$y_i^* = \beta x_i + u_i, u_i \sim N(0, \sigma^2)$$

If the relationship parameter β is estimated by regressing the observed y_i *on* x_i*, the resulting ordinary least squares estimator is inconsistent. Takeshi Amemiya (1973) has proven that the likelihood estimator suggested by Tobin for this model is consistent. [See Wikipedia at http://en.wikipedia.org/wiki/Tobit_model]*

Figure 5.1: Scatter diagram of (IPC-IPU) normalized by IPC (GAPNORM)



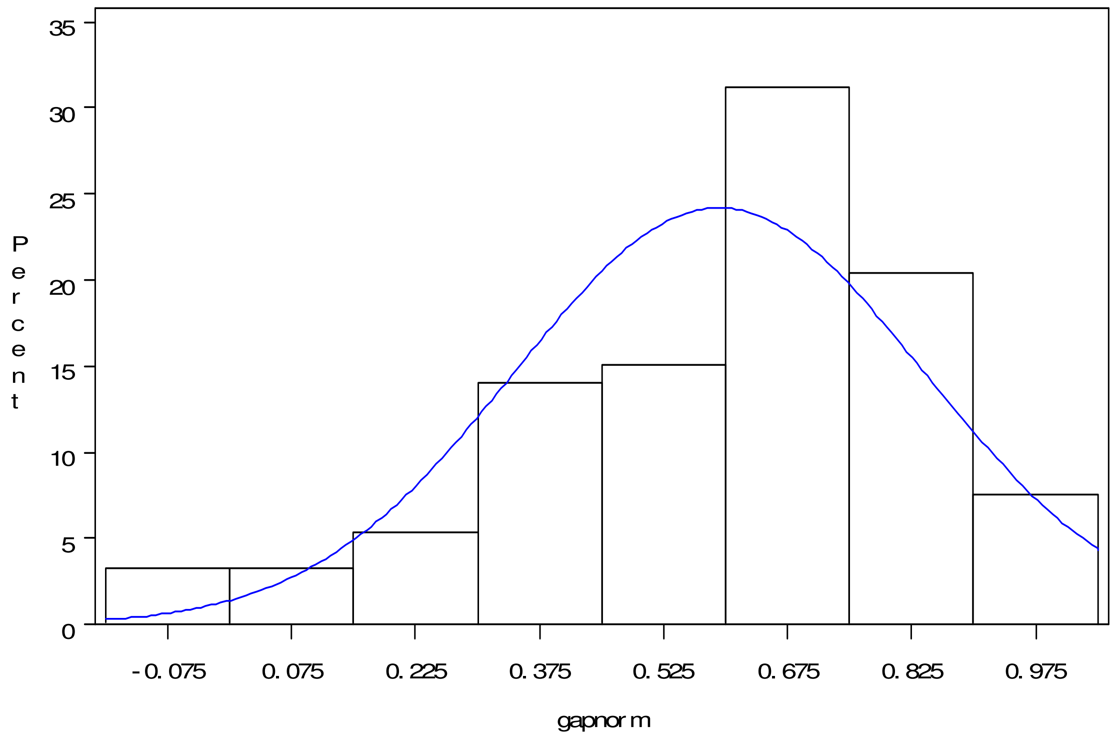


Figure 5.2: Probability distribution of GAPNORM after censoring of outliers

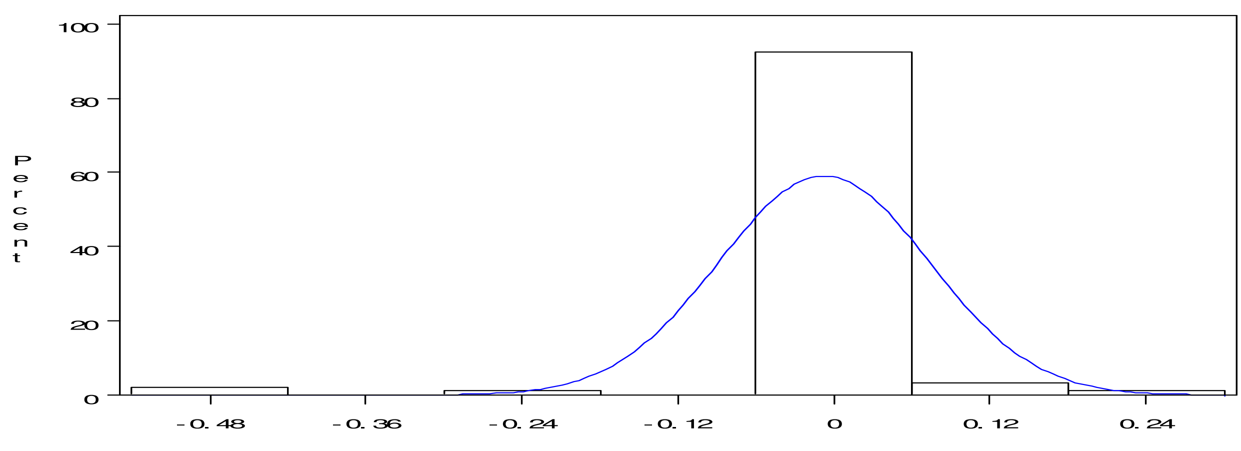


Figure 5.3: Probability distribution of SGAPNORM after censoring of outliers

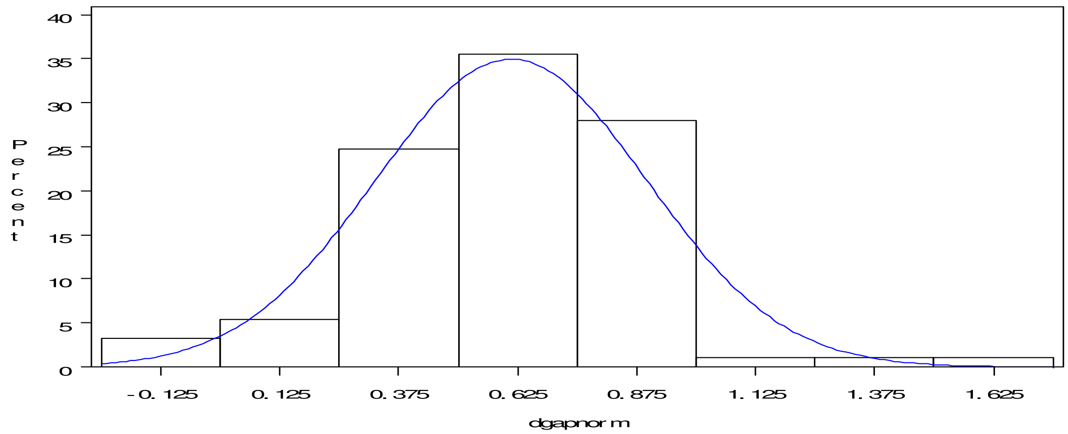


Figure 5.4: Probability distribution of DGAPNORM after censoring of outliers

Table 5.6: Tobit results to explain (IPC-IPU) gap normalized by IPC [GAPNORM]

Variable	Mean	Standard Error	Type	Lower Bound	Upper Bound	N Obs Lower Bound	N Obs Upper Bound
GAPNORM	0.605814	0.231699	Censored	-0.2	1	0	0

Model Fit Summary

Number of Endogenous Variables	1
Endogenous Variable	GAPNORM
Number of Observations	80
Log Likelihood	26.90252
Maximum Absolute Gradient	1.13E-11
Number of Iterations	0
Akaike Information Criterion	-33.805
Schwarz Criterion	-9.98477

Parameter Estimates

Parameter	Estimate	Standard Error	t Value	Approx Pr > |t|
INTERCEPT	0.811424	0.039278	20.66	<.0001
RELEASE	-1.00409	0.359622	-2.79	0.0052
CANAL1	-0.00755	0.001727	-4.37	<.0001
CANAL2	-0.00437	0.001562	-2.8	0.0052
LESSRAIN	-0.09845	0.043544	-2.26	0.0238
NONIRR	0.12191	0.054178	2.25	0.0244
HYDROFIT	0.138847	0.065751	2.11	0.0347
UNAUTH	-0.16061	0.100801	-1.59	0.1111
OM	-25.5305	9.494975	-2.69	0.0072
_SIGMA	0.172869	0.013667	12.65	<.0001

5.10 From Table 5.6 it is observed that GAPNORM is significantly influenced by the following factors:

- Average annual release of water per hectare of IPC (RELEASE): a unit increase in RELEASE reduces GAPNORM by one unit.
- Length of canal system per unit of IPC (CANAL1): a unit increase in CANAL1 reduces GAPNORM by 0.008 unit.
- Length of water course per unit of IPC (CANAL2): a unit increase in CANAL1 reduces GAPNORM by 0.004 unit.
- Less rainfall in the catchment area of the system (LESSRAIN): a one unit increase in rainfall (a dummy variable varying from 0 to 1) reduces GAPNORM by 0.1 unit.
- Diversion of water for non-irrigation purposes (NONIRR): a unit diversion of water for non-irrigation purposes (a dummy variable varying from 0 to 1) increases GAPNORM by 0.12 unit.
- Hydrologically unfit systems (HYDROFIT): unit increase in hydrological unfitness of the system (a dummy variable varying from 0 to 1) increases GAPNORM
- Expenses in operating and maintenance per unit of IPC (OM): unit increase in OM reduces GAPNORM by more than 25 units.
- Unauthorized tapping of water (UNAUTH): unit increase in unauthorized tapping (a dummy variable varying from 0 to 1) reduces GAPNORM by 0.16 units, though the result is not significant statistically. It appears that due to inflexibility the existing irrigation system can't replicate the efficiency property of unauthorized use (like bribes or corruption)!

5.11 As we concentrate on the supply side of the gap (Table 5.7), it is inferred that:

- Percentage of command area under Water Users' Association (WUAPC) has a negative influence on SGAPNORM. A unit increase in the share of area under WUA reduces SGAPNORM by 0.004 units.

- Unauthorized tapping of water (UNAUTH): unit increase in unauthorized tapping (a dummy variable varying from 0 to 1) reduces SGAPNORM by 0.12 units – a fact probably reflecting failure of systems and processes to reduce supply side gap!
- Less rainfall in the catchment area (a dummy variable varying from 0 to 1)of the system (LESSRAIN) increases SGAPNORM while increased length of water course per unit of IPC (CANAL2) reduces SGAPNORM, even though the parameter estimates are not statistically significant.

Table 5.7: Tobit results to explain supply side gap normalized by IPC (SGAPNORM)

Variable	Mean	Standard Error	Type	Lower Bound	Upper Bound	N Obs Lower Bound	N Obs Upper Bound
SGAPNORM	-0.00773	0.081041	Censored	-0.6	0.4	0	0

Model Fit Summary

Number of Endogenous Variables	1
Endogenous Variable	SGAPNORM
Number of Observations	94
Log Likelihood	110.4868
Maximum Absolute Gradient	1.14E-12
Number of Iterations	0
Akaike Information Criterion	-208.974
Schwarz Criterion	-193.714

Parameter Estimates

Parameter	Estimate	Standard Error	t Value	Approx Pr > |t|
INTERCEPT	0.004656	0.010799	0.43	0.6664
CANAL2	-0.00094	0.000661	-1.42	0.1552
WUAPC	-0.0004	0.000201	-1.98	0.0481
LESSRAIN	0.022274	0.016825	1.32	0.1856
UNAUTH	-0.11592	0.039	-2.97	0.003
_SIGMA	0.074696	0.005448	13.71	<.0001

5.12 Demand side gap (DGAPNORM), representing deficiency in demand for irrigation, on the other hand, is influenced by (Table 5.8):

- Average annual release of water per hectare of IPC (RELEASE): a unit increase in RELEASE reduces DGAPNORM by one unit, by apparently augmenting IPU.

- Length of canal system per unit of IPC (CANAL1): a unit increase in CANAL1 reduces DGAPNORM by 0.009 unit, again by raising IPU.
- Length of water course per unit of IPC (CANAL2): a unit increase in CANAL2 reduces DGAPNORM by 0.004 unit, by raising IPU.
- Percentage of command area under Water Users' Association (WUAPC) has a positive influence on DGAPNORM, apparently by economizing on irrigation use. A unit increase in the share of area under WUA increases DGAPNORM by 0.001 units.
- Less rainfall in the catchment area of the system (LESSRAIN) (a dummy variable varying from 0 to 1) reduces DGAPNORM, apparently by raising demand for irrigation.
- Lack of achievement of targeted irrigation system (ACHIEV) increases (a dummy variable varying from 0 to 1) DGAPNORM by adversely affecting irrigation demand.
- Diversion of water for non-irrigation purposes (NONIRR): a unit diversion of water for non-irrigation purposes (a dummy variable varying from 0 to 1) increases DGAPNORM by 0.13 unit, apparently by adversely affecting irrigation demand.
- Hydrologically unfit systems (HYDROFIT): unit increase in hydrological unfitness of the system (a dummy variable varying from 0 to 1) increases DGAPNORM, as it affects irrigation demand.
- Location of the system in Rajasthan (STDUM9) (a dummy variable varying from 0 to 1) as compared to Punjab (treated as benchmark with value of 0) reduces DGAPNORM, other variables remaining unchanged. This is probably because IPR is proportionately smaller as compared to IPU in case of Rajasthan as compared to Punjab.

Table 5.8: Tobit results to explain demand side gap normalized by IPC (DGAPNORM)

Variable	Mean	Standard Error	Type	Lower Bound	Upper Bound	N Obs Lower Bound	N Obs Upper Bound
DGAPNORM	0.624874	0.262481	Censored	-0.25	1.25	0	2
Model Fit Summary							
Number of Endogenous Variables	1						
Endogenous Variable	DGAPNORM						
Number of Observations	80						
Log Likelihood	7.31135						

Maximum Absolute Gradient	4.02E-08
Number of Iterations	24
Akaike Information Criterion	7.3773
Schwarz Criterion	33.57959

Parameter Estimates				
Parameter	Estimate	Standard Error	t Value	Approx Pr > |t|
INTERCEPT	0.781684	0.049784	15.7	<.0001
RELEASE	-1.04122	0.471476	-2.21	0.0272
CANAL1	-0.00986	0.001928	-5.12	<.0001
CANAL2	-0.00441	0.001923	-2.29	0.022
WUAPC	0.001448	0.000769	1.88	0.0596
LESSRAIN	-0.09422	0.054937	-1.72	0.0863
ACHIEV	0.10708	0.065066	1.65	0.0998
NONIRR	0.130304	0.070324	1.85	0.0639
HYDROFIT	0.138574	0.073375	1.89	0.0589
STDUM9	-0.10864	0.065063	-1.67	0.095
_SIGMA	0.211859	0.017113	12.38	<.0001

5.13 Unlike SAS software, application of Tobit regression using STATA allows us to measure the % contribution of various continuous explanatory variables to the estimated gaps. Table 5.9 below captures these % figures.

Table 5.9: Percentage Contribution of Continuous Variables with Statistically Significant Effects on Estimated Gaps

GAPNORM		SGAPNORM		DGAPNORM	
Variable	% contribution	Variable	% contribution	Variable	% contribution
RELEASE	0.005	-		RELEASE	0.05
CANAL1	15.14	-		CANAL1	15.06
CANAL2	6.63	CANAL2	6.0	CANAL2	6.83
WUAPC	-	WUAPC	23.1	WUAPC	20.89
OM	0.002	-	-	-	-
Total explanatory power	21.777		29.1		52.83

5.14 It will be further interesting to note a fairly large order of variation across projects in the values of some of the factors contributing to the gaps. Table 5.10 reveals the extent of such variations.

Table 5.10: Variation in values of certain efficiency determining factors

Variable	N	Mean	Std Dev	Minimum	Maximum	Remarks
Life span of a project (yr)	70	31.385714	18.771929	2	98	
% problem area in CCA	75	0.6329725	1.5642036	0	11.50748	
CCA per village (ha)	72	315.42205	226.72471	24.156716	1478.67	Huge variation
Distribution Channel/ IPC (km/ha)	72	14.805935	14.052231	0	89.720811	
Length of Water Course/IPC(km/ha)	75	5.9192077	12.668009	0	79.847909	
% water diverted to non-irrigation purposes	75	0.0004159	0.0009689	0	0.0050765	
Release of water per IPC (mm/ha)	72	0.0046814	0.0134052	0	0.1039022	
Irrigation charges collected (Rs/ha)	75	0.8381873	7.0416377	0	60.981024	Large variation
Irrigation charges assessed (Rs/ha)	75	2.969974	24.951281	0	216.11461	
Non-irrigation charges collected(Rs/ha of IPC)	75	0.0021396	0.0076399	0	0.056772	
Non-irrigation charges assessed(Rs/ha of IPC)	75	0.0199391	0.166278	0	1.440484	
Operation & maintenance cost/IPC	75	0.0019827	0.0024514	0	0.0117025	Insignificant figures with large variation
Wage/salary cost per IPC	72	4.2538504	36.069867	0	306.06595	Large component

Appendix 5.1: Important parameter values for major/medium projects, for which secondary data could be used for analysis

Obs	Project name	Project code	CCA(CWC)	CCA(STATE)	IPC(CWC)	IPC(STATE)	IPR(STATE)	IPU(CWC)	IPU-10 YR. AVG(STATE)
1	Ukai - Kakrapar	4001	331560	265389	321500	320620.00	320620.00	405340	222459.80
2	Sabarmati	4003	76320	71992	59970	48105.00	71992.00	37650	10148.30
3	Damanganga	4004	51140	51138	43650	48062.00	48062.00	9760	12765.40
4	Wankleshwarbhey	4005	2510	2514	2510	2388.00	2388.00	1770	973.40
5	Dhatarwadi-II	4006	2640	2635	2480	710.00	710.00	2850	27.00
6	Patadungari	4011	5070	5022	5070	4282.38	4282.38	4030	2332.79
7	Kadana (KLBC))	4013	10710	14403	11080	13409.00	13409.00	10870	7219.10
8	Umaria (T)	4017	2190	2192	2220	1270.00	1270.00	960	918.50
9	Bhadar (P)	4018	8000	8000	6520	6520.00	6520.00	4540	2366.90
10	Machhanala (T)	4019	3080	2463	3740	4926.00	4926.00	2570	1568.10
11	Watrak	4032	18340	23708	12570	16226.00	16226.00	13860	3803.00
12	Vaidy	4033	2010	869	1700	1698.00	1698.00	970	457.00
13	Meshwo reservoir	4035	6880	16269	6880	7980.00	7980.00	5560	2340.70
14	Mazam	4036	4720	6179	5220	5259.00	5259.00	3490	894.20
15	Hathamati	4037	17490	51667	17490	17492.00	17492.00	9170	2134.70
16	Guhai	4039	11470	11465	5830	5831.00	5973.00	6120	1869.30
17	Karad	4040	6190	6190	4550	4538.00	4538.00	4250	2201.06

18	Mahi stage - I	4041	213790	272508	212690	212694.00	212694.00	214480	129528.00
19	Deo	4043	6050	5887	7610	8300.00	8300.00	4680	2464.37
20	Sukhi	4045	20660	20701	22290	25255.00	25296.00	14820	10015.40
21	Kharicut canal / Khankat	4046	14570	14614	10200	10200.00	10200.00	10110	2981.60
22	Dantiwada (MOD)	4048	44520	59895	45850	50284.00	50284.00	50280	6617.20
23	Mukteshwar	4049	6190	6186	590	7561.00	7561.00	100	25.90
24	Rajawal	4063	4440	4436	3280	3277.00	3277.00	240	17.90
25	Hiran - II (S)	4065	3960	9510	2830	3351.52	3317.36	1020	1266.90
26	Madhuvanti	4066	2510	2510	2190	833.50	828.07	1990	1133.10
27	Uben	4069	2500	2500	2500	2117.17	2117.17	3210	1012.40
28	Shingoda	4074	6730	6725	4130	1668.00	1658.05	2520	997.10
29	Amipur	4078	8070	8070	4300	1769.40	1769.40	3830	2657.30
30	Malan	4088	3390	3385	2270	2268.00	2268.00	1810	504.23
31	Rangola	4092	7150	7150	4030	3441.00	3441.00	6290	1737.53
32	RAVAL - II / rawal	4093	4860	4860	3890	3872.00	3872.00	1740	643.41
33	Panam	4098	41120	36405	42280	38952.00	36405.00	27030	17575.60
34	HADAF / hudaf	4099	5240	5238	4640	2276.26	2276.26	3500	2514.40

35	Bhadar (s)	4101	26570	26587	17163	35745.00	35745.00	25820	10034.00
36	Moj	4102	7400	7400	5460	5400.00	5400.00	7590	2304.85
37	Venu - ii	4103	4960	5253	4960	4955.00	4955.00	2690	1326.62
38	Phophal i	4104	4680	4676	4060	5614.00	8112.00	5150	2230.00
39	UND-III Irrigation Scheme (JIVAPUR)	4108	9900	1433	9450	1201.00	1201.00	10540	205.30
40	AJI - II Irrigation Scheme	4110	2530	2529	2380	4668.00	4668.00	3690	3258.37
41	AJI - III Irrigation Scheme	4111	6620	6635	6840	6635.00	6635.00	6840	3664.00
42	Demi- I Irrigation Scheme	4113	3130	3132	1580	1578.00	1578.00	2960	1624.40
43	Jojwa Wadhwan Irrigation Scheme	4114	8800	6750	8800	7200.00	6750.00	5520	4489.00
44	Matchhu-I Irrigation Scheme	4116	10410	10409	6760	17814.00	17814.00	9830	2861.40
45	Matchhu-II Irrigation Scheme	4118	9990	9990	9520	19044.00	19044.00	8900	3675.40
46	Chhaparwadi-II	4120	1130	3560	830	5670.00	5670.00	610	1218.60

	Irrigation Scheme								
47	Brahmani Irrigation Scheme	4127	6410	12935	8850	21600.00	21600.00	14740	3857.10
48	Lamabadi Bhogavo-I Irrigation Scheme	4128	4200	4240	3200	5180.00	5180.00	2690	1271.90
49	Wadhvan Bhogavo-I Irrigation Scheme	4129	3240	3237	1670	3258.00	3258.00	2780	683.50
50	Fulzar-I Irrigation Scheme	4144	2040	2031	1210	1214.00	1214.00	2160	717.40
51	Sorthi Irrigation Scheme	4150	2150	2145	1960	1861.00	1861.00	1230	521.20
52	Vartu Irrigation Scheme	4151	3070	3065	2610	2610.00	2610.00	2620	1812.90
53	Sani Irrigation Scheme	4152	2330	2325	2760	2759.00	5518.00	1730	1282.90
54	Karjan Project	4159	56200	51000	52480	60710.00	60710.00	7160	10736.50
55	Jhuj Irrigation Scheme	4167	4180	4180	3580	3261.32	3261.32	990	1035.80

56	Kelia Irrigation Scheme	4168	3240	2210	880	1719.45	1719.45	1210	1486.20
57	Niruna	4236	3040	3036	2430	2430.00	2430.00	2470	1606.85
58	HERAN (G)	4248	3420	2752	3420	4428.00	4428.00	4290	1954.17
59	Hiran I Irrigation Scheme	4249	3960	3958	2630	1268.90	1268.90	1020	351.40
60	Giri (Surface)	6001	5000	5263	5260	7780.00	7780.00	2630	3950.10
61	Bal Valley Right Bank (Lift & Surface)	6002	2410	2410	2410	6469.00	6469.00	1200	1143.24
62	Ranbir Canal	7001	54130	38608	46000	74800.00	74800.00	46000	68623.10
63	Kathua canal	7002	11860	8463	11860	14386.00	14386.00	11860	14308.30
64	New Pattap Canal	7003	9880	9028	1600	14109.00	14109.00	1600	8625.10
65	Hemawas	9027	8300	8684	4980	8300.00	8300.00	8060	2393.30
66	Ora	9031	5190	4616	3180	4616.00	4616.00	3110	1822.30
67	West Banas	9032	8570	7952	4080	4372.00	4372.00	4210	1402.40
68	Surwal	9037	4130	3963	3300	4129.00	4129.00	2670	1426.70
69	Bharatpur Feeder	9038	5670	7178	4600	14568.00	14568.00	2000	576.88
70	Jhadol	9051	4680	1905	1000	1195.00	1195.00	1050	674.80
71	Orai	9055	9860	9260	4630	9260.00	9260.00	4600	3557.50

72	Bundi Ka Gothara	9059	5540	5560	2430	6580.00	6580.00	2580	1836.40
73	Som Kagdar	9066	5740	5731	4950	4945.00	4945.00	4450	2936.70
74	Bhim Sagar	9067	9990	9986	9990	8987.40	8987.40	7790	6587.70
75	Ummed Sagar	9074	3249	3249	4200	2540.00	3264.00	3780	1010.90

Note: Project code numbers starting with 4 corresponds to Gujarat, those with 6 to HP, those with 7 to J & K, and those with 9 to Rajasthan.

Appendix 5.2: Description of Dependent Variables Used in the Analyses

PROBLEM	Percentage area of the command area under salinity, waterlogging etc.
WUAPC	Percentage area of the command area under management of WUA
LIFE	No. of years elapsed between implementation and present
RELEASE	Average annual release (MM3) per hectare of IPC
CANAL1	Length of system canal (Metres) per hectare of IPC
CANAL2	Length of water course (MM3) per hectare of IPC
RCOLLECT	Revenue collected (Rs.) per hectare of IPC
CROPCH	Change in cropping pattern (Dummy)
INTERCP	Low inflow to the reservoir due to interception in the catchment area (Dummy)
OM	Operation and Maintenance Cost per hectare of IPC
LESSRAIN	Low inflow to the reservoir due to less rainfall in the catchment area (Dummy)
ACHIEV	Dependability has not been achieved as envisaged in the project design (Dummy)
NONIRR	Change in water diverted to non-irrigation purposes (Dummy)
HYDROFIT	Condition of the main canal & distribution system is not hydrologically fit (Dummy)
MAINTN	Non-existence / improper maintenance of water conveyance & field channels (Dummy)
COMCH	Change in Command Boundaries (Dummy)
UNAUTH	Unauthorized use of water (Dummy)
STDUM2	Dummy for Dadra & Nagar Haveli.
STDUM3	Dummy for Delhi.
STDUM4	Dummy for Gujarat.
STDUM5	Dummy for Haryana

STDUM6	Dummy for Himachal Pradesh.
STDUM7	Dummy for Jammu & Kashmir.
STDUM9	Dummy for Rajasthan.

Chapter 6

Results from Farmer Level Primary Data on Major and Medium Projects

6.1 As already mentioned earlier, primary data were collected from selected farmers in respect of utilization of irrigation water made available to them through major and medium irrigation projects. Using a multi-stage sampling procedure (discussed in detail in Chapter 3), six projects were identified from each state/UT. Branch canals, distributaries, minors/sub-minors and outlets having largest CCA were identified from the head and tail ends of their corresponding canal network. Farmers located at the head and tail ends of the selected outlets were chosen as per the sampling method explained in Chapter 3. Data were intended to be collected using seven instruments designed for this purpose. While five of them were to be administered at the level of the department – project, main/branch canal, distributary, minor/sub-minor and outlet to elicit information about the supply characteristics of the system, the sixth one was designed to collect information about the characteristics of the settlement (village) where the farmers using water from the identified outlet inhabit. Village level instrument thus incorporated information having bearing on both the demand and supply side of irrigation water and was divided into two parts. The first part was to be filled in with information provided by the departmental officials and the second part being canvassed directly at the field level by field investigators. The seventh instrument was designed to gather demand side data vis-à-vis irrigation water available through major and medium system and was administered to the identified farmers by field investigators appointed for the study. To ensure cross –checking of information some qualitative information about supply side of irrigation were introduced in the instrument administered at the level of the farmers, while similar attempts to elicit the perception of department vis-à-vis the demand parameters were made in the system level schedules.

6.2 Unfortunately, no data could be obtained from the Departments. The results presented in this chapter are solely based on the information gathered by the field investigators from the identified farmers and villages. To top it all, due to prevailing law and order problems at Jammu & Kashmir, no data could be collected from this state. In this chapter we present the results obtained from the Tobit regression carried out to identify the factors that contribute to the gaps – GAPNORM, SGAPNORM and DGAPNORM (i.e., overall gap between IPC and IPU, supply-side gap, (IPC-IPR), and demand-side gap, (IPR-IPU), respectively, each term normalized through division by IPC – that is expressed per unit of potential created. As a first step, outliers were removed following the method utilized and explained in the previous chapter.

6.3 The dependent variables are:

GAPNORM = (IPC-IPU)/IPC

SGAPNORM = (IPC-IPR)/IPC and

DGAPNORM= (IPR-IPU)/IPC

6.4 The independent variables considered in the analyses are:

MAJMD: Total operational holding under major and medium irrigation project in hectares

GMINP: Total operational holding under minor irrigation project using ground water in hectares

SMINP: Total operational holding under minor irrigation project using surface water in hectares

CROSS1=MAJMD*GMINP (interaction between areas under major-medium and minor groundwater)

CROSS2=MAJMD*SMINP (interaction between areas under major-medium and minor surfacewater)

CROSS3=MAJMD*MINP (interaction between areas under major-medium and minor irrigation)

MEMTOT = Family size

MODEPAY = Mode of payment of irrigation charges (0=paid in advance; 1=paid later)

WUA: Whether member of any Water Users' Association (0 or 1)

PACS: Whether member of any Primary Cooperative Society (0 or 1)

USUPA: Uncertainty about supply of irrigation water (0 or 1)

UUNLEVA: Un-leveled land (0 or 1)

UCHANA: Absence of irrigation channels (0 or 1)

USCARA: Scarcity of water (0 or 1)

UCONA: Unresolved conflicts with fellow farmers (0 or 1)

UREMA: Bleak prospects of remunerative returns (0 or 1)

UFINA: Financial incapability of farmer (0 or 1)

UPHYA: Physical incapability of farmer (0 or 1)

ADVKNO: Advance knowledge about supply of irrigation water to farmer (0 or 1)

REASON1: Watercourse not constructed (0 or 1)

REASON2: Watercourse damaged (0 or 1)

REASON3: Discharge capacity of minor reduced due to poor maintenance (0 or 1)

REASON4: Excess tapping of water at head end (0 or 1)

REASON5: Non-receipt of water at time when required (0 or 1)

REASON6: Non-receipt of water in required quantity (0 or 1)

REASON7: Shift from low water intensive to high water intensive crop (0 or 1)

REASON8 : Conversion of agricultural land to non-agricultural use (0 or 1)

DTDUM: Distributary dummy 0 if on located at tail and 1 if located on head end

MNDUM: Minor dummy 0 if located at tail and 1 if located on head end

OUTDUM: Outlet dummy 0 if located at tail and 1 if located on head end

STDUM2: Dummy for Dadra & Nagar Haveli (0 or 1).

STDUM3: Dummy for Delhi (0 or 1).

STDUM4: Dummy for Gujarat (0 or 1)

STDUM5: Dummy for Haryana (0 or 1)

STDUM6: Dummy for Himachal Pradesh (0 or 1)

STDUM7: Dummy for Jammu & Kashmir (0 or 1)

STDUM8: Dummy for Punjab (always set equal to 0 – i.e., Punjab is taken as benchmark)

STDUM9: Dummy for Rajasthan (0 or 1)

6.5 Table 6.1 provides the estimate of the gaps per farmer in the study area. Compared to the results obtained in Chapter 5 derived out of data provided by the irrigation serviced providers, the results here are diametrically opposite. With data obtained from the farmers, SGAPNORM per farmer appears to be positive while DGAPNORM per farmer has a negative value. One may recall that estimates in Chapter 5 suggest a negative value for SGAPNORM and a positive value for DGAPNORM.

Table 6.1: Average values of gaps for major-medium projects in ha

Variable	N	Mean	Minimum	Maximum	Median
GAPNORM	1922	0.0943470	-4.5000000	1.0000000	0
SGAPNORM	1922	0.3952333	-4.5000000	1.0000000	0.4807407
DGAPNORM	1922	-0.3008863	-2.0000000	1.9354839	-0.1666667

6.6 As one looks at a disaggregated level it is found that (Table 6.2)

- Both supply side and demand side gaps are positive in Dadra & Nagar Haveli and Gujarat – a phenomenon to be expected under normal circumstances.
- SGAPNORM is positive with a negative DGAPNORM for the rest of the states, other than Himachal Pradesh.
- Himachal Pradesh returns estimates that concur with the signs of the estimates obtained from secondary data.

Table 6.2: Average values of gaps across states

(1) DADRA & NAGAR HAVELI					
Variable	N	Mean	Minimum	Maximum	Median
GAPNORM	84	0.3927119	-0.1250000	1.0000000	0.5000000
SGAPNORM	84	0.0781365	-0.5000000	1.0000000	0
DGAPNORM	84	0.3145754	-0.1250000	1.0000000	0.2194444

(2) GUJARAT					
Variable	N	Mean	Minimum	Maximum	Median
GAPNORM	345	0.2319713	-1.5714286	1.0000000	0.2500000
SGAPNORM	345	0.1259766	-2.8709677	1.0000000	0
DGAPNORM	345	0.1059947	-1.5714286	1.9354839	0

(3) HARYANA					
Variable	N	Mean	Minimum	Maximum	Median
GAPNORM	369	0.0613640	-2.0000000	1.0000000	0
SGAPNORM	369	0.5804406	-1.0000000	1.0000000	0.7142857
DGAPNORM	369	-0.5190766	-2.0000000	1.0000000	-0.5000000

(4) HIMACHAL PRADESH					
Variable	N	Mean	Minimum	Maximum	Median
GAPNORM	369	-0.0137668	-4.5000000	1.0000000	0
SGAPNORM	369	0.1772171	-4.5000000	1.0000000	0
DGAPNORM	369	-0.1909840	-2.0000000	1.0000000	0

(5) PUNJAB					
Variable	N	Mean	Minimum	Maximum	Median
GAPNORM	371	-0.0016991	-1.0000000	1.0000000	0
SGAPNORM	371	0.6044411	-1.0000000	1.0000000	0.5833333
DGAPNORM	371	-0.6061402	-1.5000000	0.3571429	-0.5833333

(6) RAJASTHAN					
Variable	N	Mean	Minimum	Maximum	Median
GAPNORM	384	0.1338124	-1.0000000	1.0000000	0
SGAPNORM	384	0.5359104	0	1.0000000	0.5000000
DGAPNORM	384	-0.4020980	-1.5000000	0.0416667	-0.5000000

6.7 Table 6.3 identifies the factors that influence GAPNORM. We first of all enlist the factors, which do not have statistically significant impact on GAPNORM. These variables are: farmer's family size (MEMTOT), membership in *Panchayati Raj* institution (PANCH), membership of Water Users' Association (WUA), total operational holding under groundwater based minor irrigation system (GMINP), interaction between total area under major and medium irrigation and total area under minor surface water irrigation (CROSS2), absence of irrigation channels (UCHANA), scarcity of water at the reservoir (USCARA), unresolved conflict with fellow farmers (UCONA), and location of the farmer at head or tail end of the outlet (OUTDUM).

6.8 Factors that significantly influence GAPNORM are:

- Uncertainty about supply of irrigation water from major and medium irrigation projects (USUPA), the positive sign of the coefficient implying that an increase in uncertainty increases GAPNORM
- Mode of payment (MODEPAY) – movement from a system of advanced payment to payment later of water charges increases GAPNORM.
- Advanced knowledge about supply of irrigation water (ADVKNO) positively affects GAPNORM, most probably by allowing for economy in use of water – i.e., by reducing IPU.
- Location on the distributary (DTDUM), the negative coefficient implies that location on the head end reduces GAPNORM.
- Location on the minor (DTMN), the negative coefficient implies that location on the head end reduces GAPNORM.
- Location of the project in Gujarat (STDUM4) and Dadra & Nagar Haveli (STDUM2) increases GAPNORM compared to the Punjab scenario, with other factors remaining unchanged.
- On the other hand, location of the project in Haryana (STDUM5) and Himachal Pradesh (STDUM6) reduces GAPNORM under similar conditions mentioned in the previous bullet point.

6.9 Table 6.4 presents the estimates obtained in respect of SGAPNORM, the supply side of (IPC-IPU) gap normalized by IPC. Factors that influence SGAPNORM in a statistically significant manner are:

- Total operational holding under major and medium irrigation project (MAJMD) with a negative sign of the coefficient implying its increase is associated with a fall in SGAPNORM – that is, a farmer with larger landholding under major/medium irrigation confronts lesser supply side gap.
- Total operational holding under minor irrigation project using ground water (GMINP) with a positive sign of the coefficient implying its increase is associated with a rise in

SGAPNORM, thus expansion of ground water facilities on farmer's land exposes him to larger (excess) supply gap on major/medium irrigation front..

- Uncertainty about supply of irrigation water from major and medium irrigation projects (USUPA), the positive sign of the coefficient implying that an increase in uncertainty increases SGAPNORM.

Table 6.3: Tobit model to explain farmer-level gap (IPC-IPU) normalized by IPC (GAPNORM)

Continuous Dependant Variables							
Variable	Mean	Standard Error	Type	Lower Bound	Upper Bound	N Obs Lower Bound	N Obs Upper Bound
GAPNORM	0.040509	0.585615	Censored	-5	5	1	0

Model Fit Summary	
Number of Endogenous Variables	1
Endogenous Variable	GAPNORM
Number of Observations	1961
Log Likelihood	-1642
Maximum Absolute Gradient	0.0001991
Number of Iterations	18
Akaike Information Criterion	3328
Schwarz Criterion	3451

Parameter Estimates				
Parameter	Estimate	Standard Error	t Value	Approx Pr > |t|
INTERCEPT	0.067216	0.053878	1.25	0.2122
MEMTOT	-0.004691 (8.172%)	0.003371	-1.39	0.1641
PANCH	0.088454	0.078606	1.13	0.2605
WUA	-0.118514	0.087046	-1.36	0.1734
MAJMD	-0.000111 (1.328%)	0.007132	-0.02	0.9875
GMINP	-0.005448 (1.425%)	0.003412	-1.60	0.1104
SMINP	-0.022044 (0.036%)	0.059640	-0.37	0.7117
CROSS2	0.015920 (0.109%)	0.014277	1.12	0.2648
UCHANA	0.227122	0.151894	1.50	0.1348
USCARA	0.214949	0.134781	1.59	0.1108
USUPA	0.517875	0.087963	5.89	<.0001
UCONA	0.453258	0.418509	1.08	0.2788
ADVKNO	0.089044	0.033749	2.64	0.0083
MODEPAY	0.073741	0.030867	2.39	0.0169
DTDUM	-0.086748	0.027895	-3.11	0.0019
MNDUM	-0.059972	0.027985	-2.14	0.0321
OUTDUM	-0.023258	0.025683	-0.91	0.3652
STDUM2	0.294267	0.067765	4.34	<.0001
STDUM4	0.156481	0.038923	4.02	<.0001

STDUM5	-0.069757	0.039622	-1.76	0.0783
STDUM6	-0.168173	0.040092	-4.19	<.0001
_SIGMA	0.558470	0.008922	62.59	<.0001

Note: Figures in parentheses show % explanatory power of continuous right hand side variables, as per Tobit using STATA.

- Damaged water course (REASON2), reduction in discharge capacity of minor due to poor maintenance (REASON3) and excess tapping of water at head end (REASON4), with positive signs for all the coefficients imply a higher incidence of them will lead to higher SGAPNORM.
- Advance knowledge about supply of irrigation water (ADVKNO): negative sign of the coefficient implies that advanced knowledge also helps supplier to economize on supply side gap.
- Location on the distributary, minor and outlet (DTDUM, MNDUM & OUTDUM, respectively), negative coefficients for all of them implying that location on the head end reduces SGAPNORM
- Location of the project in Gujarat (STDUM4), Dadra & Nagar Haveli (STDUM2) and Himachal Pradesh (STDUM6) increases SGAPNORM compared to the Punjab scenario with other factors remaining unchanged.
- On the other hand, location of the project in Rajasthan (STDUM9) reduces SGAPNORM under similar conditions as mentioned in the previous bullet point.

6.10 Other factors that influence SGAPNORM but not in a statistically significant way are: Family size (MEMTOT), total operational holding under minor irrigation project using surface water (SMINP), Interaction between total area under major and medium irrigation and total area under minor ground water irrigation (CROSS1), Membership of Water Users' Association WUA, Location in Haryana (STDUM5), unresolved conflict with fellow farmers (REASON5),

6.11 Now we turn to the demand side of the gap and look for factors influencing this gap at farmer level. The major and statistically significant findings are as follows (Table 6.5):

- Larger the size of farmer's land under major/medium irrigation (MAJMD), the smaller the size of the demand side gap, DGAPNORM – apparently indicating scale effect of larger landholding in command area of major/medium projects.
- However, larger the size of farmer's land under groundwater irrigation (GMINP), the larger the size of the demand-side gap – thus, availability of groundwater irrigation widens rather than closes the demand side gap. Apparently, the farmer prefers use of minor groundwater sources to major/medium sources
- Uncertainty over irrigation supply (USUPA) and unresolved conflicts with fellow farmers (UCONA) are factor constraining water use and thus tends to augment demand side gap in irrigation capacity use.

Table 6.4: Tobit results to explain supply side of (IPC-IPU) gap normalized by IPC (SGAPNORM)

Continuous Dependant Variables							
Variable	Mean	Standard Error	Type	Lower Bound	Upper Bound	N Obs Lower Bound	N Obs Upper Bound
SGAPNORM	0.38207	0.472173	Censored	-5	5	0	0

Model Fit Summary	
Number of Endogenous Variables	1
Endogenous Variable	SGAPNORM
Number of Observations	1969
Log Likelihood	-875.84221
Maximum Absolute Gradient	1.5677E-11
Number of Iterations	0
Akaike Information Criterion	1794
Schwarz Criterion	1911

Note: Figures in parentheses represent % contributions of continuous explanatory variables, as per Tobit results from STRATA.

Parameter Estimates				
Parameter	Estimate	Standard Error	t Value	Approx Pr > |t|
INTERCEPT	0.598929	0.041747	14.35	<.0001
MEMTOT	0.002834 (8.19%)	0.002249	1.26	0.2076
MAJMD	-0.051211 (1.33%)	0.005244	-9.77	<.0001
GMINP	0.015328 (1.45%)	0.002663	5.76	<.0001
SMINP	-0.017331 (0.036%)	0.025120	-0.69	0.4902
CROSS1	0.000593 (3.53%)	0.000412	1.44	0.1495
WUA	0.086754	0.058021	1.50	0.1349
USUPA	0.342781	0.060164	5.70	<.0001
REASON2	0.228860	0.021376	10.71	<.0001
REASON3	0.046756	0.022698	2.06	0.0394
REASON4	0.068994	0.026156	2.64	0.0083
ADVKNO	-0.126452	0.022457	-5.63	<.0001
DTDUM	-0.045748	0.019253	-2.38	0.0175
MNDUM	-0.031415	0.018882	-1.66	0.0962
OUTDUM	-0.043740	0.017371	-2.52	0.0118
STDUM2	-0.347209	0.048833	-7.11	<.0001
STDUM4	-0.285841	0.031792	-8.99	<.0001
STDUM5	-0.038158	0.028438	-1.34	0.1797
STDUM6	-0.309103	0.031766	-9.73	<.0001
STDUM9	0.096096	0.031748	3.03	0.0025
_SIGMA	0.377523	0.006016	62.75	<.0001

Table 6.5: Tobit results to explain demand side of (IPC-IPU) gap normalized by IPC (DGAPNORM)

Continuous Dependant Variables							
Variable	Mean	Standard Error	Type	Lower Bound	Upper Bound	N Obs Lower Bound	N Obs Upper Bound
DGAPNORM	-0.30086	0.497551	Censored	-2	2	2	0

Model Fit Summary	
Number of Endogenous Variables	1
Endogenous Variable	DGAPNORM
Number of Observations	1919
Log Likelihood	-810.44592
Maximum Absolute Gradient	0.01296
Number of Iterations	22
Akaike Information Criterion	1671
Schwarz Criterion	1810

Parameter Estimates				
Parameter	Estimate	Standard Error	t Value	Approx Pr > |t|
INTERCEPT	-0.546808	0.043333	-12.62	<.0001
MEMTOT	-0.006268 (8.169%)	0.002237	-2.80	0.0051
WUA	-0.212142	0.058283	-3.64	0.0003
MAJMD	0.049453 (1.338%)	0.004806	10.29	<.0001
GMINP	-0.019861 (1.420%)	0.002293	-8.66	<.0001
SMINP	0.007169 (0.037%)	0.039533	0.18	0.8561
CROSS2	0.009778 (0.111%)	0.009492	1.03	0.3030
USUPA	0.180520	0.058847	3.07	0.0022
UCONA	0.592856	0.263104	2.25	0.0242
REASON2	-0.112331	0.021274	-5.28	<.0001
REASON3	-0.089092	0.022732	-3.92	<.0001
REASON4	-0.034410	0.025964	-1.33	0.1851
REASON5	-0.059498	0.020395	-2.92	0.0035
REASON7	-0.184449	0.108430	-1.70	0.0889
ADVKNO	0.189211	0.022653	8.35	<.0001
MODEPAY	0.116365	0.026509	4.39	<.0001
DTDUM	-0.029090	0.019440	-1.50	0.1345
MNDUM	-0.028923	0.018738	-1.54	0.1227
OUTDUM	0.019334	0.017192	1.12	0.2608
STDUM2	0.630899	0.053199	11.86	<.0001
STDUM4	0.461399	0.033010	13.98	<.0001
STDUM5	0.038311	0.034804	1.10	0.2710
STDUM6	0.214555	0.037515	5.72	<.0001
STDUM9	-0.073275	0.038715	-1.89	0.0584
_SIGMA	0.368565	0.005955	61.89	<.0001

Note: Figures in parentheses show % explanatory power of continuous right hand side variables, as per Tobit using STATA.

- The same is true of advanced knowledge of irrigation supply (ADVKNO) and modality of irrigation charge payment (MODEPAY, whether charges are to be paid in advance or afterwards). Index of deficiency in demand (DGAPNORM) seems to be boosted up with unit (rather than zero values) value in any of the terms.
- Damaged water course (REASON2), non-receipt of water at time required (REASON4), and shift to more water-intensive crop (REASON7) seem to have restricted supply at farmer's end without a corresponding decline in farmer demand, thus leading to a rise in this demand gap.

- Dadra & Nagar Haveli (SRDUM2), Gujarat (STDUM4) and HP (STDUM6) have larger demand deficiency as compared to Punjab, the base case for comparison,

6.11 Factors having influence on DGAPNORM that are not statistically significant are:

- Total operational holding under minor irrigation project using surface water (SMINP) with a positive sign;
- Interaction between total area under major and medium irrigation and total area under minor surface water irrigation (CROSS2), positively
- Excess tapping of water at the head end (REASON4) with a negative sign;
- Location on the distributary, minor and outlet (DTDUM, MNDUM & OUTDUM, respectively), negative coefficients for all of them implying that location on the head end reduces DGAPNORM
- Location of the project in Haryana (STDUM5) tends to have a positive impact on DGAPNORM, whereas project location in Rajasthan (STDUM9) has a negative impact.

6.12 It should however, be maintained that the estimates in Chapter 5 being the average per project and those in this chapter being estimated per farmer, the absolute values of GAPNORM, SGAPNORM and DGAPNORM will not be comparable.

6.13 Detailed descriptive statistics of the independent variables used in the regression analyses in this chapter are given in Appendix: 6.1 through 6.3.

Appendix 6.1: Mean values of variables used to in regression analysis of GAPNORM

Variable	N	Mean	Std Dev	Minimum	Maximum
MEMTOT	1964	8.1705703	3.9096950	0	32.0000000
PANCH	1964	0.0274949	0.1635621	0	1.0000000
WUA	1964	0.0224033	0.1480287	0	1.0000000
ADVKNO	1964	0.7830957	0.4122418	0	1.0000000
MODEPAY	1964	0.6018330	0.4896449	0	1.0000000
UCHANA	1964	0.0071283	0.0841493	0	1.0000000
USCARA	1964	0.0101833	0.1004228	0	1.0000000
USUPA	1964	0.0229124	0.1496625	0	1.0000000
UCONA	1964	0.0010183	0.0319032	0	1.0000000
DTDUM	1961	0.6578276	0.4745580	0	1.0000000
MNDUM	1961	0.6277409	0.4835302	0	1.0000000
OUTDUM	1961	0.4824069	0.4998178	0	1.0000000
GAPNORM	1964	0.0407001	0.5860754	-5.0000000	1.0000000
MAJMD	1964	1.3283024	1.9657061	0	25.0000000
GMINP	1964	1.4263493	4.0020590	0	120.0000000
SMINP	1964	0.0357994	0.3452186	0	6.4000000
CROSS2	1964	0.1089279	1.4475057	0	28.0000000
STDUM2	1964	0.0427699	0.2023894	0	1.0000000
STDUM4	1964	0.1802444	0.3844888	0	1.0000000
STDUM5	1964	0.1950102	0.3963095	0	1.0000000
STDUM6	1964	0.1955193	0.3967010	0	1.0000000

Appendix 6.2: Mean values of variables used in regression for SGAPNORM					
Variable	N	Mean	Std Dev	Minimum	Maximum
MEMTOT	1972	8.1855984	3.9341401	0	32.0000000
WUA	1972	0.0228195	0.1493655	0	1.0000000
ADVKNO	1972	0.7809331	0.4137190	0	1.0000000
USUPA	1972	0.0228195	0.1493655	0	1.0000000
DTDUM	1969	0.6576943	0.4746019	0	1.0000000
MNDUM	1969	0.6292534	0.4831274	0	1.0000000
OUTDUM	1969	0.4814627	0.4997832	0	1.0000000
SGAPNORM	1972	0.3822285	0.4720790	-4.5000000	1.0000000
MAJMD	1972	1.3250385	1.9626898	0	25.0000000
GMINP	1972	1.4467546	4.0145621	0	120.0000000
SMINP	1972	0.0356542	0.3445248	0	6.4000000
CROSS1	1972	3.5337825	26.8029295	0	800.0000000
STDUM2	1972	0.0425963	0.2019965	0	1.0000000
STDUM4	1972	0.1784990	0.3830294	0	1.0000000
STDUM5	1972	0.1982759	0.3988022	0	1.0000000
STDUM6	1972	0.1957404	0.3968702	0	1.0000000
STDUM9	1972	0.1952333	0.3964807	0	1.0000000
REASON2	1972	0.2616633	0.4396517	0	1.0000000
REASON3	1972	0.2079108	0.4059155	0	1.0000000
REASON4	1972	0.1399594	0.3470329	0	1.0000000

Appendix 6.3: Mean values of variables used in regression for DGAPNORM					
Variable	N	Mean	Std Dev	Minimum	Maximum
MEMTOT	1922	8.1670135	3.9271999	0	32.0000000
WUA	1922	0.0223725	0.1479303	0	1.0000000
ADVKNO	1922	0.7845994	0.4112070	0	1.0000000
MODEPAY	1922	0.6024974	0.4895089	0	1.0000000
USUPA	1922	0.0234131	0.1512509	0	1.0000000
UCONA	1922	0.0010406	0.0322497	0	1.0000000
DTDUM	1919	0.6581553	0.4744515	0	1.0000000
MNDUM	1919	0.6253257	0.4841649	0	1.0000000
OUTDUM	1919	0.4815008	0.4997879	0	1.0000000
DGAPNORM	1922	-0.3008863	0.4975949	-2.0000000	1.9354839
MAJMD	1922	1.3385255	1.9805436	0	25.0000000
GMINP	1922	1.4208637	4.0275730	0	120.0000000
SMINP	1922	0.0365817	0.3489310	0	6.4000000
CROSS2	1922	0.1113082	1.4631534	0	28.0000000
STDUM2	1922	0.0437045	0.2044900	0	1.0000000
STDUM4	1922	0.1795005	0.3838707	0	1.0000000
STDUM5	1922	0.1919875	0.3939658	0	1.0000000
STDUM6	1922	0.1919875	0.3939658	0	1.0000000
STDUM9	1922	0.1997919	0.3999479	0	1.0000000
REASON2	1922	0.2601457	0.4388281	0	1.0000000
REASON3	1922	0.2070760	0.4053159	0	1.0000000
REASON4	1922	0.1399584	0.3470341	0	1.0000000
REASON5	1922	0.4021852	0.4904665	0	1.0000000
REASON7	1922	0.0062435	0.0787892	0	1.0000000

Chapter 7

Results from Farmer Level Primary Data on Ground Water Based Minor Irrigation System

7.1 This chapter reports Tobit results obtained with primary data collected from farmers using water for irrigation from ground water based minor irrigation system.

7.2 The dependent variables used in the estimates are:

- GWGAPNORM: Total gap in ground water system per unit of IPC.
- GWSGAPNORM: Supply gap in ground water system per unit of IPC.
- GWDGAPNORM: Demand gap in ground water system per unit of IPC.

7.3 We identified several factors on *a priori* basis that could potentially influence the gap between IPC and IPU. Obviously, they are categorized under two distinct heads – ground water and surface water. Follows below the list of factors identified that were used as independent variables for regression analyses:

MAJMD: Total operational holding under major and medium irrigation project in hectares

GMINP: Total operational holding under minor irrigation project using ground water in hectares

SMINP: Total operational holding under minor irrigation project using surface water in hectares

CROSS1=MAJMD*GMINP (interactive term between areas under major/medium & groundwater)

CROSS2=MAJMD*SMINP (interactive term between areas under major/medium & surfacewater)

CROSS3=MAJMD*MINP (interactive term between areas under major/medium & minor irrigation)

WUAMEM : Whether member of any Water Users' Association (0 or 1)

PACS: Whether member of any Primary Cooperative Society (0 or 1)

PANCH: Whether member of a *Panchayati Raj* Institution (0 or 1)

DEPEND: Percentage of dependent (non-working age to total) members in the family

GREASON1: Decline in water table (0 or 1)

GREASON2: Lack of availability of energy – electricity or diesel (0 or 1)

GREASON3: Increased price of energy – electricity or diesel (0 or 1)

GREASON4: Decreased efficiency of lifting device (0 or 1)

GREASON5: Water available not fit for irrigation – due to pollution (0 or 1)

GREASON6: Lack of maintenance due to unaffordable maintenance cost (for privately owned system) (0 or 1)

GREASON7: Ownership dispute (for a system owned by a group of farmers) (0 or 1)

GREASON8: Lack of maintenance (for systems owned by Govt., *Panchayat*, Co-operatives) (0 or 1)

GREASON9: Shift from low water intensive to high water intensive crop (0 or 1)

GREASON10: Conversion of agricultural land to non-agricultural purposes (0 or 1)

GREASON11: Conversion of culturable wastes to agricultural purposes (0 or 1)

STDUM2: Dummy for Dadra & Nagar Haveli =1 if state=Dadra & Nagar Haveli =0 otherwise.

STDUM3: Dummy for Delhi =1 if state=Delhi, =0 otherwise.

STDUM4: Dummy for Gujarat =1 if state= Gujarat, =0 otherwise.

STDUM5: Dummy for Haryana =1 if state= Haryana, =0 otherwise.

STDUM6: Dummy for Himachal Pradesh =1 if state= Himachal Pradesh, =0 otherwise.

STDUM7: Dummy for Jammu & Kashmir =1 if state=Jammu & Kashmir , =0 otherwise.

STDUM8: Dummy for Punjab (always set equal to zero, as Punjab is being used as benchmark).

STDUM9: Dummy for Rajasthan =1 if state= Rajasthan, =0 otherwise.

7.4 We begin with the estimated values of dependent variables. While Table 7.1 reports the estimates of average GWGAPNORM, GWSGAPNORM and GWSGAPNORM per farmer for all the states and UTs covered under this study, Table 7.2 provides the estimates disaggregated at the level of states and UTs. Table 7.1 suggests that more than 83% of the gap arises from the demand side. The situations are different across the states and UTs. Table 7.2 captures the variation. It is found that in Punjab and Rajasthan, the total gaps are accounted for by demand side factors. More than 99% of the gap in Gujarat and about 97% of the gap in Chandigarh arise due to deficient demand. A little over 90% of the gap in Haryana results from slackened demand. The situation in Himachal Pradesh (33%) and Delhi (41%) are a little different, where the lion's share of gap arises due to deficiency in supply. About three fourth of the gap in Dadra & Nagar Haveli is explained by deficient demand.

Table 7.1: Average values of (IPC-IPU) gaps for groundwater irrigation

Variable	N	Mean	Minimum	Maximum	Median
GWGAPNORM	269	0.5465388	0	1.0000000	0.5000000
GWSGAPNORM	269	0.0918591	-0.2000000	1.0000000	0
GWDGAPNORM	269	0.4546797	-1.0000000	1.2000000	0.5000000

Table 7.2: Average values of (IPC-IPU) gap for groundwater irrigation across states/UTs

(1) CHANDIGARH

Variable	N	Mean	Minimum	Maximum	Median
GWGAPNORM	47	0.6071093	0	0.8823529	0.6875000
GWSGAPNORM	47	0.0188629	-0.1428571	0.5294118	0
GWDGAPNORM	47	0.5882465	0	0.8571429	0.5000000

(2) DADRA & NAGAR HAVELI

Variable	N	Mean	Minimum	Maximum	Median
GWGAPNORM	14	1.0000000	1.0000000	1.0000000	1.0000000
GWSGAPNORM	14	0.2489067	0	0.7346939	0.1250000
GWDGAPNORM	14	0.7510933	0.2653061	1.0000000	0.8750000

(3) DELHI

Variable	N	Mean	Minimum	Maximum	Median
GWGAPNORM	38	0.5280520	0	1.0000000	0.5000000
GWSGAPNORM	38	0.3113672	0	1.0000000	0
GWDGAPNORM	38	0.2166848	0	1.0000000	0

(4) GUJARAT

Variable	N	Mean	Minimum	Maximum	Median
GWGAPNORM	33	0.4868387	0.0161290	0.5495495	0.5000000
GWSGAPNORM	33	0.0030030	0	0.0990991	0
GWDGAPNORM	33	0.4838357	0.0161290	0.5000000	0.5000000

(5) HARYANA

Variable	N	Mean	Minimum	Maximum	Median
GWGAPNORM	41	0.5305063	0.3000000	0.9090909	0.5000000
GWSGAPNORM	41	0.0504435	0	1.0000000	0
GWDGAPNORM	41	0.4800628	-0.5000000	0.8750000	0.5000000

(6) HIMACHAL PRADESH

Variable	N	Mean	Minimum	Maximum	Median
GWGAPNORM	22	0.4288961	0	1.0000000	0.0750000
GWSGAPNORM	22	0.2881641	-0.2000000	1.0000000	0
GWDGAPNORM	22	0.1407320	-1.0000000	1.2000000	0

(7) PUNJAB					
Variable	N	Mean	Minimum	Maximum	Median
GWGAPNORM	30	0.5055556	0.5000000	0.6666667	0.5000000
GWSGAPNORM	30	0	0	0	0
GWDGAPNORM	30	0.5055556	0.5000000	0.6666667	0.5000000

(8) RAJASTHAN					
Variable	N	Mean	Minimum	Maximum	Median
gwgapnorm	44	0.5000000	0.5000000	0.5000000	0.5000000
gwsgapnorm	44	0	0	0	0
gwdgapnorm	44	0.5000000	0.5000000	0.5000000	0.5000000

7.5 Let us now concentrate on the Tobit results. It is found that (Table 7.3) GWGAPNORM is influenced in a statistically significant manner by

- Family size (MEMTOT) in a negative manner, implying that an increase in family size reduces GWGAPNORM through creation of both supply and demand-side pressures.
- Total operational holding under major and medium irrigation project in hectares (MAJMD) in a positive manner, implying that an increase in former leads to an increase in GWGAPNORM.
- Total operational holding under minor irrigation project using surface water in hectares (SMINP), negatively, thus highlighting positive role of conjunctive irrigation use.
- Interaction between total operational holding under major and medium irrigation project in hectares and operational holding under minor irrigation project using ground water in hectares (CROSS1), negatively, implying a larger size interaction between ground water based minor irrigation system and major & medium irrigation system – i.e., conjunctive irrigation – further reduces GWGAPNORM.

Table 7.3: Tobit result to explain (IPC-IPU) gap for groundwater projects							
Variable	Mean	Standard Error	Type	Lower Bound	Upper Bound	N Obs Lower Bound	N Obs Upper Bound
GWGAPNORM	0.544755	0.243735	Censored	-0.2	1	0	32

Model Fit Summary	
Number of Endogenous Variables	1
Endogenous Variable	GWGAPNORM
Number of Observations	276
Log Likelihood	69.69099
Maximum Absolute Gradient	0.0005722
Number of Iterations	75
Akaike Information Criterion	-105.38198
Schwarz Criterion	-43.83517

Parameter Estimates				
Parameter	Estimate	Standard Error	t Value	Approx Pr > |t|
INTERCEPT	0.539587	0.038448	14.03	<.0001
MEMTOT	-0.007989 (7.47%)	0.003694	-2.16	0.0306
MAJMD	23.317861 (0.039%)	0.071179	327.59	<.0001
GMINP	-0.001190 (2.85%)	0.003761	-0.32	0.7518
SMINP	0.166274 (0.015%)	0.056718	2.93	0.0034
CROSS1	-38.744633 (0.004%)	0.042707	-907.21	<.0001
GREASON2	0.031328	0.025635	1.22	0.2217
GREASON3	0.066185	0.024876	2.66	0.0078
GREASON4	0.086983	0.032097	2.71	0.0067
GREASON5	-0.089471	0.039334	-2.27	0.0229
GREASON7	0.194863	0.078338	2.49	0.0129
GREASON10	0.495228	0.081124	6.10	<.0001
STDUM2	47.356939	8.302209E-17	5.7E17	<.0001
STDUM3	-0.068871	0.041801	-1.65	0.0994
STDUM4	-0.107890	0.036325	-2.97	0.0030
STDUM6	-0.281806	0.049040	-5.75	<.0001
_SIGMA	0.172575	0.007904	21.83	<.0001

Note: % contributions of continuous explanatory variables as per application of STRATA are indicated in parentheses

- Increased price of energy (GREASON3), decreased efficiency of lifting devise (GREASON4), ownership dispute for a system owned by a group of farmers (GREASON7) and conversion of agricultural land for non-agricultural purposes (GREASON10), in a positive manner, implying that an increase incidence of any one of them increases GWGAPNORM – mainly through their adverse influence on the demand side.

- Availability of water not fit for irrigation due to pollution (GREASON5), in a negative way – apparently a counter-intuitive result, as it is expected to cut down rather than augment actual demand for irrigation (i.e., IPU).
- Location in Dadra & Nagar Haveli (STDUM2) in a positive way – increases GWGAPNORM, as rapid industrialization and a fairly large scale conversion of agricultural land seem to push down demand for irrigation – i.e., IPU, as compared to the benchmark case of Punjab.
- Location in Delhi (STDUM1), Gujarat (STDUM4) and Himachal Pradesh (STDUM6) in a negative way – decreases GWGAPNORM, probably because deficiency in demand and/or excess supply of irrigation is relatively less in these areas as compared to the same in Punjab.
- Lack of availability of energy to run the lifting devices (GREASON2) has a positive impact on GWGAPNORM, possibly because of adverse effect on demand – i.e., IPU. However, the relationship is not statistically significant.

7.6 As we concentrate on the supply side gap, it is observed that (Table 7.4) GWSGAPNORM is influenced in a statistically significant way by

- Family size (MEMTOT) in a negative manner, implying an increase in family size reduces GWSGAPNORM – apparently because of implied supply side pressure.
- Total operational holding under major and medium irrigation project in hectares (MAJMD) in a positive manner, implying an increase in the former leads to an increase in GWSGAPNORM.
- Interaction between total operational holding under major and medium irrigation project in hectares and operational holding under minor irrigation project using ground water in hectares (CROSS1), negatively, implying a larger interaction between ground water based minor irrigation system and major & medium irrigation system – conjunctive irrigation – reduces GWSGAPNORM.

- Increased price of energy (GREASON3), decreased efficiency of lifting devise (GREASON4), lack of maintenance due to unaffordable maintenance cost (GREASON8), ownership dispute for a system owned by a group of farmers (GREASON7) and conversion of agricultural land for non-agricultural purposes (Greason10), in a positive manner, implying an increase in any one of them increases GWSGAPNORM. All these factors are expected to affect demand, but here it appears to affect supply side gap too probably through downward adjustment in IPR, as strictly speaking, a sensible supplier would sooner or later adjust actual supply (in this case IPR) to fall in demand.
- Location of farmers in Dadra & Nagar Haveli (STDUM2), Delhi (STDUM3), Haryana (STDUM5) and HP (STDUM6) seems to have higher supply-side gap, as compared to the benchmark case of Punjab.

7.7 GWSGAPNORM is also influenced by

- operational holding under minor irrigation project using ground water in hectares (GMINP) (negatively)
- operational holding under minor irrigation project using surface water in hectares (SMINP) (positively)
- Increased price of energy – electricity or diesel and water available not fit for irrigation – pollution (GREASON3) (positively)

However, these relationships are not statistically significant.

Table 7.4: Tobit results to explain supply side of (IPC-IPU) gap in groundwater irrigation

Variable	Mean	Standard Error	Type	Lower Bound	Upper Bound	N Obs Lower Bound	N Obs Upper Bound
GWSGAPNORM	0.094176	0.264746	Censored	-0.2	1	0	15

Model Fit Summary	
Number of Endogenous Variables	1
Endogenous Variable	GWSGAPNORM
Number of Observations	273
Log Likelihood	25.22050
Maximum Absolute Gradient	1.25196E-6
Number of Iterations	43
Akaike Information Criterion	-14.44101
Schwarz Criterion	50.52948

Parameter Estimates				
Parameter	Estimate	Standard Error	t Value	Approx Pr > |t|
INTERCEPT	-0.070078	0.067038	-1.05	0.2959
MEMTOT	-0.009713 (7.50%)	0.004607	-2.11	0.0350
MAJMD	0.150700 (0.04%)	0.088783	1.70	0.0896
GMINP	-0.001119 (2.84%)	0.004527	-0.25	0.8048
SMINP	0.052616 (0.01%)	0.067088	0.78	0.4329
CROSS1	-0.587727 (0.004%)	0.242930	-2.42	0.0155
GREASON1	0.105379	0.038621	2.73	0.0064
GREASON3	0.048044	0.038178	1.26	0.2082
GREASON4	0.073432	0.038705	1.90	0.0578
GREASON5	0.060055	0.045732	1.31	0.1891
GREASON6	0.064589	0.035785	1.80	0.0711
GREASON7	0.304114	0.093057	3.27	0.0011
GREASON10	0.723129	0.094549	7.65	<.0001
STDUM2	0.277134	0.085975	3.22	0.0013
STDUM3	0.212934	0.058271	3.65	0.0003
STDUM5	0.139330	0.061918	2.25	0.0244
STDUM6	0.428488	0.075680	5.66	<.0001
_SIGMA	0.204088	0.009138	22.33	<.0001

Note: % contributions of continuous explanatory variables as per application of STRATA are indicated in parentheses

7.8 Finally, to consider the factors contributing to demand deficiency, it is observed (Table 7.5) that GWDGAPNORM is influenced in a statistically significant manner by

- Operational holding under minor irrigation project using surface water in hectares (SMINP) positively – thus signifying the advantages of conjunctive use of water between two sources of minor irrigation from the demander's (i.e., farmer's) point of view.

- Decline in water table (GREASON1), water available not fit for irrigation – pollution (GREASON5), lack of maintenance due to unaffordable maintenance cost (GREASON6) and conversion of agricultural land for non-agricultural purposes (GREASON10), in a negative manner, implying that an increase in any one of them creates a situation of lesser deficiency in demand, GWDGAPNORM, as actual supply of irrigation to farmer falls more than his demand.
- Farmer location in Delhi (STDUM3), Gujarat (STDUM4), Haryana (STDUM5) and Himachal Pradesh (STDUM6) in a negative way – reduces index of demand deficiency, GWDGAPNORM, as compared to the benchmark case of Punjab.

7.9 GWDGAPNORM is also influenced by

- Total operational holding under major and medium irrigation project in hectares in a positive manner, implying that an increase in one of them leads to an increase in GWDGAPNORM.
- Operational holding under minor irrigation project using ground water in hectares (GMINP) (positively)
- Interaction between total operational holding under major and medium irrigation project in hectares (MAJMD) and operational holding under minor irrigation project using ground water in hectares (GMINP), positively, implying that a stronger interaction between the two – conjunctive irrigation – economizes on use of irrigation and thus increases GWDGAPNORM.
- Farmer location in Dadra & Nagar Haveli (STDUM2), positively, as compared to Punjab, for reasons already elaborated earlier.

However, these relationships are not statistically significant.

Table 7.5: Tobit result to explain demand side of (IPC-IPU) gap for groundwater irrigation

Variable	Mean	Standard Error	Type	Lower Bound	Upper Bound	N Obs Lower Bound	N Obs Upper Bound
GWDGAPNORM	0.445236	0.275638	Censored	-0.5	1	6	13

Model Fit Summary	
Number of Endogenous Variables	1
Endogenous Variable	GWDGAPNORM
Number of Observations	278
Log Likelihood	0.11127
Maximum Absolute Gradient	4.16196E-6
Number of Iterations	29
Akaike Information Criterion	29.77745
Schwarz Criterion	84.19177

Parameter Estimates				
Parameter	Estimate	Standard Error	t Value	Approx Pr > |t|
INTERCEPT	0.687685	0.048590	14.15	<.0001
MAJMD	0.121987 (0.04%)	0.095823	1.27	0.2030
GMINP	0.001167 (2.84%)	0.004878	0.24	0.8109
SMINP	0.134161 (0.015%)	0.070925	1.89	0.0585
CROSS1	0.199134 (0.004%)	0.244235	0.82	0.4149
GREASON1	-0.142022	0.039484	-3.60	0.0003
GREASON5	-0.157545	0.046985	-3.35	0.0008
GREASON6	-0.081838	0.034281	-2.39	0.0170
GREASON10	-0.242798	0.084281	-2.88	0.0040
STDUM2	0.137224	0.084010	1.63	0.1024
STDUM3	-0.346268	0.060057	-5.77	<.0001
STDUM4	-0.089855	0.048499	-1.85	0.0639
STDUM5	-0.214482	0.052194	-4.11	<.0001
STDUM6	-0.598487	0.064720	-9.25	<.0001
_SIGMA	0.217625	0.009792	22.22	<.0001

Note: % contributions of continuous explanatory variables as per application of STRATA are indicated in parentheses

Chapter 8

Results from Farmer Level Primary Data on Surface Water Based Minor Irrigation System

8.1 The present chapter looks into the factors contributing to the estimated gaps in minor irrigation systems utilizing surface water.

8.2 The dependent variables used in the estimates are:

- SWGAPNORM: Gap in surface water system per unit of IPC therein.
- SWSGAPNORM: Supply gap in surface water system per unit of IPC therein.
- SWDGAPNORM: Demand gap in surface water system per unit of IPC therein.

8.3 We list below the factors identified as potential contributors to the gaps that were used as independent variables for regression analyses:

MAJMD: Total operational holding under major and medium irrigation project in hectares

GMINP: Total operational holding under minor irrigation project using ground water in hectares

SMINP: Total operational holding under minor irrigation project using surface water in hectares

CROSS1=MAJMD*GMINP (to capture joint effect of major/medium & groundwater irrigations)

CROSS2=MAJMD*SMINP (to capture joint effect of major/medium & surface water irrigations)

CROSS3=MAJMD*MINP (to capture joint effect of major/medium & minor irrigations)

MEMTOT: Family size

WUAMEM : Whether member of any Water Users' Association (0 or 1)

PACS: Whether member of any Primary Cooperative Society (0 or 1)

PANCH: Whether member of a *Panchayat* Raj Institution (0 or 1)

DEPEND: Percentage of dependent members (% of non-working age members) in the family

SREASON1: Decline in water available at source (0 or 1)

SREASON2: Lack of availability of energy – electricity or diesel (for surface lift schemes) (0 or 1)

SREASON3: Increased price of energy – electricity or diesel (for surface lift scheme) (0 or 1)

SREASON4: Water available not fit for irrigation – pollution(0 or 1)

SREASON5: Poor maintenance due to unaffordable maintenance cost (for privately owned system) (0 or 1)

SREASON6: Ownership dispute (for a system owned by a group of farmers) (0 or 1)

SREASON7: Lack of maintenance (for systems owned by Govt., Panchayat, Co-operatives) (0 or 1)

SREASON8: Non-receipt of water at time when required (0 or 1)

SREASON9: Non-receipt of water in required quantity (0 or 1)

SREASON10: Shift from low water intensive crop to high water intensive crop (0 or 1)

SREASON11: Conversion of agricultural land to non-agricultural purposes (0 or 1)

STDUM2: Dummy for Dadra & Nagar Haveli (0 or 1)

STDUM3: Dummy for Delhi (0 or 1)

STDUM4: Dummy for Gujarat (0 or 1)

STDUM5: Dummy for Haryana (0 or 1)

STDUM6: Dummy for Himachal Pradesh (0 or 1)

STDUM7: Dummy for Jammu & Kashmir (0 or 1)

STDUM8: Dummy for Punjab (always taken as unity for benchmarking Punjab)

STDUM9: Dummy for Rajasthan (0 or 1)

8.4 To begin with the dependent variables, Table 8.1 presents the estimated gaps under different definitions – SWGAPNORM, SWSGAPNORM and SWDGAPNORM. The estimates are averaged at the level of a farmer. It is found that on an average, the estimates gaps under all the definitions are positive. Total gap per farmer is about 21.5% of IPC, out of which about 6% arise due to supply side problems and the rest (15.5%) due to deficient demand.

Table 8.1: Average values of (IPC-IPU) gap & its demand and supply side components for minor surface water irrigation

Variable	N	Mean	Minimum	Maximum	Median
SWGAPNORM	85	0.2146353	-15.6666667	1.0000000	0.5000000
SWSGAPNORM	85	0.0586469	-9.0000000	1.0000000	0
SWDGAPNORM	85	0.1559884	-16.1666667	9.0000000	0.4000000

8.5 Table 8.2 captures variations in estimates across regions.

- The entire irrigation potential created in Chandigarh – one such system was studied – has been lying unutilized and the gap is explained by supply constraints alone;
- In spite of a high supply side gap, the 31 systems studied in Dadra & Nagar Haveli, register a negative total gap of about 4%, implying a significant excess demand of irrigation water from these systems.
- About 56% of the potential created has been lying unutilized in Delhi, mostly due to deficient demand.
- About 50% of the potential created has been lying unutilized in Gujarat, totally due to deficient demand.
- Total IPC of 2 systems studied in Haryana is lying unutilized, totally due to deficient demand.
- In Himachal Pradesh, in spite of deficient supply, more than 14% of IPC has been lying unutilized.

Table 8.2: Average values of total, supply-side and demand-side gap in (IPC-IPU) for minor surface water irrigation across states

(1) CHANDIGARH

Variable	N	Mean	Minimum	Maximum	Median
SWGAPNORM	1	1.0000000	1.0000000	1.0000000	1.0000000
SWSGAPNORM	1	1.0000000	1.0000000	1.0000000	1.0000000
SWDGAPNORM	1	0	0	0	0

(2) DADRA & NAGAR HAVELI

Variable	N	Mean	Minimum	Maximum	Median
SWGAPNORM	31	-0.0382671	-15.6666667	1.0000000	0.7142857
SWSGAPNORM	31	0.3483211	0	0.7777778	0.2500000
SWDGAPNORM	31	-0.3865882	-16.1666667	1.0000000	0.2500000

(3) DELHI

Variable	N	Mean	Minimum	Maximum	Median
SWGAPNORM	10	0.5581751	0.2727273	1.0000000	0.5000000
SWSGAPNORM	10	0.1163502	-0.4545455	1.0000000	0
SWDGAPNORM	10	0.4418249	0	0.7272727	0.5000000

(4) GUJARAT

Variable	N	Mean	Minimum	Maximum	Median
SWGAPNORM	14	0.5000000	0.5000000	0.5000000	0.5000000
SWSGAPNORM	14	0	0	0	0
SWDGAPNORM	14	0.5000000	0.5000000	0.5000000	0.5000000

(5) HARYANA

Variable	N	Mean	Minimum	Maximum	Median
SWGAPNORM	2	1.0000000	1.0000000	1.0000000	1.0000000
SWSGAPNORM	2	0	0	0	0
SWDGAPNORM	2	1.0000000	1.0000000	1.0000000	1.0000000

(6) HIMACHAL PRADESH

Variable	N	Mean	Minimum	Maximum	Median
SWGAPNORM	27	0.1425381	-2.3333333	1.0000000	0
SWSGAPNORM	27	-0.2954248	-9.0000000	1.0000000	0
SWDGAPNORM	27	0.4379630	-0.2000000	9.0000000	0

8.6 Tables 8.3 through 8.5 identify the factors that contribute to such gaps. We infer the following from Table 8.3:

- Total operational holding under major and medium irrigation project in hectares (MAJMD) has a positive influence on SWGAPNORM as also total operational holding under minor irrigation project using ground water in hectares (GMINP). A positive influence indicates that an increase in area under major/medium or ground water irrigation increases gap in surface water minor irrigation systems. This is possibly a reflection of of conjunctive use of alternative irrigation sources.
- Location of projects in Gujarat (STDUM4) increases the gap while the gap gets reduced for projects located in Himachal Pradesh (STDUM6), with Punjab as the reference point for comparison.

8.7 While the above-stated relations are statistically significant, this is not true of the rest of the explanatory variables in Table 8.3, as elaborated below:

- Family size (MEMTOT) influences SWGAPNORM negatively.
- Total operational holding under minor irrigation project using surface water in hectares (SMINP) affects SWGAPNORM negatively.
- Lack of maintenance (for systems owned by Govt., Panchayat, Co-operatives) – i.e., SREASON7 affects SWGAPNORM negatively.
- Location in Delhi (STDUM3) affects SWGAPNORM positively, vis-à-vis Punjab.

Table 8.3: Tobit result to explain (IPC-IPU) gap for minor surface irrigation

Variable	Mean	Standard Error	Type	Lower Bound	Upper Bound	N Obs Lower Bound	N Obs Upper Bound
SWGAPNORM	0.379341	0.615738	Censored	-2	2	2	0

Number of Endogenous Variables	1
Endogenous Variable	SWGAPNORM
Number of Observations	85
Log Likelihood	-61.22628
Maximum Absolute Gradient	4.24365E-7
Number of Iterations	16
Akaike Information Criterion	142.45256
Schwarz Criterion	166.87907

Parameter Estimates				
Parameter	Estimate	Standard Error	t Value	Approx Pr > |t|
INTERCEPT	0.806065	0.164581	4.90	<.0001
MEMTOT	-0.023145 (7.47%)	0.023369	-0.99	0.3220
MAJMD	7.493524 (0.0014%)	4.211603	1.78	0.0752
GMINP	0.100562 (0.229%)	0.054100	1.86	0.0630
SMINP	-0.250880 (1.125%)	0.044739	-5.61	<.0001
STDUM3	0.399467	0.246803	1.62	0.1055
STDUM4	0.605679	0.182366	3.32	0.0009
STDUM6	-0.450689	0.130623	-3.45	0.0006
SREASON7	-0.321871	0.292587	-1.10	0.2713
_SIGMA	0.483050	0.037875	12.75	<.0001

Note: Figures in parentheses display % contributions of continuous explanatory variables.

8.8 Analysis of Table 8.4 reveals the following:

- Total operational holding under major and medium irrigation project in hectares (MAJMD) has a positive influence on SWSGAPNORM as also total operational holding under minor irrigation project using ground water in hectares (GMINP). A positive influence indicates that an increase in area under major/medium or ground water irrigation increases gap in surface water minor irrigation systems, causing more excess capacity in surface water irrigation supply.
- Location of projects in Gujarat (STDUM4) reduces the gap while the gap gets reduced for projects located in Himachal Pradesh (STDUM6), with Punjab as the norm.

8.9 While the above-stated relations are statistically significant, this is not true of the following results:

- Family size (MEMTOT) influences SWGAPNORM negatively, thus reducing gap between IPC & IPR.

- Total operational holding under minor irrigation project using surface water in hectares (SMINP) affects SWGAPNORM negatively.
- Lack of maintenance (for systems owned by Govt., Panchayat, Co-operatives) – i.e., SREASON7 affects SWGAPNORM negatively.
- Location in Delhi (STDUM3) affects SWGAPNORM positively, vis-à-vis Punjab.

These relations, however, are not statistically significant.

Table 8.4: Tobit result to explain supply side of (IPC-IPU) gap for minor surface irrigation

Variable	Mean	Standard Error	Type	Lower Bound	Upper Bound	N Obs Lower Bound	N Obs Upper Bound
SWSGAPNORM	0.144921	0.475072	Censored	-2	2	2	0

Number of Endogenous Variables	1
Endogenous Variable	SWSGAPNORM
Number of Observations	85
Log Likelihood	-46.38572
Maximum Absolute Gradient	7.91943E-8
Number of Iterations	26
Akaike Information Criterion	120.77144
Schwarz Criterion	154.96856

Parameter Estimates				
Parameter	Estimate	Standard Error	t Value	Approx Pr > |t|
INTERCEPT	0.497661	0.138335	3.60	0.0003
MEMTOT	-0.030211 (7.47%)	0.019806	-1.53	0.1272
MAJMD	10.252733 (0.00141%)	3.514558	2.92	0.0035
GMINP	0.122235 (0.229%)	0.051881	2.36	0.0185
SMINP	0.028762 (1.125%)	0.038196	0.75	0.4515
STDUM3	-0.258111	0.245120	-1.05	0.2923
STDUM4	-0.536892	0.285486	-1.88	0.0600
STDUM5	-0.728764	0.336233	-2.17	0.0302
STDUM6	-0.395669	0.109653	-3.61	0.0003
SREASON1	0.271928	0.167222	1.63	0.1039
SREASON2	0.186762	0.213226	0.88	0.3811
SREASON3	-0.177915	0.183002	-0.97	0.3309
SREASON5	0.169127	0.185798	0.91	0.3627
_SIGMA	0.402770	0.031593	12.75	<.0001

Note: Figures in parentheses display % contributions of continuous explanatory variables.

8.10 A close look into Table 8.5 reveals that SWDGAPNORM is influenced in a statistically meaningful way by:

- Total operational holding under minor irrigation project using surface water in hectares (SMINP) in a negative fashion. An increase in area under surface water reduces SWDGAPNORM.
- Location in Gujarat (STDUM4) tends to increase SWDGAPNORM, as compared to Punjab.

8.11 On the other hand,

- Increase in total operational holding under minor irrigation project using ground water in hectares (GMINP) increases SWDGAPNORM.
- Surface water schemes located in Delhi (STDUM3) has a higher SWDGAPNORM as compared to the same in Punjab.

These two relationships are not however statistically significant.

8.12 Variations in the factors influencing the gaps are given in tables as Appendix 8.1-8.3.

Table 8.5: Tobit results to explain demand side of (IPC-IPU) gap for minor surface irrigation

Variable	Mean	Standard Error	Type	Lower Bound	Upper Bound	N Obs Lower Bound	N Obs Upper Bound
SWDGAPNORM	0.240302	1.331236	Censored	-8	8	1	1

Number of Endogenous Variables	1
Endogenous Variable	SWDGAPNORM
Number of Observations	85
Log Likelihood	-140.62074
Maximum Absolute Gradient	4.38169E-6
Number of Iterations	10
Akaike Information Criterion	293.24148
Schwarz Criterion	307.89739

Parameter Estimates				
Parameter	Estimate	Standard Error	t Value	Approx Pr > |t|
INTERCEPT	0.418808	0.179766	2.33	0.0198
GMINP	0.028659 (0.229%)	0.137939	0.21	0.8354
SMINP	-0.407337 (1.125%)	0.110485	-3.69	0.0002
STDUM3	0.581822	0.435132	1.34	0.1812
STDUM4	1.242101	0.441411	2.81	0.0049
_SIGMA	1.247384	0.097891	12.74	<.0001

Note: Figures in parentheses display % contributions of continuous explanatory variables.

Appendix 8.1: Average values of variables used to explain SWGAPNORM					
Variable	N	Mean	Std Dev	Minimum	Maximum
SWGAPNORM	85	0.2146353	1.8356643	-15.6666667	1.0000000
MEMTOT	85	7.4705882	3.3685811	2.0000000	20.0000000
MAJMD	85	0.0014118	0.0130158	0	0.1200000
GMINP	85	0.2294118	0.9965970	0	6.0000000
SMINP	85	1.1249412	1.4722130	0	8.0000000
STDUM3	85	0.1176471	0.3241019	0	1.0000000
STDUM4	85	0.1647059	0.3731162	0	1.0000000
STDUM6	85	0.3176471	0.4683244	0	1.0000000
SREASON7	85	0.0352941	0.1856173	0	1.0000000

Appendix 8.2: Average values of variables involved in explaining SWSGAPNORM					
Variable	N	Mean	Std Dev	Minimum	Maximum
MEMTOT	85	7.4705882	3.3685811	2.0000000	20.0000000
SREASON1	85	0.1176471	0.3241019	0	1.0000000
SREASON2	85	0.2000000	0.4023739	0	1.0000000
SREASON3	85	0.1764706	0.3834825	0	1.0000000
SREASON5	85	0.1176471	0.3241019	0	1.0000000
STDUM3	85	0.1176471	0.3241019	0	1.0000000
STDUM4	85	0.1647059	0.3731162	0	1.0000000
STDUM5	85	0.0235294	0.1524772	0	1.0000000
STDUM6	85	0.3176471	0.4683244	0	1.0000000
SWSGAPNORM	85	0.0586469	1.0850474	-9.0000000	1.0000000
MAJMD	85	0.0014118	0.0130158	0	0.1200000
GMINP	85	0.2294118	0.9965970	0	6.0000000
SMINP	85	1.1249412	1.4722130	0	8.0000000

Appendix 8.3: Average values of variables used to explain SWDGAPNORM					
Variable	N	Mean	Std Dev	Minimum	Maximum
STDUM3	85	0.1176471	0.3241019	0	1.0000000
STDUM4	85	0.1647059	0.3731162	0	1.0000000
SWDGAPNORM	85	0.1559884	2.0875628	-16.1666667	9.0000000
GMINP	85	0.2294118	0.9965970	0	6.0000000
SMINP	85	1.1249412	1.4722130	0	8.0000000

Chapter 9

Summary & Conclusions

9.1 Based on literature review, brain-storming sessions, interactions with officials, experts and field staff, and analysis of both secondary and primary data collected in this connection, the IIMA Study Team arrived at several pinpointed conclusions, which are categorized and summarized below, as per the terms of reference of this study.

TOR 1: To examine various issues associated with irrigation potential created, irrigation potential utilized, gross irrigation and net irrigation including the definition, the reporting practices and consistencies in data etc.

9.2 Regarding distinction between major, medium and minor projects as well as their ownership status, there is no room for ambiguity, as the Task Force Report (CWC, January 2002) has clearly and categorically defined the same and the Study Team also re-checked in course of discussion with all relevant officials. However, in reality, data preserved and presented to the Study Team by states raises some eyebrows, as certain states submitted different lists at different points in time in course of this study, which differ not only in terms of CCA, IPC and IPU figures (though slightly), but also in terms of categorization of projects across major, medium and minor categories. Though a part of the problem is careless categorization and presentation of data, one can't deny the fact that there is also a legitimate dynamic element which allows CCA, IPC and IPU figures to vary over time, not only due to natural calamities and human error, but also as a result of calculated response to changing market situation by the farmer (e.g., change in cropping pattern as compared to the assumed/projected one). In the absence of a built-in formal mechanism to review and formally accommodate such dynamic features, it is extremely difficult *ex post facto* to differentiate between genuine changes and careless mistakes.

9.3 The subject of widening gap between IPC and IPU hinges upon a few important definitions and their applications at ground level. These definitions are CCA, irrigation intensity, IPC and IPU, on the one hand, and net irrigated area (NIA), gross irrigated area (GIA), and implied irrigation intensities, on the other. While CCA and NIA are physical figures, IPC, IPU, GCA are gross figures[1], when a specific cropping pattern (projected or actual, depending on the term being used) and an assumed water requirement pattern is applied across cropping seasons on CCA. Although these definitions are very clearly re-stated and standardized by the Task Force Report, there are several problems, especially with regard to their perceived applications.

- All these figures are subject to dynamic changes – whether caused by natural factors like flood, earthquake, etc., or by deliberately/inadvertently made human decisions in course of the development process. Apparently, in the absence of any clearly stipulated obligations on the part of the State/UT Departments of Irrigation and Water Resources (DIWR) to maintain such historical records (at least for that component of irrigation under state ownership and control), it appears that assigned ownership and control of such precious national assets is a myth rather than a reality. It may be mentioned in this context that only three out of 329 major/medium irrigation projects on which some data could be procured from relevant states/UTs reported some current figures on problem areas within irrigation command due to salinity, water-logging or other reasons[2].
- While all states under jurisdiction of IIMA study had exclusive Departments of Irrigation & Water Resources (DIWR), this is not true of any of the three UTs covered by this study, where irrigation matters are being handled alongside such other matters as Public Works, Urban Development etc.- matters inviting a lot more attention with rapid

[1] *IPC=$\sum CCA_i$(projected irrigation intensity for ith season), whereas IPU=$\sum CCA_i$(actual irrigation intensity for ith season).*

[2] *These three projects are Ukai-Kakrapar, Kadana Reservoir and Mahi – all three from the state of Gujarat, where our fear is that the figures are not carefully reported. More specifically, we fear that there is serious underreporting on this front.*

urbanization of these areas than irrigation. Though it may be looked upon as consistent moves with the growing and non-reversible pattern of urbanization and industrialization, this trend doesn't augur well with the age-old goals of the nation like promoting livelihood, maintaining food security and appropriately conserving water bodies and natural resources etc.

- Although historical records were not available on several important irrigation parameters[3], information could be procured from DIWR for as many as 329 major/medium projects across states and relevant UTs on CCA, IPC (at project completion stage as well as in the current period; we have referred to the latter as IPR – i.e., irrigation potential realized, a term coined by IIMA Study Team to facilitate decomposition of (IPC-IPR) gap into supply-side and demand-side gaps for further analysis) and IPU, together with irrigation intensities used[4]. Information on NIA, GIA and irrigation intensity on irrigated land was available from published secondary sources up to district level (apparently collated by State Directorates of Economics & Statistics from the records of the Revenue Department, which are prepared by the lowest ground level functionaries called *Patwaris*, among their other jobs and with little knowledge of modern measurement and data collection techniques; the same data are also used by State/UT Agriculture Departments). If appropriately collected and carefully recorded and maintained, figures for NIA must match with the same for CCA, and the same for GIA with its counterpart – namely, IPU. Unfortunately, these can't be matched except at state or country level, as the latter are collected at project level, especially when the state provides irrigation services, whereas the former are collected by *Patwaris* at lowest level (i.e., *mauja*/village level) with hardly any coordination

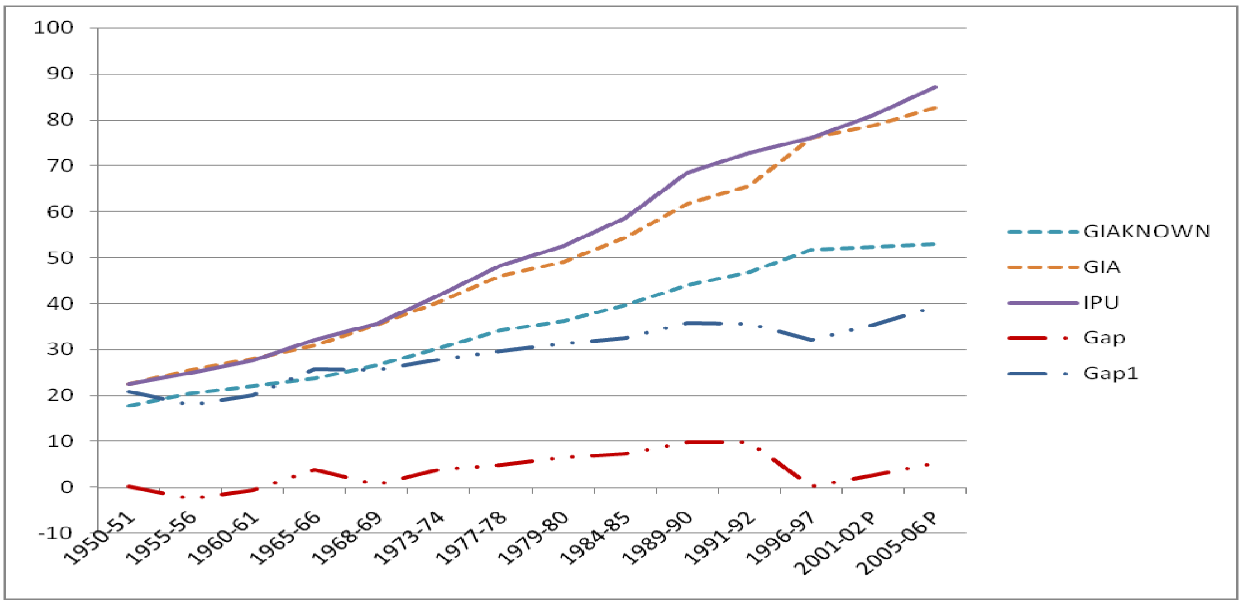
[3] *In spite of attempts made by IIMA study team to procure DPRs and detailed information in this regard at multiple hierarchical levels (through primary questionnaires # 1-5) for at least each selected major/medium project for further data collection (these were dropped from questionnaire for secondary data collection following suggestions from the states/UTs to make this study feasible), hardly any such information was made available except from the state of Gujarat, but that too unfortunately at a very late stage to permit processing and analysis.*

[4] *Seasonal variations in irrigation intensities were not always available, thus constraining our policy analysis, though such information was specifically asked for in a first-stage secondary questionnaire for data collection on major/medium projects.*

between Revenue/Agriculture Department, on the one hand, and Irrigation Department, on the other. This is true even when the task of collection of irrigation revenue is assigned to the Revenue Department in some places (instead of Irrigation Department directly collecting the same).

- An exercise to assess the gap between estimates of irrigation potential utilized (IPU) and gross irrigated area (GIA) reveals interesting insights into the present situation. Figure 9.1 below compares data available from the Ministry of Agriculture (MoA), Government of India on GIA according to sources of irrigation with data maintained by Ministry of Water Resources (MoWR), Government of India on IPU. While the data on GIA is available on a yearly basis, data on IPU is available at certain points of time (end of a plan period). To make the datasets comparable, cumulative figures for IPU have been plotted along with the data on source-wise GIA for the years that mark the end of a particular plan period. Further, as data from both the sources provide source-wise disaggregation, comparisons have been made at disaggregated levels. However, pattern of disaggregation in data available from these two Ministries are not identical. While MoWR data distinguishes between major and medium projects, on the one hand, and minor projects, on the other, the MoA data are available separately for canals (government and privately owned) and tanks as sources of surface water irrigation, with tube wells and other wells as underground sources. MoA data also reports a component called "other" sources that is not covered under the sources already mentioned (govt. canals, private canals, tanks, tube wells and other wells). Ideally, IPU should be equal to GIA, i.e., GAP=(IPU-GIA)/IPU*100 should be equal to zero. But as it is seen from Figure 9.1, GAP is found to be negative during the decade of fifties and then it turned and remained positive till date, coming almost close to zero in 1968-69 and again during 1996-97. However, there have been ups and downs in this movement, with the maximum gap recorded during 1989-90 – a figure close to 10%. A positive value of GAP indicates an over-estimation of IPU vis-à-vis GIA, or an under-estimation of GIA vis-à-vis IPU, which is hard to explain, given the fact that MoA data includes an unspecified category of 'others'. If one leaves out from GIA this unspecified category, this gap (referred to as GAP1 as compared to GAP) becomes even larger in recent times.

Figure 9.1: Percentage Gap between Gross Irrigated area and Irrigation Potential Utilized in India between 1950-51 and 2005-06 {area measured in million hectares}



- A fairly good number of major/medium irrigation projects have ceased to be irrigation projects either because of conversion to high-priority drinking water projects or because of non-availability of any irrigation water (for reasons including inter-state feud or too much of interception in common catchment area of several projects across states), but unfortunately these are not properly reported, nor even properly recorded in state/UT documents, thus most likely overstating IPC for the country as a whole. Unfortunately, there is no clue available to measure this extent of over-statement. However, thanks to the keen interest of the-then nodal officer to this study from the state of Rajasthan, a rather conservative estimate is a loss of 55.10 thousand hectares of IPC (i.e., about 4.58%) out of a state total of 1202.41 thousand hectares under all major/medium projects of the state[5]. This figure is likely to vary across states and regions. Moreover, one must also take into account partial diversion of water from irrigation to non-irrigation purpose. If the data made available to IIMA Study Team from 329 major/medium projects are to be trusted, the extent of this diversion is of the order of 18% at this stage. Although there is no hard historical data on this point, but it appears from discussion with officials that this diversion is taking place at an alarmingly high rate, especially in urban fringes. An even more alarming issue is inconsistency in reported data. Annexure 9.1 identifies 11 major/medium irrigation projects out of the data available to the Study Team, which display no irrigation provided, in spite of positive IPC, even though in one case water is used for non-irrigation purposes. It shows lack of consistency in data provided and one wonders whether IPC is really lost or these are simply cases of serious reporting errors!

- Yet another problem in reporting of data for major/medium projects is discrepancies between CCA, IPC and IPU figures as quoted by CWC and states/UTs. Although IIMA Study Team could procure secondary data on such projects for as many as 329 cases (with a startling exception of absolutely no data from Haryana and for only one project from Punjab in spite of repeated efforts, reminders and appeals), comparison with CWC data could be made in only 75 cases where information on all the relevant irrigation measures are available. Missing information is not only a problem of state/UT data, but also of CWC data available through its publication. The latter is not only backdated, but also inclusive of gaps and even misprints on occasions. This explains very little comparability (i.e., in only 75 cases as reported in Appendix 5.1) between these two sources of data. Within this restricted sample size of 75 observations, we found only slight over-reporting (exactly 1.96%) and moderately high over-reporting (10.27%) in state/UT data vis-à-vis the same on CCA and IPC, respectively. But on IPU we found a

[5] *These projects are reported as: Phool Sagar, Jaswant Sagar, Ramgarh, Santhal Sagar, Gurgaon Canal (due to inter-state problem), Jawai(a) & Narain Sagar.*

fairly large order of upward bias (42.45%) in CWC data vis-à-vis state/UT reported data. Accordingly, gap between IPC and IPU as percentage of IPU turned out to be 50.76% on the basis of exclusive state/UT level data, and only 4.64% on the basis of exclusive CWC data for this common set of 75 major/medium projects, for which full-fledged secondary data was available to permit a logical comparison. Given the fact that states/UTs are required to obtain approval as well as financial support for proposed projects, it appears that CWC data are not dated unlike state/UT source figures. If loss of CCAs is not properly reported (though quite real for natural as well as human factors) to CWC after approval is obtained, it is not surprising to have a fairly high degree of coherence in physical figures of CCA between the two sources. IPC and IPU figures, however, are much more prone to changes at a later stage after project approval, as they are susceptible to changes not only due to normal dynamic changes (like less rainfall or water availability), but also due changes in market forces (e.g., changes in cropping pattern, deficiency in demand for irrigation due to changes in market prospects for crops etc) and political forces (e.g., extending irrigation under political pressure). From available records it is not easy to demarcate the role of one factor from that of the other over time, though an attempt has been made to identify and even estimate the contributions of certain underlying factors based on secondary as well as primary data collected and using sophisticated statistical analysis. A fairly large order of underestimate in IPU figures from states/UTs vis-à-vis the same from CWC source is probably indicative of serious bottlenecks in supply or in demand or in both, which the present study has attempted to analyze.

- Not only there are problems of missing and inconsistent data pertaining to important irrigation parameters of major/medium projects, but also there are large scale variations in the possible explanatory variables as displayed in Table 9.1 below. This is true even if one restricts to a sample of 75 projects, on which information on most variables were available.

Table 9.1: Variation in values of selected explanatory variables on major/medium projects

Variable	N	Mean	Std Dev	Minimum	Maximum	Remarks
Life span of a project (yr)	70	31.385714	18.771929	2	98	5 cases not reported
% problem area in CCA	75	0.6329725	1.5642036	0	11.50748	Positive figures reported only in 3 cases
CCA per village (ha)	72	315.42205	226.72471	24.156716	1478.67	Seems too much of variation; 3 cases nor reported for the first two variables
Distribution Channel/ IPC (km/ha)	72	14.805935	14.052231	0	89.720811	
Length of Water Course/IPC(km/ha)	75	5.9192077	12.668009	0	79.847909	
% water diverted to non-irrigation purposes	75	0.0004159	0.0009689	0	0.0050765	Large variation; though still a small fraction, seems to be growing at an alarming rate with urbanization
Release of water per IPC (mm/ha)	72	0.0046814	0.0134052	0	0.1039022	Large variation
Irrigation charges collected (Rs/ha)	75	0.8381873	7.0416377	0	60.981024	Large variation in all; charges collected still a small fraction of assessed figures for both irrigation & non-irrigation use
Irrigation charges assessed (Rs/ha)	75	2.969974	24.951281	0	216.11461	
Non-irrigation charges collected(Rs/ha of IPC)	75	0.0021396	0.0076399	0	0.056772	
Non-irrigation charges assessed(Rs/ha of IPC)	75	0.0199391	0.166278	0	1.440484	
Operation & maintenance cost/IPC	75	0.0019827	0.0024514	0	0.0117025	Insignificant figures with large variation
Wage/salary cost per IPC	72	4.2538504	36.069867	0	306.06595	A very large component, as compared to OM expenses & that too with large variation

- With respect of minor irrigation projects, majority of them are in the private sector. So, the only meaningful way to assess the quality of such data is on the basis of periodic census data available in printed and tabular form at three different time points. Unfortunately, such data are not available in micro form (i.e., against codified individual units), nor even at village level (in similar codified form) to allow comparison not merely across space, but also over time. So, hardly any extra mileage could be obtained from availability of village-wise aggregative minor irrigation data to the IIMA Study Team for the 3rd Minor Irrigation Census, except for the fact that such data helped us draw an appropriate sample for primary data collection on minor irrigation sources for further analysis. There being no second dataset other than census data, there is hardly any scope for comparison across secondary data sources.

TOR 2: To suggest procedure for collection of related data to be applied uniformly throughout the country

9.4 Although experts and officials favored use of shorter questionnaire for both secondary and primary data collection for this study, IIMA Study Team favored maintaining full rigor of the study, keeping in mind the need for developing an MIS for organizing irrigation data for the future, even though there was constant fear of not getting sufficient response or adequate information from the respondents (i.e., states/UTs or farmers). Though this fear turned out to be true, this exercise turned out to be a useful one for responding to TOR 2. The IIMA Study Team had prepared one set of questionnaire (shown in Annexure 1) for collecting secondary data on all major/medium irrigation projects from the states/UTs under their jurisdiction. Based on the perception that the major chunk of minor projects are under private ownership and control, no extra efforts were made to collect secondary data on minor irrigation projects from states/UTs, except those which were already available from published census data. For collection of primary data on both major/medium and minor irrigation projects, a multi-stage random sampling process was utilized to draw the sample, and questionnaires were prepared accordingly. For sample major/medium projects, a set of 7 questionnaires were used to seek detailed information at (1) project level (Annexure 2.1), (2) selected main/branch level (Annexure 2.2), (3) selected distributary level (Annexure 2.3), (4) selected minor level (Annexure 2.4), (5) selected outlet level (Annexure 2.5), (6) selected village level, which is the largest beneficiary from the selected outlet (Annexure 2.6A & 2.6B[6]), and (7) selected beneficiary household level (Annexure 2.7). In case of minor projects, only project, village and beneficiary household level questionnaires were canvassed for carefully selected villages (based on 3rd census data), which were almost solely dependent on minor irrigation facilities. In spite of awfully low response of the officials towards these canvassed questionnaires in general (especially on Annexures 2.1-2.5 and 2.6A for major/medium projects), several stylized facts came out in course of our deliberations and persuasion, which are worth-mentioning at this juncture:-

- Although Annexure 2.1 provides a format for maintaining secondary data for each and every major/medium project, which ought to be preserved not only by states/UTs but also by CWC & Planning Commission along with DPR and historical records at least at each 5-year interval, this format too has missed a number of important points, which are highlighted as follows. First, dated information on problem areas within command areas together with contributions of various reasons must be compulsorily maintained. Second, physical command area figures must also be maintained at least at the end of each 5-year interval, though these figures are likely to change slowly over years[7]. Third,

[6] *Following instructions from Irrigation Department officials at the ground level, the village questionnaire was divided into two components – (a) information pertaining to matters on which official data are available from various offices, which the Irrigation Department agreed to collect and forward to the Study Team (though it never happened in spite of long waiting), and (b) information pertaining to matters like occupational profile, incidence of major diseases, infrastructure facilities, land use and land market, functioning of water user associations, if any etc., which the Study Team had to collect through trained investigators.*

[7] *CCA being a physical figure defined over a year, seasonal changes in it, as mistakenly shown under item 5 second column of Annexure 1 is not a correct representation and needs to be corrected.*

rainfall figures must be noted not only for catchment area, but also for the irrigated command area.

- Annexure 2.1 to 2.5 provides a model questionnaire for collection and maintenance of records for major/medium irrigation projects beginning from project level all the way down to outlet level. The fact that the state of Gujarat, which maintains probably the most exhaustive data on functioning of such irrigation systems has been able to fill in and submit these completed questionnaires (though belatedly for purpose of processing, analysis and inclusion in this Study Report) bears testimony to the possibility of implementation of the proposed formats. In the absence of this system level data sought through questionnaires I to V, it is not possible to examine in details whether, how and to what extent the IPC-IPU gap is contributed by supply side failures at different levels, resulting in exclusive dependence on farmer-level data for conducting the analysis.

- It came to notice in course of collection of data that a number of minor irrigation projects are owned, controlled and run by state/UT government authorities, though at national or even at some state level they may not constitute a dominant part. Ideally, system questionnaires I to V ought to be canvassed for government run minor irrigation system for periodic but regular review. Because of inadvertent exclusion of government owned minor irrigation projects in the sample, we may have also inadvertently undermined the role of conjunctive use of major/medium and minor irrigation facilities. An ideal MIS system must allow for possibility of conjunctive use of irrigation water not only in major/medium project dominated areas, but also in government minor irrigation project areas (left out from primary data collection). IIMA Study sample of minor irrigation projects were drawn exclusively from villages almost exclusively dependent on minor irrigation, irrespective of whether irrigation system is government or privately owned. Since it is extremely costly to conduct census operations on minor irrigation more frequently than at a decade's interval, given shorter life span of minor projects, it is desirable to have review of minor irrigation system at each 5 year interval on the basis of a suitably stratified random sampling exercise.

- Collection of village level data (questionnaires VIA and VIB) ought to be an important component of the necessary MIS exercise for an efficient irrigation system in the country. This is because such village data not only provides a check on the functioning of irrigation supply system at the lowest administrative or civil society level - namely, at the level of village *panchayats* / water users' associations (WUAs), but also provides an opportunity to relate possible demand-side deficiency in irrigation to possible lack of village infrastructure and facilities, which could boost up irrigation demand. Unfortunately, in the absence of necessary village level data being provided by local Irrigation Authorities (in spite of their promises), the study has failed to relate possible village level factors to the observed gap in functioning of supply/demand side of our irrigation system. This shortcoming needs to be consciously overcome in an ideal MIS system on irrigation. The necessary administrative setup to implement this MIS system will be detailed in the following chapter on Recommendations arising out of this Study.

TOR 3: To clearly identify the irrigation potential, which has been created but never utilized or not regularly utilized or gone into disuse.

9.5 IIMA Study Team designed the study in a manner so as to be able to take care of these concerns through relevant information expected to be provided by the state level official sources. Specific questions to collect information on these issues were introduced in secondary and primary level questionnaires canvassed at the state level. Unfortunately, as mentioned earlier, the response from the respective DIWR officials is still awaited (barring a belated response from Gujarat). As a result, the study team could not do proper justice to the issue at hand. It seems historical data pertaining to irrigation parameters are not at all systematically maintained, even though these may be collected at certain points in time. As per secondary information provided by states for only 75 major and medium projects, IPC is found to be 50.76% higher than IPU. Obviously, the sample of usable data for 75 projects is too small compared to the data on 329 projects formally handed over to the Study Team. In the absence of any historical records maintained or reported, no distinction could be made across (i) potential created; (ii) potential created, but never utilized; (iii) potential created and gone into disuse – whether through a conscious decision to divert irrigation water for non-irrigational use, or it is a case of simple physical loss.

TOR 4: To identify the reasons for gap in the irrigation potential created, irrigation potential realized and gross irrigated area

9.6 This study attempted to address the reasons as well as their contributions behind the observed gaps between IPC, IPU and GIA on the basis of both secondary and primary data collected on major/medium as well as minor irrigation projects. While secondary data on major/medium irrigation projects attempted to cover all such projects across the states/UTs under jurisdiction of this Study[8], data could be obtained for only 329 projects, and that too in a fragmented manner – i.e., without meaningful values or even any values available for some of the parameters. For minor irrigation projects, the secondary data used is available census data. Primary data for both types of irrigation was collected from the field using a fairly comprehensive sampling design from almost9 all states/UTs under jurisdiction of this study.

9.7 The observed gap between IPU and GIA has already been discussed in paragraph 9.3 above, using secondary source data (see Figure 9.1). This gap looks more like a result of lack of coordination and reconciliation in data collection between two broad sources – namely, Dept. of Irrigation & Water Resources, on the one hand, and the Department of Agriculture/Revenue, on the other, rather than anything else. However, when one tries to match these two sources of data, one finds an unambiguously defined category of 'others' in MoA data sources, which

[8] *The state of Jammu & Kashmir turned out to be an exception as in spite of our best and repeated efforts, primary data collection efforts had to be suspended in view of critical law and order conditions prevailing there.*

needs to be specifically accounted for and matched with GIA from known sources of irrigation. Obviously, this is a stupendous task, which needs to be performed in the interest of generating a logical dataset on use of irrigated tracts in this country. We have clear-cut recommendations on this aspect of data discrepancies, to which we shall turn in the final chapter.

9.8 Analysis of published secondary source data on major/medium as well as minor irrigation categories reveals the following lacunae in aggregation and time series analysis of the observed gap between IPC and IPU:-

- Major/medium irrigation projects are on a different footing as compared to minor ones in terms of life span, ownership and control. While the former have a much longer life time than the latter, they confront altogether different types of problems regarding ownership, control and hence in terms of effectiveness. Larger irrigation projects have almost invariably been under state ownership and control in a more or less centralized hierarchical organizational structure, where agency problem between owner-supplier of irrigation and user-demander is quite pervasive. On the other hand, ground water source in particular being an open access common property resource almost everywhere in this country, given the current state of acts and legislations, it has almost always much shorter life span, even though it may be a much more effective irrigation instrument in the hands of an owner-user, especially during the early stages of its life. Considering these conceptual differences between the two broad categories of irrigation, further confirmed by our analysis of published secondary data, innocent and inadvertent addition of all irrigation capacities may compound the confusion over widening gap between IPC and IPU, rather than help explain the same.

- Time lag between creation of irrigation capacity in the form of IPC and its realization in the form of IPU is much larger in case of major/medium projects than in minor ones, as much larger order of public investment are involved in the former than in the latter in creating the necessary infrastructure network to effectively tap the benefits of capacity created. This is also confirmed by our analysis, though neglected in commonly presented aggregative version of the problem. Given frequently observed large time lag between initiation and completion of projects, it is necessary to a systematic and disciplined approach towards drastically cutting down costly time lags.

- Annual data on IPC and IPR are not available for the country as a whole, nor for the states/UTs separately, to fine-tune this argument. However, application of modern econometric testing on IPC-IPU gap figures at the end of each plan period reveals that structural change during 1992-97 Plan period was the highest (shown by a broken horizontal line in Figure 9.2) and supported by statistics of structural change popularly known as Chow test reported in Appendix 9.2. Though there are some structural changes at the end of almost every Plan period, as per the statistical rule of maximum value of F, the most major structural change seems to have taken place during 1992-97. If one performs Augmented Dicky Fuller (ADF) test to understand the exact stochastic process behind the observed secular trend in (IPC-IPU) gap, it is found that this gap is expected to increase during the next plan period.

- MoWR doesn't apply any discount rate while adding IPC over years, although irrigation engineers in course of discussion and submitted data have admitted that all major/medium irrigation systems, being physical systems, are subject to natural and normal wear and tear, which keeps their lifespan limited to approximately 100 years. A simple algebraic exercise shows that application of an annual discount rate of 12.9% renders an initial endowment of 100 in year 0 to an insignificant figure close to 0 at the end of 100 years. So, if irrigation engineers do really believe in a finite lifespan of 100 years for major/medium projects, as they proclaim, they can't shy away from applying a discount rate of 12.9% per annum to cumulative IPC figures. In this context, an assertion to the effect that during their lifetime, such irrigation projects have steady efficiency level up to the end of the 100th year (and then suddenly producing zero output at the end of their stipulated lifespan) doesn't make any sense. Moreover, this practice of ignoring any discounting on past figures of IPC is totally inconsistent with the practices followed elsewhere in the world, and especially in our neighboring countries in the context of major/medium and minor irrigation projects. A few sample discount rates are re-produced together with references in Appendix 9.3. So, ignoring discounting of past figures of IPC simply boils down to deliberate overstating of the cumulative IPC figures and then looking frantically for reasons to explain the implications of overstated IPC figures!

9.9 In order to explain the gap between IPC and IPU, the IIMA Study Team conceptualized the problem in terms of a simple supply-demand diagram for irrigation services, irrespective of whether it is a case of major/medium or minor irrigation. In Figure 9.3 there is an investment in irrigation capacity, which may be termed as supply in potential (or in engineering sense as capacity creation) sense, S_{eng} - a vertical line in the diagram. This is different from the economic concept of regular supply and demand curves, SS and DD, respectively, which aren't independent of price of irrigation, as costs need to be incurred to make potential irrigation available to farmers at his doorsteps through development of canals, channels and a delivery system (represented by a typical upward–sloping supply curve, SS), and an effective demand curve of the usual downward-sloping shape (DD), wherein farmers display their willingness to pay. If regular demand and supply curves, DD and SS, are considered, equilibrium takes place at point X at price P_0. The equilibrium quantity decided by economic logic is nothing but IPU, which differs from the potential, IPC, as given by the vertical supply curve, S_{eng}. At this price, unfortunately, there is a gap between IPC and IPU, i.e., there is excess capacity, on the one hand, and deficient demand, on the other – a typical situation often encountered in reality. For both demand and supply gaps to disappear, not only the price of irrigation must rise to P_1, but also the farmers must be willing to pay the same – i.e., there must be enough boost in the demand curve, to say D_1D_1, such that that the demand curve for irrigation also passes through the same point Y, where the rising economic supply curve meets the potential supply curve, thus making full utilization of created irrigation potential. In summary form, this is the story of gap between IPC and IPU, which the IIMA Study Team has been trying to analyze in operational terms. It may be highlighted in this context that when developmental investments are made to create irrigation potential, suitable intervention measures are needed to push down costs of supply and/or to boost up demand, so that the farmers are willing to pay the right price for full utilization of potential created. In other words, the lesson is that merely leaving everything to the whims of an often ill-functioning market in water is likely to generate puzzling demand-supply gaps, as we are observing between IPC and IPU over the years. The story of milk, popularly known as the AMUL story becomes relevant in this context, where visionary leadership didn't remain content with investment in capacity, but undertook pro-active steps to play with supply of milk and milk products, but also to boost up the demand for the same. Probably this is what is missing in the context of irrigation! Administered pricing of irrigation water together with administered allocation of water across conflicting uses, sometimes in response to the demands of the spot market, seem to have further compounded the problem, thus raising serious doubts about sustainability of livelihoods, food safety and ecological safety – all revolving around wise use of water.

Figure 9.2: Behavior of Gap (Cgap) between IPC & IPU during Plan Periods

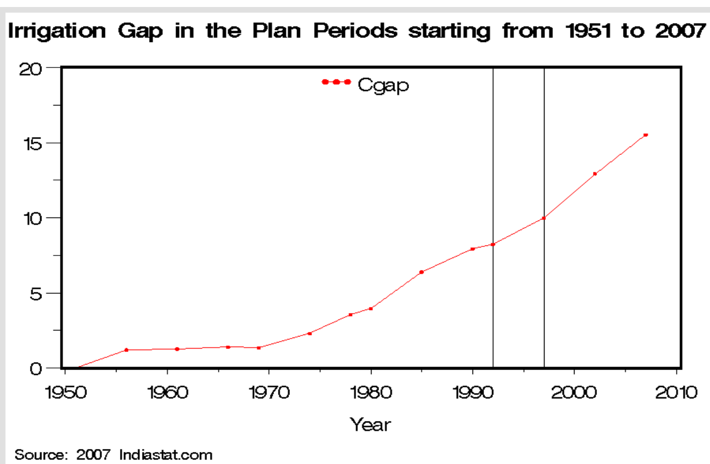
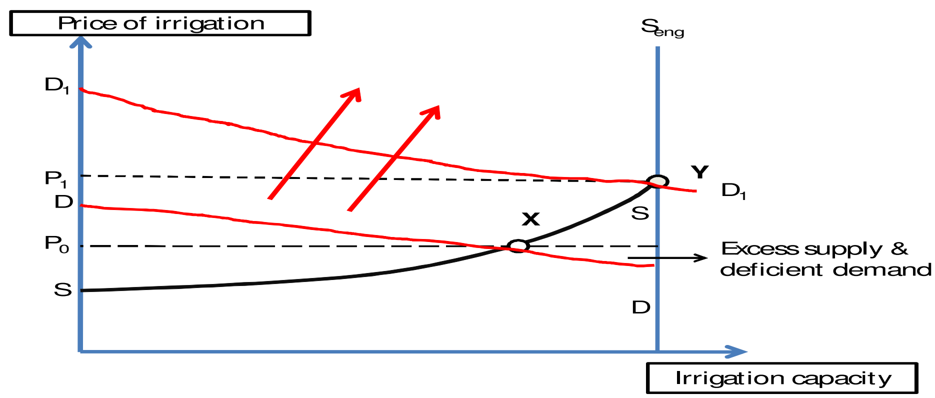


Figure 9.3: A Conceptual Framework to understand (IPC-IPU) Gap



9.10 In order to bring out the role of factors governing the supply and demand side of irrigation services in an operational manner, the IIMA Study Team introduced an intermediary concept, IPR – irrigation potential realized at any point in time by the suppliers of irrigation. Thus, while IPC refers to potential created on completion of a project, IPR is realized potential by suppliers at the current period, while IPU is an actual figure utilized by the farmers – the owner-users. This means the gap between IPC and IPU can be decomposed as IPC – IPU = (IPC – IPR) + (IPR – IPU), where the first component refers to the supply side gap (positive, if IPC>IPR, i.e., irrigation suppliers fail to supply the stipulated potential), whereas the second component refers to deficiency of demand if farmers fail to utilize the potential made available to them by suppliers, i.e., if IPR>IPU. Naturally, both supply and demand side gaps will depend upon a host of factors confronting the suppliers and demanders of irrigation, respectively. A number of factors and policy parameters may enter both sides of the game. With secondary data available on major/medium projects, on the one hand, and collected primary data from a carefully selected sample of farmers on both major/medium and minor projects across the states/UTs under consideration, on the other, an attempt is made in this study to estimate the role and contributions of various factors in this context. As secondary data on minor irrigation was available at aggregative level for only the last two census years, only estimation of these two gaps and classification of states as per the gaps could be done with such data.

9.11 Estimation of (IPC-IPU) gap as well as its decomposition into supply and demand-side components for purpose of analysis and identification of underlying explanatory variables is performed at four levels in order to get maximum possible mileage in terms of policy: first, on the basis of available secondary data from states/UTs on major & medium projects; second, on the basis of collected primary data as per a rigorous sampling framework from farmers again on major & medium projects across five relevant states/UTs (namely, Dadra & Nagar Haveli, Gujarat, HP, Haryana, Punjab & Rajasthan[10]); third, on the basis of collected primary data as per a rigorous sampling framework from farmers on minor groundwater projects across eight relevant states/UTs (i.e., barring J & K); and fourth, on the basis of collected primary data as per a rigorous sampling framework from farmers on minor surface water projects across eight relevant states/UTs (barring J & K). We first report the broad features of the sizes and nature of gaps at these four levels (namely, in Tables 9.2 to 9.5), before attempting to bring out the factors explaining these gaps. The stylized facts arising out of these tables are:

- The distribution of all gaps are humped on the left hand side except for supply-side gap for major/medium projects (Table 9.2) so that median values are generally less than mean values. (IPC-IPU) gap as per state figures is several times larger the same provided by CWC. Even if one sticks to the state provided figures, one is surprised by the finding that there is indeed excess rather than shortage of supply from Irrigation Dept. point of view, so that (IPC-IPR) is always negative, meaning that the burden of the observed gap is passed on more than 100% to the demand side, as per DIWR perspective. In other words, there is severe deficiency in demand for irrigation, in spite of the fact that there is excess supply of water. This is more or less the picture obtained from the four states of

[10] *The state of J & K couldn't be covered in spite of repeated efforts over a fairly long period of time for reasons stated earlier.*

Gujarat, HP, J & K, and Rajasthan from where some sensible secondary data could be obtained in this context.

- The picture obtained from Table 9.2 doesn't match with the same arising from farmer level data in Table 9.3, where these gaps are normalized per unit of IPC. Whereas average normalized value of gap (i.e., IPC-IPU) is only 0.09 – that is less than 10% as per primary data, it is as high as 0.51 – that is more than 50% as per data provided by state Departments. To us, the farmer data based figures more sensible than state provided figures at project level, which are subject to so many errors as elaborated earlier in this chapter. Moreover, whereas states deny any supply side gap and even assert excess supply on average, the farmer level data in Table 9.4 display deficiency of supply to the extent of 40% on average and deficiency of demand to the order of 30%. These two scenarios simply don't match, and if collected primary data are to be trusted, there is a need for serious recapitulation of the figures created, maintained and reported by state Departments.

Table 9.2: Secondary data based estimation of (IPC-IPU) gaps in ha. for major/medium projects

Variables (in ha)	N	Mean	Median	Sum
Gap as per CWC	75	723.64	420.00	54273.00
Gap as per state	75	8813.86	3095.15	661039.52
Supply side gap as per state	75	-360.06	0	-27004.46
Demand side gap as per state	75	9173.92	3228.59	688043.98

Table 9.3: Primary data based estimation of (IPC-IPU) gaps in ha. for major/medium projects

Variable	N	Mean	Minimum	Maximum	Median
Gap normalized by IPC	1922	0.0943470	-4.5000000	1.0000000	0
Supply side gap normalized by IPC	1922	0.3952333	-4.5000000	1.0000000	0.4807407
Demand side gap normalized by IPC	1922	-0.3008863	-2.0000000	1.9354839	-0.1666667

- When we turn to efficiency of minor irrigation water use, it is found that the (IPC-IPU)/IPC gap increased from 19% to 28% for groundwater and decreased from 50% to 41% for surface water between the census figures of 1993-94 and 2000-01[11]. Primary data based on farmer survey shows a much larger figure of 55% for minor groundwater at this stage (Table 9.4) and a much lower figure of 21% for minor surface water projects at this stage (Table 9.5). Both these tables display deficient supply and demand for these two broad categories of minor irrigation, though demand deficiency seems much more dominant as compared to supply side deficiency. Although more or less a similar pattern was already there in the last two census reports, the picture seems to have much sharper in recent times to signal demand side deficiency (rather than a mere supply side deficiency). Obviously, policy prescriptions must address comprehensive farmer side factors too and can't merely afford to concentrate on supply side issues.

Table 9.4: Primary data based estimation of (IPC-IPU) gaps in ha. for minor groundwater projects

Variable	N	Mean	Minimum	Maximum	Median
Gap normalized by IPC	269	0.5465388	0	1.0000000	0.5000000
Supply side gap normalized by IPC	269	0.0918591	-0.2000000	1.0000000	0
Demand side gap normalized by IPC	269	0.4546797	-1.0000000	1.2000000	0.5000000

Table 9.5: Primary data based estimation of (IPC-IPU) gaps in ha. for minor surface water projects

Variable	N	Mean	Minimum	Maximum	Median
Gap normalized by IPC	85	0.2146353	-15.6666667	1.0000000	0.5000000
Supply side gap normalized by IPC	85	0.0586469	-9.0000000	1.0000000	0
Demand side gap normalized by IPC	85	0.1559884	-16.1666667	9.0000000	0.4000000

9.12 Identification of the factors contributing to these different measures of gaps and estimates of their relative contributions has been made in two steps. The first step involves applying Tobit[12]regression models to identify the factors that contribute to the gaps – total gap (IPC-IPU), supply side gap (IPC-IPR) and demand side gap (IPR-IPU). Absolute values of the

[11] *These figures are arrived at based on tables already reproduced in Chapter 4 from 2nd & 3rd Minor Irrigation Censuses.*

[12] *Justification for using Tobit rather than OLS regression lies in the fact that the former is not unduly influenced by extreme values of the dependent variable, and hence provides better estimates in a statistical sense.*

gaps were normalized on dividing them by IPC to create three distinct variables: GAPNORM, SGAPNORM and DGAPNORM, respectively. While the first captures the total gap, the second one captures the extent of supply side gap. The last variable deals with the demand side gap – all per unit of IPC created. Tobit regressions help identify not only the sign of the coefficients that facilitate understanding the nature of contribution of various factors – positive or otherwise – to the gap in question, but also the magnitude and statistical significance of the estimated regression coefficients. This step is performed using a statistical package called SAS (Statistical Analysis System). As SAS doesn't provide % contributions of different explanatory variables, a second step is involved to re-run Tobit using a different software package called STRATA to estimate the percentage contribution of the relevant variables to the gaps in question.

9.13 Based on collected secondary data, Tables 9.6 and 9.7 report contributions of various factors to the relevant gaps. While the former table displays % contributions together with signs of continuous explanatory variables, the latter displays only the signs of discrete explanatory (all binary dummy) variables[13]. Among a fairly large number of explanatory variables tried (a comprehensive list can be obtained from Annexure 2.1), only 5 continuous variables and another 5 discrete variables (displayed in Tables 9.6 and 9.7, respectively) turned out to be statistically significant/nearly significant in explaining the gaps in major and medium projects. The following conclusions emerged out of these two tables:

- The five continuous explanatory variables have limited explanatory power which varies from roughly 22% to 53%. This is not surprising in view of the fact that a large number of other possible explanatory variables could not be included to extract more

[13] *Due to inadequate variation in these discrete binary variables, no statistical package is capable of estimating their % contributions to the gaps. This fact highlights the need for collection of more precise quantitative information on these discrete variables by DIWS across states/UTs as well as their central counterpart. It may be noted that the IIMA Study was keen to collect quantitative information on these variables from the very beginning, but had to compromise at the stage of secondary data collection from the states/UTs following a request from some of the states, but on the understanding that such detailed data would be provided for only sample projects at the next stage of primary data collection. Unfortunately, these expectations were hardly realized. Worse still, one or two states even couldn't return filled-in simplified secondary data schedules.*

explanatory power. Failure to convert discrete explanatory variables into continuous ones has also constrained this exercise, although the Tobit regression equations fitted are quite significant in statistical terms (indicated by the significance level of _SIGMA in relevant tables in Chapters 5-8).

- Lengths of irrigation channels and watercourse per unit of IPC (CANAL1 and CANAL2, respectively) seem to have fairly good amount of explanatory power in reducing both overall and demand side gaps for major and medium projects. Percentage comment area under WUA (WUAPC) has even higher explanatory power in reducing supply side gap apparently by increasing IPR – i.e. irrigation potential current realized. However, this factor seems to be increasing IPR more than IPU, thus creating larger demand side gap – a fact which is not surprising in view of the fact that expansion of IPU is dependent on a larger number of factors than mere extension of comment area under WUA. Operation and maintenance expenditure per unit of IPC (OM) is another significant factor (though its coefficient and explanatory power is small in view of the small units in which OM is measured) in reducing the overall gap. The same thing is also true of the extent of water release per unit of IPC (RELEASE) which reduces the demand side gap as well as the overall gap in a significant manner (Table 9.6).

- Less rainfall in catchment area (LESSRAIN) apparently reduces both IPR and probably to a lesser extent IPU (as farmers may adjust IPU with a lag), which explains the signs of this explanatory variables in Table 9.7. Diversion of water for non-irrigation purposes (NONIRR), hydrological unfitness of irrigation channels (HYDROFIT) and failure to achieve planned irrigation design (ACHIEVE) seem to have reduced IPU and expanded the reported gaps in Table 9.7. Interestingly, unauthorized withdrawal of water (UNAUTH) seems to have augmented IPR, though not in a legitimate manner, and thus increased IPU too to some extent, thus explaining the negative signs against this variable in Table 9.7. In other words, the formal irrigation system has failed to utilize available irrigation capacity and resources to augment IPR and IPU, whereas informal and illegitimate mechanisms have done the same (as it often happens with bribes!)[14].

Table 9.6: % Contribution of Continuous Variables with Statistically Significant Effects on Gaps in Major & Medium Projects Estimated on the basis of Collected Secondary Data.

Variables	GAPNORM	SGAPNORM	DGPNORM
RELEASE=extent of water release per unit of IPC	(-) 0.005*		(-) 0.05*
CANAL1=length of irrigation network per unit of IPC	(-) 15.14*		(-) 15.06*
CANAL2=length of watercourse per unit of IPC	(-) 6.63*	(-) 6.0*	(-) 6.83*
WUAPC=% command area under WUA	-	(-) 23.1*	(+) 20.89*
OM=Operation & maintenance expenditure per unit of IPC	(-)0.002*	-	-
Total explanatory power of variables	21.777	29.1	52.83

*Note: Signs in parentheses indicate signs of regression coefficients. *indicates results which are statistically significant up to 10% level for a two-tailed test.*

9.14 Table 9.8 displays the effect of several continuous variables from farmer side, which provide some explanation for various gaps for major and medium projects as well as minor ground water and minor surface water projects, though the explanatory power of these variables are rather low (varying from 1.36% to 14.54%). The continuous variables identified for this causal connection are 6 - farmer's family size (MEMTOT), farmer's land holding under major/medium, minor ground water and minor surface water projects (MAJMD, GMINP and SMINP, respectively), and two interactive terms between major/medium irrigation on the one hand and ground water or surface water minor irrigation on the other (CROSS1 and CROSS2 respectively). The stylize features extracted in this context are as follows:

- Farmer's family size (MTOT), wherever statistically significant, is found to have reduced demand side gap for major and medium projects and overall gap in minor ground water projects. It has also helped supplier of minor ground water – mostly the farmer himself,

[14] *Since this sample of 75 projects comes mostly from Gujarat and Rajasthan, we did not find any virtue in including state dummy variables in regression analysis.*

to economize on supply side gap (SGAPNORM). This variable has a fairly large order of explanatory power varying from 7.47% to 8.19% (Table 9.8). Thus, a larger family size helps.

Table 9.7: Signs of statistically significant/nearly significant dummy variables to explain gaps in major / medium projects on the basis of collected secondary data

(0 or 1) Dummy variables as reasons for gap	GAPNORM	SGAPNORM	DGAPNORM
LESSRAIN=less rainfall in catchment area	(-)*	(+)	(-)*
NONIRR=diversion of water for non-irrigation purposes	(+)*		(+)*
HYDROFIT=hydrological unfitness of irrigation channels	(+)*		(+)*
UNAUTH=unauthorized withdrawal of water	(-)	(-)*	
ACHIEV=failure to achieve planned design for the system			(+)*

Note: indicates results which are statistically significant up to 10% level for a two-tailed test.*

- Area under major/medium irrigation (MAJMD), while reduces supply side gap, apparently by raising IPR, cannot reduce demand deficiency gap as IPU is probably slow to respond. In case of minor ground water irrigation, expansion of area under MJMD does not help reduce gaps under minor ground water nor under minor surface water – thus there being no advantages from major and medium irrigation in terms of conjunctive use of water. However, expansion of farmer's area under ground water irrigation reduces demand side gap in major/medium projects though not capable of reducing supply side gap or deficiency. Expansion of ground water definitely reduces overall and supply side gap in minor ground water though they are not statistically significant. Area under groundwater having statistically significant but positive effects on gaps under minor surface water irrigation, apparently there are no advantages of conjunctive use. There are some statistically significant benefits of conjunctive use only in case of major/medium irrigation and ground water irrigation. The interactive term between major/medium irrigation and surface water minor irrigation being positive and statistically significant means there are also no positive economies in conjunctive use of water through use of two types of surface water irrigation (Table 9.8).

Table 9.8: % Contributions of continuous explanatory variables in Tobit regression to explain gaps in different type of projects

	Major & medium projects			Minor groundwater projects			Minor surface water projects		
Variables	gapnorm	sgapnorm	dgapnorm	gapnorm	sgapnorm	dgapnorm	gapnorm	sgapnorm	dgapnorm
MEMTOT	(-) 8.17	(+) 8.19	(-) 8.17*	(-) 7.47*	(-) 7.50*		(-)7.47	(-)7.47	
MAJMD	(-) 1.33	(-) 1.33*	(+) 1.34*	(+)0.04*	(+) 0.04*	(+)0.04	(+) 0.001*	(+) 0.001*	
GMINP	(-) 1.43	(+) 1.45*	(-) 1.42*	(-) 2.85	(-)2.84	(+) 2.84	(+) 0.23*	(+) 0.23*	(+) 0.23
SMINP	(-) 0.036	(-) 0.04	(+) 0.04	(+) 0.02*	(+) 0.01	(+) 0.02*	(-) 1.13*	(+) 1.13	(-) 1.13*
CROSS 1		(+) 3.53		(-) 0.004*	(-)0.004*	(-) 0.004			
CROSS 2	(+) 0.11		(+)0.11*						
Total explanatory power	11.076	14.54	11.08	10.384	10.349	2.904	8.831	8.831	1.36

*Note: MEMTOT= total members in farmer family; MAJMD= farmer holding under major / medium project; GMINP= farmer holding under minor groundwater irrigation; SMINP= farmer holding under minor surface water irrigation; CROSS1= interactive MAJMD & GMINP; CROSS2= interactive term between MAJMD & SMINP. Signs in parenthesis indicate signs of regression coefficients. * indicates results which are statistically significant up to 10% level for a two-tailed test.*

9.15 A number of dummy variables were tried to explain gaps in major/medium as well as minor irrigation projects on the basis of primary data collected by these Study Team. Their effects are listed in Tables 9.9-9.10. The stylized facts are:

- Membership in Water Users' Association (WUA) reduces demand side gap in major/medium irrigation projects. Uncertainty about supply (USUPA) and unresolved conflict with the fellow farmer (UCONA) will obviously open the gaps. Advance knowledge of water supply (ADVKNO) and mode of payment of water charges afterwards (MODEPAY), which are closely associated with timeliness of water supply seem to have opened demand side gaps and also overall gap (apparently by increasing IPR), these variables may reduce supply side gap by slightly increasing IPR.

- Among the other reasons damage of water course (REASON2) apparently reduces IPR and thus increases supply side gap and reduces demand side gap.
- Reduction in discharge capacity of minor due to poor maintenance (REASON3) reduces IPR and thus demand side gap.
- Excess tapping of water at high end (REASON4) has clearly augmented supply side gap.

Table 9.9: Signs of statistically significant / nearly significant dummy variables explaining gaps in major / medium projects on the basis of collected primary data

(0 or 1) dummy variables as reasons for gap	GAPNORM	SGAPNORM	DGAPNORM
WUA=membership in Water User's Association			(-)*
USUPA=uncertainty about supply	(+)*	(+)*	(+)*
UCONA=unresolved conflict with fellow farmer			(+)*
ADVKNO=advanced knowledge of water supply	(+)*	(-)*	(+)*
MODEPAY=payment of water charges in installment afterwards rather than in advance	(+)*		(+)*
REASON2=water course changed		(+)*	(-)*
REASON3=discharge capacity of minor reduced due to poor maintenance			(-)*
REASON4=excess tapping of water at high end		(+)*	
REASON5=non-receipt of water in time			(-)*
REASON7=shift to water-intensive crop			(-)*
DTDUM=location on head end of distributary	(-)*		
MNDUM=location on head end of minor	(-)*	(-)*	
OUTDUM=location of head end of outlet		(-)*	

*Note: Signs in parenthesis indicate signs of regression coefficients. * indicates results which are statistically significant up to 10% level for a two-tailed test.*

- Non-receipt of water in time (REASON5) reduces demand side gap. Similar effect is observed if there is a shift to water intensive crop (REASON7).

- Location of irrigation field in head channels (DTDUM, MNDUM and OUTDUM) seems to be enjoying lesser supply side deficiencies, as normally expected.

9.16 A similar exercise is done in Table 9.10, where possible reasons for gap are related to observed gaps in groundwater use[15]. For most of these schemes, the separation and the consequent agency problem between owner and user is less. In this context, the observed stylized features are:

- Decline in water table (GREASON1) apparently reduces IPR, thus raising supply side gap/deficiency, while reducing demand-side gap/deficiency.
- Increased energy price (GREASON3) or decreased efficiency of lifting device (GREASON4), which directly affect the farmer, reduces IPU and/or IPU, thus expanding gaps.
- Unfit water for irrigation (GREASON5) is expected to reduce IPR more than IPU, thus producing the observed results.
- Poor maintenance (GREASON6) clearly reduces IPR, thus opening supply side deficiency, while closing demand side deficiency to some extent.
- Unresolved ownership dispute (GREASON7) across farmers is likely to reduce IPR as well as IPC, producing the displayed results.
- Shift of agricultural land to non-agriculture (GREASON10) is expected to reduce IPU more than IPR (if the installed capacity isn't destroyed), thus expanding supply gap and reducing demand gap to some extent.

[15] *Unfortunately, no listed qualitative reason of this kind was found to be statistically significant in explaining the observed gaps pertaining to surface water irrigation.*

Table 9.10: Signs of statistically significant / nearly significant dummy variables explaining gaps in minor groundwater projects on the basis of collected primary data

(0 or 1) Dummy variables as reasons for gap	GAPNORM	SGAPNORM	DGAPNORM
GREASON1= decline in water table		(+)*	(-)*
GREASON3=increased price of energy – electricity / diesel	(+)*		
GREASON4=decreased efficiency of lifting device	(+)*	(+)*	
GREASON5=water available, but not fit for irrigation	(-)*		(-)*
GREASON6= poor maintenance		(+)*	(-)*
GREASON7=unresolved ownership dispute	(+)*	(+)*	
GREASON10=conversion of agricultural land for non-agricultural use	(+)*	(+)*	(-)*

*Note: signs in parenthesis indicate signs of regression coefficients. * indicates results which are statistically significant up to 10% level for a two-tailed test.*

9.17 Finally, we turn to Table 9.11, which has attempted to capture the effects of state/UT dummies, while treating the case of Punjab as benchmark. Thus, each dummy variable shows whether movement from Punjab to any other state/UT significantly changes the sizes of the gaps, and if so, in which direction. The stylized facts which emanate at this stage are as follows:

- The UT of Dadra Nagar Haveli (STDUM2) is confronting rapid industrialization and a fairly large scale conversion of agricultural land under major/medium projects into non-agriculture, which not only has induced reduction in IPU, but also economizing on supply side gap (as we have captured in some of the photographs taken, where irrigation authorities stopped supplying irrigation, given poor demand and willingness to pay, especially in specific segments). In case of minor groundwater, a reduction in IPU and/or IPR has produced almost similar results.

- The state of Delhi (STDUM3) is facing acute shortage of water together with large scale diversion, which the Department is finding hard to cope with. As a result, there is no wonder that supply gap for minor groundwater irrigation is increasing, whereas demand deficiency is getting reduced. The overall gap is lower because the demand-side effect seems more powerful.

- In Gujarat (STDUM4), demand deficiency is higher and supply deficiency lower vis-à-vis Punjab for major/medium projects, with the demand side force apparently more powerful than the supply side force for a rapidly growing state even in the context of agriculture. For groundwater, given owner's better control over sources of supply, demand deficiency and overall gap are relatively smaller. However, for minor surface irrigation, the situation is similar to surface large/medium projects.

- For Haryana (STDUM5), supply gap is significantly lower (as compared to Punjab) for all three types of irrigation. Demand gap too is lower for minor groundwater source.

- For HP (STDUM6), relative supply gap is smaller for medium and minor surface water irrigation, but higher for groundwater source. Relative demand gap, on the other hand, is larger for medium projects and smaller for two types of minor irrigation.

- For Rajathan (STDUM9), results are significant only for major/medium projects. Here relative supply deficiency is larger and demand deficiency lower, as normally expected.

9.18 Two broad conclusions thus emerge out the summarized results reproduced above. First, a lot more quantitative efforts are needed to exactly and comprehensively cover the roles of various contributing factors to the observed gaps in irrigation use. Second, even though supply side deficiency seem to be biased downward by DIWS (and contradicted by farmer level results), there is no denying the fact that demand-side deficiency which demands a much more comprehensive policy exercise, are quite important and can't be ignored in policy making. While tightening of screws on the supply side to make supply easy and cheaper is no doubt a fundamental task, but simultaneous boosting of farmer's effective demand for irrigation – a two-pronged approach any successful corporate will try to do, constitutes a sufficient condition for success in irrigation supply. Naturally, policy exercise has to go beyond mere creation of WUAs in certain patches of the country.

Table 9.11: Signs of statistically significant/nearly state dummy variables explaining gaps in major/medium & minor (groundwater or surface water) projects on the basis of collected primary data									
	Major & medium projects			Minor groundwater projects			Minor surface water projects		
Variables	gapnorm	sgapnorm	dgapnorm	gapnorm	sgapnorm	dgapnorm	gapnorm	sgapnorm	dgapnorm
STDUM2=dummy for Dadra Nagar Haveli	(+)*	(-)*	(+)*	(+)*	(+)*	(+)			
STDUM3=dummy for Delhi				(-)*	(+)*	(-)*	(+)		
STDUM4=dummy for Gujarat	(+)*	(-)*	(+)*	(-)*		(-)*	(+)*	(-)*	(+)*
STDUM5=dummy for Haryana	(-)*	(-)*	(+)		(+)*	(-)*		(-)*	
STDUM6=dummy for HP	(-)*	(-)*	(+)*	(-)*	(+)*	(-)*	(-)*	(-)*	
STDUM9=dummy for Rajasthan	(-)	(+)*	(-)*						

*Note: * indicates results which are statistically significant up to 10% level for a two-tailed test.*

Appendix 9.1: Major/Medium Projects with Incomplete/inconsistent Data

Obs	IIMA Project code	Project name	IPC as per state in ha	Water use for irrigation MCM (last 10 years)	Water use for non-irrigation MCM (last 10 years)	Remarks
1	4009	Saraswati Reservoir Project, Patan (Gujarat)	6711.88	0	0.000	Seems irrigation use data missing
2	4050	SIPU (Gujarat)	20562.00	0	14.692	Seems water use data missing or no longer an irrigation project
3	7001	Ranbir Canal (J & K)	74800.00	0	0.000	Seems irrigation use data missing
4	7002	Kathua canal (J & K)	14386.00	0	0.000	do
5	7003	New Pattap Canal (J & K)	14109.00	0	0.000	do
6	7004	Kandi Canal (J & K)	3229.00	0	0.000	do
7	7006	Ranjan Canal (J & K)	2600.00	0	0.000	do
8	7010	Marval Lift irrigation scheme (J & K)	4290.00	0	0.000	do
9	7011	Lahapora (J & K)	441.00	0	0.000	do
10	7012	Awantipora Canal Phase I (J & K)	1612.00	0	0.000	do
11	9011	Phool Sagar (Rajasthan)	2676.00	0	0.000	Project reported dead

Appendix 9.2: Reporting Structural Change in Irrigational Gap (IPC-IPU) Series during 1951 to 2007

Break Point (Year)	F Value	Pr > F
1956	2.81	0.1217
1961	5.86	0.0207
1966	16.12	0.0007
1969	32.18	<.0001
1974	49.94	<.0001
1978	55.87	<.0001
1980	45.21	<.0001
1985	39.08	<.0001
1990	18.72	0.0004
1992	**57.06**	**<.0001**
1997	9.23	0.0054
2002	6.72	0.0142
2007	5.44	0.0398

Appendix 9.3: A Sample of Annual Discount Rates applied elsewhere in evaluating Irrigation Projects

Serial #	Discount rates applied	References
1	15-20%	Maniruzzaman, M et al:"Water-saving Techniques through Improved Water Distribution System in Deep Tubewell Area of Bangladesh", Online Journal of Biological Sciences, 2(3), pp.178-82, 2002.
2	15%	*www.parc.gov.pk/data/CatPak/* (Pakistan Government database as of 8.11.08)
3	10%	Folmer, Henk and van Kooten, G. Cornelis - Resource Economics and Policy Analysis Research Group, University of Victoria, Working paper 2006-07
4	15%	Thiruchelvam, Selliah and Pathmarajah, S.: An Economic Analysis of Salinity Problems in the Mahaweli River System H Irrigation Scheme in Sri Lanka in http://www.crdi.ca/en/ev-8418-201-1-DO_TOPIC.html.
5	5-12% (7% for India)	M Ali, JH Narciso: "Economic evaluation and farmers' perception of green manure use in rice-based farming systems", Green Manure Production Systems for Asian Ricelands. International Rice Research Institute, Philipines, 1994.
6	10%	Cline, William R.:"Cost Benefit Analysis of Irrigation Projects in Northeastern Brazil", American Journal of Agriculture Economics, Vol 55 No.4, pp 622-627, 1973.

Appendix 9.4: Glossary of Variables used in Regression Analysis

Dependent Variables:

(a) Major and Medium Projects:

GAPNORM = (IPC-IPU)/IPC

SGAPNORM = (IPC-IPR)/IPC and

DGAPNORM= (IPR-IPU)/IPC

(b) Minor Ground Water based Projects:

GWGAPNORM: Total Gap in ground water system/IPC of ground water system.

GWSGAP: Supply gap in ground water system/IPC of ground water system.

GWDGAP: Demand gap in ground water system/IPC of ground water system.

(c) Minor Surface Water based Projects:

SWGAPNORM: Gap in surface water system/IPC of surface water system.

SWSGAPNORM: Supply gap in surface water system/IPC of surface water system.

SWDGAPNORM: Demand gap in surface water system/IPC of surface water system.

(d) Independent Variables

PROBLEM: Percentage area of the command area under salinity, waterlogging etc.

WUAPC: Percentage area of the command area under management of WUA

LIFE: No. of years elapsed between implementation and present

RELEASE: Average annual release (MM3) per hectare of IPC

CANAL1: Length of system canal (Metres) per hectare of IPC

CANAL2: Water released (MM3) per hectare of IPC

RCOLLECT: Revenue collected (Rs.) per hectare of IPC

CROPCH: Change in cropping pattern (Dummy)

INTERCP: Low inflow to the reservoir due to interception in the catchment area (Dummy)

OM: Operation and Maintenance Cost per hectare of IPC (Dummy)

LESSRAIN: Low inflow to the reservoir due to less rainfall in the catchment area (Dummy)

ACHIEV: Dependability has not been achieved as envisaged in the project design (Dummy)

NONIRR: Change in water diverted to non-irrigation purposes (Dummy)

HYDROFIT: Condition of the main canal & distribution system is not hydrologically fit (Dummy)

MAINTN:Non-existence / improper maintenance of water conveyance & field channels (Dummy)

COMCH: Change in Command Boundaries (Dummy)

UNAUTH: Unauthorized use of water (Dummy)

MAJMD: Total operational holding under major and medium irrigation project in hectares

GMINP: Total operational holding under minor irrigation project using ground water in hectares

SMINP: Total operational holding under minor irrigation project using surface water in hectares

CROSS1=MAJMD*GMINP

CROSS2=MAJMD*SMINP

WUAMEM : Whether member of any Water Users' Association

PACS: Whether member of any Primary Cooperative Society

USUPA: Uncertainty about supply of irrigation water from major and medium irrigation project.

UUNLEVA: Unlevelled Land

UCHANA: Absence of irrigation channels

USCARA: Scarcity of water

UCONA: Unresolved conflicts with fellow farmers

UREMA: Bleak prospects of remunerative returns

UFINA: Financial incapability

UPHYA: Physical incapability

ADVKNO: Advance knowledge about supply of irrigation water

DTDUM: Distributary dummy 1 if on Tail and 2 if on Head

MNDUM: Minor dummy 1 if on Tail and 2 if on Head

OUTDUM: Outlet dummy 1 if on Tail and 2 if on Head

REASON1: Watercourse not constructed

REASON2: Watercourse damaged

REASON3: Discharge capacity of minor reduced due to poor maintenance

REASON4: Excess tapping of water at the head end

REASON5: Non-receipt of water at time when required

REASON6: Non-receipt of water in required quantity

REASON7: Shift from low water intensive crop to high water intensive crop

REASON8 : Conversion of agricultural land to non-agricultural use.

GREASON1: Decline in water table

GREASON2: Lack of availability of energy – electricity or diesel

GREASON3: Increased price of energy – electricity or diesel

GREASON4: Decreased efficiency of lifting devise

GREASON5: Water available not fit for irrigation – pollution

GREASON6: Lack of maintenance due to unaffordable maintenance cost (for privately owned system)

GREASON7: Ownership dispute (for a system owned by a group of farmers)

GREASON8: Lack of maintenance (for systems owned by Govt., Panchayat, Co-operatives)

GREASON9: Shift from low water intensive crop to high water intensive crop

GREASON10: Conversion of agricultutal land to non-agricultural purposes

GREASON11: Conversion of culturable wastes to agricultural purposes.

SREASON1: Decline in water available at source

SREASON2: Lack of availability of energy – electricity or diesel (for surface lift schemes)

SREASON3: Increased price of energy – electricity or diesel (for surface lift scheme)

SREASON4: Water available not fit for irrigation – pollution

SREASON5: Lack of maintenance due to unaffordable maintenance cost (for privately owned system)

SREASON6: Ownership dispute (for a system owned by a group of farmers)

SREASON7: Lack of maintenance (for systems owned by Govt., Panchayat, Co-operatives)

SREASON8: Non-receipt of water at time when required

SREASON9: Non-receipt of water in required quantity

SREASON10: Shift from low water intensive crop to high water intensive crop

SREASON11: Conversion of agricultutal land to non-agricultural purposes

SREASON12: Conversion of culturable wastes to agricultural purposes.

(e) Dummy Variables used for the States

STDUM1: Dummy for Chandigarh =1 if state=Chandigarh =0 otherwise

STDUM2: Dummy for Dadra & Nagar Haveli =1 if state=Dadra & Nagar Haveli =0 otherwise.

STDUM3: Dummy for Delhi =1 if state=Delhi =0 otherwise.

STDUM4: Dummy for Gujarat =1 if state= Gujarat =0 otherwise.

STDUM5: Dummy for Haryana =1 if state= Haryana=0 otherwise.

STDUM7: Dummy for Jammu & Kashmir =1 if state=Jammu & Kashmir =0 otherwise.

STDUM6: Dummy for Himachal Pradesh =1 if state= Himachal Pradesh =0 otherwise.

STDUM9: Dummy for Rajasthan =1 if state= Rajasthan=0 otherwise.

Chapter 10

Recommendations

10.1 The purpose of this chapter is to take care of the 5th and last terms of reference for this Study, namely –

TOR 5: To suggest measures for minimizing the gap between IPC and IPU,

Based on the conceptual framework, sampling design, findings from analysis of both secondary and primary data and the conclusions arrived at in the preceding chapter, the present chapter attempts to come up with a set of action points together with a roadmap corresponding to each problem/issue identified to minimize the gap between IPC and IPR.

10.2 While the Ministry posed the problem of widening gap between IPC and IPU, it seems to have taken too simplistic a view of things, apparently and inadvertently adding non-homogenous categories like groundwater and surface water resources, on the one hand, and older and newer capacity created, on the other, thus treating all as equals. Although taking an aggregative view is a good starting point and a nice way to pose the problem to sensitize all relevant quarters, beyond a point such an approach tends to hinder rather than help find a solution, by creating deliberate overstatements of IPC, by ignoring a natural discounting factor for older projects, especially when enough evidences are there worldwide on application of a reasonable discount rate. Government of India must therefore take a reasonable stand on this discounting factor, especially to guard against application of too high a rate so as to encourage opportunism in the maintenance of our irrigation projects. Second, considering the fact that different sources of irrigation have different lifespan, besides having different regimes of property rights, not only do we need to create unambiguous property rights as much as possible, but also to apply different discount rates, given variations in resource settings. An example will probably make this point clear. An open access common property resource will typically have a higher discount rate, as compared to a closed access common property resource. Naturally, this task can be best performed only by a High Power Committee at the national level. Such a committee must also deliberate on inter-temporal behavior of IPC and IPU curves to bring out the implications of regime/structural changes and suggest suitable policy to counter projected changes in the wrong direction. A third task of this committee should be to undertake and monitor measures to minimize time gap between commissioning of an irrigation project and its completion, which is found to be especially long for state run major & medium projects.

10.3 In view of the growing scarcity of water in today's context and its multifarious national and international implications, it is probably high time to put irrigation resources on the concurrent list rather than leaving the matter to be decided by mere local level considerations by respective states/UTs. Loss of irrigation resources therefore need to be subject to a compensatory program just as loss of forests even for developmental projects is subject to a compensatory afforestation program. The proposed High Power Committee must ensure that there is enough teeth in irrigation laws to protect these sources from inadvertent or opportunistic destruction/encroachment (e.g., by movements of livestock across unlined irrigation channels near Surat as shown in one of the pictures in Annexure 10).

10.4 To encourage repair and maintenance of existing irrigation sources, on the one hand, and also to encourage further investment in fresh surface irrigation projects, on the other, several measures are suggested to be undertaken by the proposed High Power Committee. First, it must highlight and attempt to estimate the social rate of return on investment in irrigation, considering its linkages with livelihood, food-safety and ecological safety issues. Second, this committee must develop a water use efficiency index at aggregative level for projects, areas, districts and states, so that such indices can be used to provide incentives by CWC in sanction of fresh projects, on the one hand, and by the Central government to provide fiscal incentives to such constituencies. Third, innovative schemes must be developed under NREGA to provide necessary operation and maintenance support to existing and fresh irrigation projects. Finally, considering inter-linkages between agriculture, forestry, fisheries, irrigation, urban and industrial land use, a comprehensive long-term land use planning and policy must be developed for the country as a whole to put an end to fragmented and short-sighted land use policy.

10.5 To assimilate and reconcile data discrepancies, a Standing District Level Water Planning & Utilization Committee is proposed under chairmanship of *Zilla Pramukh* under joint convener-ship of District Executive Engineer and Project Officer, DRDA. The Committee must meet regularly to ensure data reconciliation at *mauja*/village level for command areas of major/medium projects not only at project level, but also source-wise, irrespective of source (i.e., inclusive of minor irrigation sources – whether state or privately owned) with concerted efforts of Irrigation, Agriculture and Revenue Department officials at the lowest level. Once this is done, Irrigation Departments will have necessary data at multiple layers at project level for necessary monitoring and control. At the same time, the same data can be used to generate aggregative figures at block, district, state and country level, with source-wise breakups for monitoring and control by Agriculture and other line Departments. For minor irrigation, there is not much reconciliation needed, as State/UT Irrigation Departments do not preserve the large chunk of data pertaining to private minor irrigation. Still there is need for concerted efforts by both Agriculture and Irrigation Departments to collect and collate source-wise data on irrigation use, which can then be aggregated at block, district and state level for macro-level management of Irrigation Facilities. At the national level, the proposed High Power Committee of Planning Commission will act as the think-tank and overall monitoring authority of District Level Standing Committees, though at the initial stage this exercise may be performed on pilot basis for selected areas and projects, so that the experiences gathered there from can be applied to the country as a whole.

10.6 The constitution of District Level Standing Committee must allow for enough flexibility in the inclusion of core members as well as invitees to suit varying contexts across the length and breadth of the country. Besides *Zilla Pramukh* as Chairman and District Executive Engineer and Project Officer, DRDA as joint conveners, this Committee must include suitable officials from District Departments of Environment and Forestry, Agriculture, Animal Husbandry &

Fisheries and Agri-mechanical Engineering so as to ensure suitable conservation, usage and efficient use of water resources. With all sources of irrigation proposed to be declared as national resource and placed on concurrent list with necessary constitutional amendment at this juncture of human development, the Study Team deems it necessary to include both District Executive Engineer and Project Officer, DRDO as joint conveners to ensure enough control in the hands of the former to protect the resource, while involving the latter at helm of affairs to continuously resolve conflicts between conservation and development goals with respect to water resources. To follow a stakeholder cooperation approach, the IIMA Study Team proposes inclusion of several other line department district level officials from Urban Development, District Industries Center etc., depending upon contextual features, as invitees to ensure planned allocation of scarce water resources across alternative uses and minimize its wastage.

10.7 Given the influence of a number of factors operating on supply and/or demand side of IPC-IPU gap, it is imperative that not only supply side efforts to standardize supply are necessary, but also steps are urgently needed through effective involvement of WUAs and PRIs to boost up demand side deficiency in irrigation. Successful functioning of any economic activity (wherever some economic costs are involved, even though the costs are not always charged to the beneficiaries) requires a close look not only at the supply side but also at the demand side, as good corporate organizations as well as premiere rural development organizations have been practicing all over the world. In other words, for proper understanding and interactive management of both demand and supply side factors behind macro level inefficiency in irrigation use (as reflected by widening gap between IPC and IPU), what we need is a marriage between management and technology in the true sense of the term. There are three specific recommendations in this context:

- Appendix 9.4 has already listed the variables from both demand and supply side of irrigation, which have been used in the current study, though many of them did not turn out to be statistically significant in regression analysis and quite a lot of them could not be converted from discrete binary variables to continuous quantitative variables to achieve greater variation in them and to assess their percentage contributions to the various gaps in irrigation system. The list provided therein is by no means an exhaustible one for several reasons. First the detailed supply side variables, IIMA Study Team tried to collect data on from DIWS at state/UT level, could not be included, as such data are hardly made available to the Study Team. Second given severe time constraint, in spite of unplanned lingering of the study beyond the target dates, quite a few of the variables on which data could be collected by the Study Team at village and farmer level, could not be thoroughly checked and cleaned up for inclusion in regression analysis (even though all of these constitutes a part of the questionnaires circulated for secondary and primary data collection). Third, there are always a number of missing variables, inadvertently left out in questionnaires and subsequent analysis. Fourth, for whatever reasons the four IIMs did not work as cohesively and as uniformly as it was probably intended. So, there is a lot of scope for learning from each other. So, it is recommended for consideration of MoWR that a small committee may be constituted with a retired senior personal of the Ministry, as Chairperson who will go through the submitted reports, besides listening to the presentations by four IIM Study Teams as well as the reactions/suggestions of the various state/UT governments, and formulate a strategy for taking the lessons out of this exercise forward. The single member committee may be assisted by some subordinate staff. A quick output from this exercise will act as valuable input to the proposed High Power Committee of MoWR (as proposed earlier in this chapter). Since the Proposed High Power Committee cannot meet frequently, a sub- committee of the same may be assigned the responsibility of assimilating district and state level data at the national level.

- Although the ToR of this Study did not include Examining the functioning of WUAs, there is no denying the fact that only WUAs and PRIs can help implement a comprehensive plan to Continuously pushed up both demand and supply of irrigation. A clear understanding has to be developed whether and to what extent existing inefficient irrigation systems can be salvaged and how to take all precautions before investing in fresh capacity creation in irrigation. In other words, the government. should not choose a binary solution in one direction or the other. A suitable combination of improvement schemes as well as fresh irrigation schemes is necessary at this juncture. The country must achieve convergence of purpose across schemes and various government agencies related to irrigation and water resources with the help of the proposed committees.

- In order to achieve marriage between management and technology, MoWR must take the issues arising out of this study further by encouraging collaboration between selected IIMs on the one hand, and the existing R&D organizations under CWC/MoWR , on the other, so that they can work together for undertaking joint researches and preparation of teaching/training materials for courses as well as management development programs for the Ministry. To draw captive attention of some IIM faculty, the Ministry may think in terms of instituting one or two chair professors at selected IIMs, who will devote full time to address and logically pursue the issues thrown up by this study as well as those being regularly confronted by the Ministry. After all, the Ministry requires full time personnel who can coordinate this task and achieve the proposed marriage between technology and management to manage all kinds of inefficiency issues - whether at state or country level or at the micro level (i.e., at farmer level).

ANNEXURE 1

Annexure 1

DATA FORMAT FOR SECONDARY DATA COLLECTION ON MAJOR/MEDIUM SURFACE IRRIGATION

Under the MoWR, Govt. of India Project on "Gap between irrigation potential created and utilized", conducted by IIM, Ahmedabad

1. **General information:**

(a)Name of the Project:

(b)Code:

(c) Major/Medium:

(d)State:

(e) District:

(f)Year of initiation of the project:

(g) Year of completion of the project:

(h)Number of village (s) covered:

(i) Projected life time of the irrigation scheme:

(j) Problem areas, if any, within command at this stage (in ha): Waterlogged………………………..
Saline………………………….. Any other (specify)……………

2. **Storage capacity of the reservoir (MCM):**

		1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06
Pre-monsoon	**Live**										
	Dead										
	Gross										
	Released in main canal										
Post-monsoon	**Live**										
	Dead										
	Gross										
	Released in main canal										

Capacity of storage tanks created (MCM) at this stage, if any, to store excess rainfall in the event of reservoir overflowing:- ……………………………….

3. Annual average rainfall in the catchment area:

Year	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06
Average rainfall (mm)										

4. Physical properties of the irrigation system at present:

	Main canal	Branch canal	Distributaries	Minors	Sub-Minor	Water course
Length of canal (Meter)						

5. Irrigation potential created– season wise:

Particulars	Command area considered (CCA) at planning stage	Irrigation intensity considered	Potential created after completion	Designed potential at this stage, if there is any change (Mention year)
Kharif (ha)				
Rabi (ha)				
Summer (ha)				
Perennial (ha)				

6. Actual irrigation potential utilized– season wise:

Particulars	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06
Kharif (ha)										
Rabi (ha)										
Summer (ha)										
Perennial (ha)										

7. Reasons behind less utilization of potential created: Tick mark the relevant & specify if any other.

a) Change in cropping pattern then envisaged in the project design _______________

b) Less inflow received in the dam:

(i) Due to interception in catchment area ____________________

(ii) Due to reduction in rainfall _____________________

c) Dependability has not been achieved as envisaged in the project design ___________________

d) Change in water allocation for non irrigation purpose ________________________

e) Condition of the main canal & distribution system is not hydro logically fit ___________________

f) Non-existence / improper maintenance of maintained water conveyances & field channels __________________________

g) Change in command boundaries ____

h) Change in CCA ____

i) Unauthorized utilization (e/g., by pumping)____________________

j) Any other reason please specify: ____________________

____

8. **(a) Approximate no. of Water Users Association (WUA) in command area at this stage:**

(b) Percentage of command area covered by WUA:

9. Water use (in MCM) for last 10 years:

Year	Irrigation	For purpose other then irrigation	Total
1996-97			
1997-98			
1998-99			
1999-00			
2000-01			
2001-02			
2002-03			
2003-04			
2004-05			
2005-06			

10. Annual revenue and expenditure on O & M for last ten years (in lakhs of Rupees):

Year		1996-07	1997-08	1998-09	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06
Revenue from Irrigation	Assessed										
	Actual recovery										
Revenue from other sources	Assessed										
	Actual recovery										
Total O & M Expenses	Work										
	Salaries										

ANNEXURE 2

Annexure 2.1

SERIAL NO. [ ]

STUDY TO IDENTIFY THE CAUSES BEHIND INCREASING GAP BETWEEN IPC AND IPU

(Sponsored by Ministry of Water Resources, Government of India)

SCHEDULE - I

MAJOR/MEDIUM/MINOR PROJECT DETAILS*

Code

Name of Project <pcode> ____________________________ [|]

Project type <ptype> ________________________________ [|]
(1: Major; 2: Medium; 3: Minor-deep tube well; 4: Minor-surface flow; 5: Minor-surface lift)

Ownership type <pown> ____________________________ [|]
(1: Government; 2: Panchayat; 3: Coop/NGO; 4: group of farmers)

State(s) <scode> _________________________________ [|]

District(s) <dstcode> ________________________________ [|]

River/reservoir <rcode> ___________________________ [|]

Culturable Command Area <pcca> _______________________ (000 Ha)

Name & designation of the person interviewed:

Stages	Name & signature of team member	Date (d-m-yr)
1. Interview:	<piname>	<pidt>
2. Schedule checking:	<pcname>	<pcdt>
3. Schedule re-checking:	<prname>	<prdt>
4. Data computerization:	<pdname>	<pddt>

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AHMEDABAD

Indian Institute of Management, Ahmedabad

* *For major/medium project, get a copy of project planning report from Irrigation Deptt. Objective of this schedule is to facilitate selection of suitable branch for canvassing of questionnaire at stage-II. For minor projects, get information on this schedule from relevant authorities owning the irrigation device – whether govt., panchayat, coop/NGO, or group of individuals.*

1. Summary Particulars of the Project :

Parameters	Design stage		At completion		Present	
Year	<pydes>		<pycom>		<pyprs>	
	Source	**Availability**	**Source**	**Availability**	**Source**	**Availability**
Assessed water availability in Million Cubic Meter(MCM) : [total and break up by sources]	<pds1>	<pda1>	<pcs1>	<pca1>	<pps1>	<ppa1>
	<pds2>	<pda2>	<pcs2>	<pca2>	<pps2>	<ppa2>
	<pds3>	<pda3>	<pcs3>	<pca3>	<pps3>	<ppa3>
Command Area of the Project (000ha)	<pdcom>		<pccom>		<ppcom>	
Net Irrigated Area (000ha)	<pdnia>		<pcnia>		<ppnia>	
Gross Irrigated Area[1] (000ha)	<pdgia>		<pcgia>		<ppgia>	
Approved budget of the project (Rs. Crore)	<pdbud>		<pcbud>		NAP	
No. of main & branch canals /channels	<pdmb>		<pcmb>		<ppmb>	
Length of main & branch canals /channels(km) initially designed	<pdlg>		<pclg>		<pplg>	
Of which lined (km)	<pdln>		<pcln>		<ppln>	
Capacity of reservoir, if any (MCM)	<pdcp>		<pccp>		<ppcp>	
Benefit–cost ratio	<pdbc>		NAP		NAP	

[1] *Re-estimate gross irrigated area as areas under kharif, autumn, rabi, summer & four times perennial crops.*

2.1 Technical Features at Design Stage: Mention year <dinyr> _______________

Name of main & branch canals/ channels	Location (H, T)	Length		Discharge (cumec)				Distributary/ Minor		Area			Annual Duty (ha/mcm)[2]
		Lined (Km)	Unlined (Km)	S	K	A	R	Total No.	Total Length (Km)	CCA (ha)	Net Area Irrigated (ha)	Gross Area Irrigated (ha)	
<dmc1>	<dmloc1>	<dmlin1>	<dmunlin1>	<dmds1>	<dmdk1>	<dmda1>	<dmdr1>	<ddmn1>	<ddml1>	<dmcca1>	<dmnig1>	<dmgig1>	<dmandt1>
<dmc2>	<dmloc2>	<dmlin2>	<dmunlin2>	<dmds2>	<dmdk2>	<dmda2>	<dmdr2>	<ddmn2>	<ddml2>	<dmcca2>	<dmnig2>	<dmgig2>	<dmandt2>
<dmc3>	<dmloc3>	<dmlin3>	<dmunlin3>	<dmds3>	<dmdk3>	<dmda3>	<dmdr3>	<ddmn3>	<ddml3>	<dmcca3>	<dmnig3>	<dmgig3>	<dmandt3>
<dmc4>	<dmloc4>	<dmlin4>	<dmunlin4>	<dmds4>	<dmdk4>	<dmda4>	<dmdr4>	<ddmn4>	<ddml4>	<dmcca4>	<dmnig4>	<dmgig4>	<dmandt4>
<dmc5>	<dmloc5>	<dmlin5>	<dmunlin5>	<dmds5>	<dmdk5>	<dmda5>	<dmdr5>	<ddmn5>	<ddml5>	<dmcca5>	<dmnig5>	<dmgig5>	<dmandt5>
<dmc6>	<dmloc6>	<dmlin6>	<dmunlin6>	<dmds6>	<dmdk6>	<dmda6>	<dmdr6>	<ddmn6>	<ddml6>	<dmcca6>	<dmnig6>	<dmgig6>	<dmandt6>
<dmc7>	<dmloc7>	<dmlin7>	<dmunlin7>	<dmds7>	<dmdk7>	<dmda7>	<dmdr7>	<ddmn7>	<ddml7>	<dmcca7>	<dmnig7>	<dmgig7>	<dmandt7>

H= Head, T= Tail, Cumec= Cubic meter per second, S= Summer, K= Kharif, A= Autumn, R= Rabi

---

[2] *Annual duty (D) for a crop requiring n number of irrigation at water depth d for a total maturity period B is D=(864B/n*d) ha/mcm. Irrigation Dept. is supposed to provide an overall figure, if not separate figures for separate crops and seasons, which can then be weighted to arrive at an overall estimate of D.*

2.2 Technical Features on Completion: Mention year <cinyr> ________________

Name of main & branch canals/ channels	Length		Discharge (cumec)				Distributary/ Minor		Area			Annual Duty (ha/mcm)
	Lined (Km)	Unlined (Km)	S	K	A	R	Total No.	Total Length (Km)	CCA (ha)	Net Area Irrigated (ha)	Gross Area Irrigated (ha)	
<cmc1>	<cmlin1>	<cmunlin1>	<cmds1>	<cmdk1>	<cmda1>	<cmdr1>	<cdmn1>	<cdml1>	<cmcca1>	<cmnig1>	<cmgig1>	<cmandt1>
<cmc2>	<cmlin2>	<cmunlin2>	<cmds2>	<cmdk2>	<cmda2>	<cmdr2>	<cdmn2>	<cdml2>	<cmcca2>	<cmnig2>	<cmgig2>	<cmandt2>
<cmc3>	<cmlin3>	<cmunlin3>	<cmds3>	<cmdk3>	<cmda3>	<cmdr3>	<cdmn3>	<cdml3>	<cmcca3>	<cmnig3>	<cmgig3>	<cmandt3>
<cmc4>	<cmlin4>	<cmunlin4>	<cmds4>	<cmdk4>	<cmda4>	<cmdr4>	<cdmn4>	<cdml4>	<cmcca4>	<cmnig4>	<cmgig4>	<cmandt4>
<cmc5>	<cmlin5>	<cmunlin5>	<cmds5>	<cmdk5>	<cmda5>	<cmdr5>	<cdmn5>	<cdml5>	<cmcca5>	<cmnig5>	<cmgig5>	<cmandt5>
<cmc6>	<cmlin6>	<cmunlin6>	<cmds6>	<cmdk6>	<cmda6>	<cmdr6>	<cdmn6>	<cdml6>	<cmcca6>	<cmnig6>	<cmgig6>	<cmandt6>
<cmc7>	<cmlin7>	<cmunlin7>	<cmds7>	<cmdk7>	<cmda7>	<cmdr7>	<cdmn7>	<cdml7>	<cmcca7>	<cmnig7>	<cmgig7>	<cmandt7>

2.3 Technical Features at Present: Mention year <pinyr> _______________

Name of main & branch canals/ channels	Length		Discharge (cumec)				Distributary/ Minor		Area			Annual Duty (ha)
	Lined (Km)	Unlined (Km)	S	K	A	R	Total No.	Total Length (Km)	CCA (ha)	Net Area Irrigated (ha)	Gross Area Irrigated (ha)	
<pmc1>	<pmlin1>	<pmunlin1>	<pmds1>	<pmdk1>	<pmda1>	<pmdr1>	<pdmn1>	<pdml1>	<pmcca1>	<pmnig1>	<pmgig1>	<pmandt1>
<pmc2>	<pmlin2>	<pmunlin2>	<pmds2>	<pmdk2>	<pmda2>	<pmdr2>	<pdmn2>	<pdml2>	<pmcca2>	<pmnig2>	<pmgig2>	<pmandt2>
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<pmc4>	<pmlin4>	<pmunlin4>	<pmds4>	<pmdk4>	<pmda4>	<pmdr4>	<pdmn4>	<pdml4>	<pmcca4>	<pmnig4>	<pmgig4>	<pmandt4>
<pmc5>	<pmlin5>	<pmunlin5>	<pmds5>	<pmdk5>	<pmda5>	<pmdr5>	<pdmn5>	<pdml5>	<pmcca5>	<pmnig5>	<pmgig5>	<pmandt5>
<pmc6>	<pmlin6>	<pmunlin6>	<pmds6>	<pmdk6>	<pmda6>	<pmdr6>	<pdmn6>	<pdml6>	<pmcca6>	<pmnig6>	<pmgig6>	<pmandt6>
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3.1 Factors responsible for deviations in parameters between design stage and completion (if any):

Factors	**Approximate loss/gain in Irrigation Potential Created**[3]
Lack of availability of water at source	<pavail>
Change in mid-course design due to non-technical factors	<pmidcd>
Change in land use in CCA	<plandus>
Problem in land acquisition	<plandaq>
Unforeseen factors (mention, if any)	
(i)	<pcont1>
(ii)	<pcont2>
(iii)	<pcont3>

3.2 Factors responsible for deviations in parameters between completion and present (if any):

Factors	**Approximate loss/gain in Irrigation Potential Created**
(a) Lack of availability of water at source due to change in	
(a.1) rainfall in catchment area	<pdevrf>
(a.2) river run-off	<pdevro>
(a.3) land use pattern in catchment area	<pdevlup>
(a.4) Change in land use in CCA	<pdevcca>
(b) Lowered discharge capacity of distributaries at lower heads due to leakages/overuse at upper head	<pdevdc>
(c) Unforeseen factors (mention)	
(c.1)	<pdevcon1>
(c.2)	<pdevcon2>
(c.3)	<pdevcon3>

[3] *Indicate gain by '+' and loss by '-' sign in front of each number.*

4. Cropping Pattern in CCA[4] (Area in '000 hectares)

Crop	Season	Design Stage	On Completion	Present
<pcr1>	<psn1>	<pcpd1>	<pcpc1>	<pcpp1>
<pcr2>	<psn2>	<pcpd2>	<pcpc2>	<pcpp2>
<pcr3>	<psn3>	<pcpd3>	<pcpc3>	<pcpp3>
<pcr4>	<psn4>	<pcpd4>	<pcpc4>	<pcpp4>
<pcr5>	<psn5>	<pcpd5>	<pcpc5>	<pcpp5>
<pcr6>	<psn6>	<pcpd6>	<pcpc6>	<pcpp6>
<pcr7>	<psn7>	<pcpd7>	<pcpc7>	<pcpp7>
<pcr8>	<psn8>	<pcpd8>	<pcpc8>	<pcpp8>
<pcr9>	<psn9>	<pcpd9>	<pcpc9>	<pcpp9>

5 Management of the Project:

5.1.1: Staffing Pattern (Technical)

Designation (Describe)	Function (Describe)	Required	Sanctioned	In Position (number)		
				Present <psftp>	**5 years ago** <psft5>	**10 years ago** <psft10>
<ptdes1>	<ptfn1>	<ptreq1>	<ptsan1>	<ptpr1>	<pt51>	<pt101>
<ptdes2>	<ptfn2>	<ptreq2>	<ptsan2>	<ptpr2>	<pt52>	<pt102>
<ptdes3>	<ptfn3>	<ptreq3>	<ptsan3>	<ptpr3>	<pt53>	<pt103>
<ptdes4>	<ptfn4>	<ptreq4>	<ptsan4>	<ptpr4>	<pt54>	<pt104>

[4] *Only crops covering more then 10% of GCA should be entered here.* ***Crop codes:*** *Groundnut:1; Cotton:2; Paddy:3; Bajra:4; Tur:5; Castor:6; Jowar:7; Maize:8; Sesamum:9; Gram:10; Wheat:11; Rapeseed & Mustard:12; Garlic:13; Onion:14; Tobacco:15; Urad:16; Potato:17; Sugercane:18; Banana:19; Sunflower:20; Soyabean:21 Add if required.* ***Season codes:*** *Kharif:1; Rabi:2; Summer:3; Autumn:4 & Perennial:5.*

5.1.2: Staffing Pattern (Non-technical)

Designation	Function	Required	Sanctioned	In Position (number)		
				Present <psfnp>	**5 years ago** <psfn5>	**10 years ago** <psfn10>
<pntdes1>	<pntfnt1>	<pntreq1>	<pntsant1>	<pntpr1>	<pnt51>	<pnt101>
<pntdes2>	<pntfnt2>	<pntreq2>	<pntsant2>	<pntpr2>	<pnt52>	<pnt102>
<pntdes3>	<pntfnt3>	<pntreq3>	<pntsant3>	<pntpr3>	<pnt53>	<pnt103>
<pntdes4>	<pntfnt4>	<pntreq4>	<pntsant4>	<pntpr4>	<pnt54>	<pnt104>

5.2 Financial Position during last five years (Rs. in lakhs)

Financial year	Amount Budgeted		Amount Approved		Amount Released/received	
	Plan	**Non-plan**	**Plan**	**Non-plan**	**Plan**	**Non-plan**
<pfy1>	<pplanb1>	<pnplanb1>	<pplana1>	<pnplana1>	<pplanr1>	<pnplanr1>
<pfy2>	<pplanb2>	<pnplanb2>	<pplana2>	<pnplana2>	<pplanr2>	<pnplanr2>
<pfy3>	<pplanb3>	<pnplanb3>	<pplana3>	<pnplana3>	<pplanr3>	<pnplanr3>
<pfy4>	<pplanb4>	<pnplanb4>	<pplana4>	<pnplana4>	<pplanr4>	<pnplanr4>
<pfy5>	<pplanb5>	<pnplanb5>	<pplana5>	<pnplana5>	<pplanr5>	<pnplanr5>

5.3 Expenditure during last five years (Rs. in lakhs)

Financial year	Salary & compensation for regular staff	Wage bill for contractual staff	Travel Conveyance and Stationeries	Expenditure on routine maintenance	Capital Expenditure	
					Expansion of Irrigation system	Creation of other assets
<pfy1>	<pesc1>	<pewc1>	<petc1>	<perm1>	<peis1>	<peca1>
<pfy2>	<pesc2>	<pewc2>	<petc2>	<perm2>	<peis2>	<peca2>
<pfy3>	<pesc3>	<pewc3>	<petc3>	<perm3>	<peis3>	<peca3>
<pfy4>	<pesc4>	<pewc4>	<petc4>	<perm4>	<peis4>	<peca4>
<pfy5>	<pesc5>	<pewc5>	<petc5>	<perm5>	<peis5>	<peca5>

6. Loss in CCA (in hectares) between completion of project and present date due to

Reasons	Urbanization	Salinity	Soil Degradation	Other (specify)
Loss in CCA	<plccau>	<plccas>	<plccasd>	<plccao>

7. Loss in Irrigation potential due to diversion of water meant for irrigation (in hectares) between completion of project and present

	Water diverted from irrigation purposes to			
	Drinking water purposes	Industrial purposes	Environmental purposes	Other (specify)
Loss in Irrigation Potential	<plipdp>	<plipip>	<plipep>	<plipop>

8.1 Revenue Realization

Year	Average Irrigation Rate (Rs./ha)	Actual area irrigated (ha)	Assessed Revenue (Rs. in lakhs)	Actual Revenue Collected (Rs. in lakhs)
2002-03	<prevr23>	<pairr23>	<parev23>	<prevc23>
2003-04	<prevr34>	<pairr34>	<parev34>	<prevc34>
2004-05	<prevr45>	<pairr45>	<parev45>	<prevc45>
2005-06	<prevr56>	<pairr56>	<parev56>	<prevc56>
2006-07	<prevr67>	<pairr67>	<parev67>	<prevc67>
2007- till date	<prevr78>	<pairr78>	<parev78>	<prevc78>

8.2 Revenue Realization across Sectors

Year	Total Availability of water for distribution (MCM)	Revenue Collected from Water Distributed for							
		Irrigation		Industrial purposes		Drinking water purposes		Environmental cleaning	
		Rate	Amt.	Rate	Amt.	Rate	Amt	Rate	Amt.
		Rs./MCM	Rs. (000)	Rs./MCM	Rs. (000)	Rs./MCM	Rs. (000)	Rs./MCM	Rs. (000)
1991-92	<pwat92>	<pirr92>	<pira92>	<pinr92>	<pina92>	<pdkr92>	<pdka92>	<penvr92>	<penva92>
1996-97	<pwat97>	<pirr97>	<pira97>	<pinr97>	<pina97>	<pdkr97>	<pdka97>	<penvr97>	<penva97>
2001-02	<pwat02>	<pirr02>	<pira02>	<pinr02>	<pina02>	<pdkr02>	<pdka02>	<penvr02>	<penva02>
2002-03	<pwat03>	<pirr03>	<pira03>	<pinr03>	<pina03>	<pdkr03>	<pdka03>	<penvr03>	<penva03>
2003-04	<pwat04>	<pirr04>	<pira04>	<pinr04>	<pina04>	<pdkr04>	<pdka04>	<penvr04>	<penva04>
2004-05	<pwat05>	<pirr05>	<pira05>	<pinr05>	<pina05>	<pdkr05>	<pdka05>	<penvr05>	<penva05>
2005-06	<pwat06>	<pirr06>	<pira06>	<pinr06>	<pina06>	<pdkr06>	<pdka06>	<penvr06>	<penva06>
2006-07	<pwat07>	<pirr07>	<pira07>	<pinr07>	<pina07>	<pdkr07>	<pdka07>	<penvr07>	<penva07>

9. Irrigation Potential Lost that might be recovered through different managerial corrections (in Hectares)

Action proposed (Describe)	Likely expenditure (Rs. Lakh)	Potential Area to be recovered (hectare)	Observations and remarks on failure to initiate such action (Describe)
<pact1>	<pexp1>	<parea1>	<pobs1>
<pact2>	<pexp2>	<parea2>	<pobs2>
<pact3>	<pexp3>	<parea3>	<pobs3>
<pact4>	<pexp4>	<parea4>	<pobs4>
<pact5>	<pexp5>	<parea5>	<pobs5>

Annexure 2.2

SERIAL NO. [ ]

STUDY TO IDENTIFY THE CAUSES BEHIND INCREASING GAP BETWEEN IPC AND IPU

Sponsored by
Ministry of Water Resources, Government of India

SCHEDULE – II*

SELECTED MAIN/BRANCH CANAL DETAILS FOR MAJOR/MEDIUM PROJECTS

Code

Name of Project <pcode> ________________________ [|]

Name of Main/Branch Canal <mcode>______________ [|]

State(s) <scode> ______________________________ [|]

District(s) <dstcode>______________________________ [|]

River/reservoir <rcode> ____________________________ [|]

Culturable Command Area <mcca>___________________ (000Ha)

Name & designation of the person interviewed:

Stages	Name & signature of team member	Date
1. Interview:	<miname>	<midt>
2. Schedule checking:	<mcname>	<mcdt>
3. Schedule re-checking:	<mrname>	<mrdt>
4. Data computerization:	<mdname>	<mddt>

Indian Institute of Management, Ahmedabad

** The main/branch canal with highest CCA is to be chosen for canvassing this questionnaire.*

1.1 Technical Features at Inception of the Main/Branch (Distributary/ Minor) (Mention year <inyr>**……………):**

Name of distributary /minor	Year operationalized	Location on the main/branch canal	Length		Discharge (cumec)				Outlet		Area			Annual Duty (ha)
			Lined (Km)	Unlined (Km)	S	K	A	R	Total Number		CCA (ha)	Net Area Irrigated (ha)	Gross Area Irrigated (ha)	
									H	T				
<dds1>	<ddope1>	<ddloc1>	<ddlin1>	<ddunlin1>	<ddds1>	<dddk1>	<ddda1>	<dddr1>	<ddoth1>	<ddott1>	<ddcca1>	<ddnig1>	<ddgig1>	<ddandt1>
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<dds7>	<ddope7>	<ddloc7>	<ddlin7>	<ddunlin7>	<ddds7>	<dddk7>	<ddda7>	<dddr7>	<ddoth7>	<ddott7>	<ddcca7>	<ddnig7>	<ddgig7>	<ddandt7>
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1.2 Technical Features at Present (Distributary/Minor/Sub-minor wise) (Mention year <prye>**……….):**

Name of distributary/minor	Discharge (cumec)				Outlet		Area			Annual Duty (ha)
	S	K	A	R	Total Number		CCA (ha)	Net Area Irrigated (ha)	Gross Area Irrigated (ha)	
					F	DF				
<pds1>	<pdis1>	<pdik1>	<pdia1>	<pdir1>	<pof1>	<podf1>	<pdcca1>	<pdnig1>	<pdgig1>	<pdandt1>
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<pds9>	<pdis9>	<pdik9>	<pdia9>	<pdir9>	<pof9>	<podf9>	<pdcca9>	<pdnig9>	<pdgig9>	<pdandt9>
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F = Functioning; DF = Disfunctioning

1.3 Technical Features 5 Years ago (Distributary/Minor) (Mention year <m5yr>**………….):**

Name of distributary/minor	Discharge (cumec)				Outlet		Area			Annual Duty (ha)
	S	K	A	R	Total Number		CCA (ha)	Net Area Irrigated (ha)	Gross Area Irrigated (ha)	
					F	DF				
<fyds1>	<fydis1>	<fydik1>	<fydia1>	<fydir1>	<fyof1>	<fyodf1>	<fydcca1>	<fydnig1>	<fydgig1>	<fydadt1>
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<fyds4>	<fydis4>	<fydik4>	<fydia4>	<fydir4>	<fyof4>	<fyodf4>	<fydcca4>	<fydnig4>	<fydgig4>	<fydadt4>
<fyds5>	<fydis5>	<fydik5>	<fydia5>	<fydir5>	<fyof5>	<fyodf5>	<fydcca5>	<fydnig5>	<fydgig5>	<fydadt5>
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<fyds8>	<fydis8>	<fydik8>	<fydia8>	<fydir8>	<fyof8>	<fyodf8>	<fydcca8>	<fydnig8>	<fydgig8>	<fydadt8>
<fyds9>	<fydis9>	<fydik9>	<fydia9>	<fydir9>	<fyof9>	<fyodf9>	<fydcca9>	<fydnig9>	<fydgig9>	<fydadt9>
<fyds10>	<fydis10>	<fydik10>	<fydia10>	<fydir10>	<fyof10>	<fyodf10>	<fydcca10>	<fydnig10>	<fydgig10>	<fydadt10>
<fyds11>	<fydis11>	<fydik11>	<fydia11>	<fydir11>	<fyof11>	<fyodf11>	<fydcca11>	<fydnig11>	<fydgig11>	<fydadt11>
<fyds12>	<fydis12>	<fydik12>	<fydia12>	<fydir12>	<fyof12>	<fyodf12>	<fydcca12>	<fydnig12>	<fydgig12>	<fydadt12>
<fyds13>	<fydis13>	<fydik13>	<fydia13>	<fydir13>	<fyof13>	<fyodf13>	<fydcca13>	<fydnig13>	<fydgig13>	<fydadt13>
<fyds14>	<fydis14>	<fydik14>	<fydia14>	<fydir14>	<fyof14>	<fyodf14>	<fydcca14>	<fydnig14>	<fydgig14>	<fydadt14>

F = Functioning; DF = Disfunctioning

1.4 Technical Features 10 Years ago (Distributary/Minor/Sub-Minor wise) (Mention year<m10yr>**……….):**

Name of distributary/minor	Discharge (cumec)				Outlet		Area			Annual Duty (ha)
	S	K	A	R	Total Number		CCA (ha)	Net Area Irrigated (ha)	Gross Area Irrigated (ha)	
					F	DF				
<tyds1>	<tydis1>	<tydik1>	<tydia1>	<tydir1>	<tyof1>	<tyodf1>	<tydcca1>	<tydnig1>	<tydgig1>	<tydandt1>
<tyds2>	<tydis2>	<tydik2>	<tydia2>	<tydir2>	<tyof2>	<tyodf2>	<tydcca2>	<tydnig2>	<tydgig2>	<tydandt2>
<tyds3>	<tydis3>	<tydik3>	<tydia3>	<tydir3>	<tyof3>	<tyodf3>	<tydcca3>	<tydnig3>	<tydgig3>	<tydandt3>
<tyds4>	<tydis4>	<tydik4>	<tydia4>	<tydir4>	<tyof4>	<tyodf4>	<tydcca4>	<tydnig4>	<tydgig4>	<tydandt4>
<tyds5>	<tydis5>	<tydik5>	<tydia5>	<tydir5>	<tyof5>	<tyodf5>	<tydcca5>	<tydnig5>	<tydgig5>	<tydandt5>
<tyds6>	<tydis6>	<tydik6>	<tydia6>	<tydir6>	<tyof6>	<tyodf6>	<tydcca6>	<tydnig6>	<tydgig6>	<tydandt6>

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<tyds8>	<tydis8>	<tydik8>	<tydia8>	<tydir8>	<tyof8>	<tyodf8>	<tydcca8>	<tydnig8>	<tydgig8>	<tydandt8>
<tyds9>	<tydis9>	<tydik9>	<tydia9>	<tydir9>	<tyof9>	<tyodf9>	<tydcca9>	<tydnig9>	<tydgig9>	<tydandt9>
<tyds10>	<tydis10>	<tydik10>	<tydia10>	<tydir10>	<tyof10>	<tyodf10>	<tydcca10>	<tydnig10>	<tydgig10>	<tydandt10>
<tyds11>	<tydis11>	<tydik11>	<tydia11>	<tydir11>	<tyof11>	<tyodf11>	<tydcca11>	<tydnig11>	<tydgig11>	<tydandt11>
<tyds12>	<tydis12>	<tydik12>	<tydia12>	<tydir12>	<tyof12>	<tyodf12>	<tydcca12>	<tydnig12>	<tydgig12>	<tydandt12>
<tyds13>	<tydis13>	<tydik13>	<tydia13>	<tydir13>	<tyof13>	<tyodf13>	<tydcca13>	<tydnig13>	<tydgig13>	<tydandt13>
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F = Functioning; DF = Disfunctioning

2. Factors responsible for deviations in parameters during the last ten years (if any):

Factors	**Approximate loss/gain in Irrigation Potential Created**
Lack of availability of water at source	<mavail>
Change in land use in CCA	<mlandus>
Lowered discharge capacity of minors at lower heads due to leakages/overuse at upper head	<mprobdc>
Lowered discharge capacity of minors due to lack of maintenance	<mlckmnt>
Unforeseen factors (mention if any)	
(i)	<mcont1>
(ii)	<mcont2>
(iii)	<mcont3>

3. Cropping Pattern in CCA of the selected Main/Branch Canal (Area in hectares)

Crop	Season	At inception		Present		5 years ago		10 years ago	
		H	T	H	T	H	T	H	T
<bcr1>	<bsn1>	<mcpih1>	<mcpit1>	<mcpph1>	<mcppt1>	<mcph51>	<mcpt51>	<mcph101>	<mcpt101>
<bcr2>	<bsn2>	<mcpih2>	<mcpit2>	<mcpph2>	<mcppt2>	<mcph52>	<mcpt52>	<mcph102>	<mcpt102>
<bcr3>	<bsn3>	<mcpih3>	<mcpit3>	<mcpph3>	<mcppt3>	<mcph53>	<mcpt53>	<mcph103>	<mcpt103>
<bcr4>	<bsn4>	<mcpih4>	<mcpit4>	<mcpph4>	<mcppt4>	<mcph54>	<mcpt54>	<mcph104>	<mcpt104>
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<bcr6>	<bsn6>	<mcpih6>	<mcpit6>	<mcpph6>	<mcppt6>	<mcph56>	<mcpt56>	<mcph106>	<mcpt106>
<bcr7>	<bsn7>	<mcpih7>	<mcpit7>	<mcpph7>	<mcppt7>	<mcph57>	<mcpt57>	<mcph107>	<mcpt107>
<bcr8>	<bsn8>	<mcpih8>	<mcpit8>	<mcpph8>	<mcppt8>	<mcph58>	<mcpt58>	<mcph108>	<mcpt108>
<bcr9>	<bsn9>	<mcpih9>	<mcpit9>	<mcpph9>	<mcppt9>	<mcph59>	<mcpt59>	<mcph109>	<mcpt109>

Season codes: Kharif:1; Rabi:2; Summer:3; Autumn:4 & Perennial:5.
Crop codes: Groundnut:1; Cotton:2; Paddy:3; Bajra:4; Tur:5; Castor:6; Jowar:7; Maize:8; Sesamum:9; Gram:10; Wheat:11; Rapeseed & Mustard:12; Garlic:13; Onion:14; Tobacco:15; Urad:16; Potato:17; Sugercane:18; Banana:19; Sunflower:20; Soybean:21 Add if required

4. Management of the Main/Branch Canal:

4.1.1: Staffing Pattern (Technical)

Designation (Describe)	Function (Describe)	Required	Sanctioned	In Position (number)		
				Present <bsftp>	**5 years ago** <bsft5>	**10 years ago** <bsft10>
<mtdes1>	<mtfn1>	<mtreq1>	<mtsan1>	<mtpr1>	<mt51>	<mt101>
<mtdes2>	<mtfn2>	<mtreq2>	<mtsan2>	<mtpr2>	<mt52>	<mt102>
<mtdes3>	<mtfn3>	<mtreq3>	<mtsan3>	<mtpr3>	<mt53>	<mt103>
<mtdes4>	<mtfn4>	<mtreq4>	<mtsan4>	<mtpr4>	<mt54>	<mt104>

4.1.2: Staffing Pattern (Non-technical)

Designation	Required	Sanctioned	In Position (number)		
			Present <bsfnp>	**5 years ago** <bsfn5>	**10 years ago** <bsfn10>
<mntdes1>	<mntreq1>	<mntsant1>	<mntpr1>	<mnt51>	<mnt101>
<mntdes2>	<mntreq2>	<mntsant2>	<mntpr2>	<mnt52>	<mnt102>
<mntdes3>	<mntreq3>	<mntsant3>	<mntpr3>	<mnt53>	<mnt103>
<mntdes4>	<mntreq4>	<mntsant4>	<mntpr4>	<mnt54>	<mnt104>

4.2 Financial Position during last five years (Rs. in lakhs)

Financial year	**Amount Released/received**	
	Plan	**Non-plan**
<mfy1>	<mplanr1>	<mnplanr1>
<mfy2>	<mplanr2>	<mnplanr2>
<mfy3>	<mplanr3>	<mnplanr3>
<mfy4>	<mplanr4>	<mnplanr4>
<mfy5>	<mplanr5>	<mnplanr5>

4.3 Expenditure during last five years (Rs. in lakhs)

Financial year	**Salary & compensation for regular staff**	**Wage bill for contractual staff**	**Travel Conveyance and Stationeries**	**Expenditure on routine maintenance**	**Capital Expenditure**	
					Expansion of Irrigation system	**Creation of other assets**
<mfy1>	<mesc1>	<mewc1>	<metc1>	<merm1>	<meis1>	<meca1>
<mfy2>	<mesc2>	<mewc2>	<metc2>	<merm2>	<meis2>	<meca2>
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<mfy5>	<mesc5>	<mewc5>	<metc5>	<merm5>	<meis5>	<meca5>

5. Loss in CCA (in hectares) between inception of project and present

	Urbanization	Industrialization	Salinity	Soil Degradation	Other (specify)
Loss in CCA	<mlccau>	<mlccai>	<mlccas>	<mlccasd>	<mlccao>

6. Loss in Irrigation potential due to diversion of water meant for irrigation (in hectares) between inception of project and present

	Water diverted from irrigation purposes to			
	Drinking water purposes	**Industrial purposes**	**Environmental purposes**	**Other (specify)**
Loss in Irrigation Potential	<mlipdp>	<mlipip>	<mlipep>	<mlipop>

7.1 Revenue Realization

Year	Average Irrigation Charges (Rs./ha)	Actual area irrigated (ha)	Assessed Revenue (in Lakhs Rs.)	Actual Revenue Collected (in Lakhs Rs.)
2002-03	<mrevr23>	<mairr23>	<marev23>	<mrevc23>
2003-04	<mrevr34>	<mairr34>	<marev34>	<mrevc34>
2004-05	<mrevr45>	<mairr45>	<marev45>	<mrevc45>
2005-06	<mrevr56>	<mairr56>	<marev56>	<mrevc56>
2006-07	<mrevr67>	<mairr67>	<marev67>	<mrevc67>
2007- till date	<mrevr78>	<mairr78>	<marev78>	<mrevc78>

7.2 Revenue Realization across Sectors

Year	Total Availability of water for distribution (MCM)	Revenue Collected from Water Distributed for							
		Irrigation		Industrial purposes		Drinking water purposes		Environmental cleaning	
		Rate	Amt.	Rate	Amt.	Rate	Amt	Rate	Amt.
		Rs./MCM	Rs. (000)	Rs./MCM	Rs. (000)	Rs./MCM	Rs. (000)	Rs./MCM	Rs. (000)
1991-92	<mwat92>	<mirr92>	<mira92>	<minr92>	<mina92>	<mdkr92>	<mdka92>	<menvr92>	<menva92>
1996-97	<mwat97>	<mirr97>	<mira97>	<minr97>	<mina97>	<mdkr97>	<mdka97>	<menvr97>	<menva97>
2001-02	<mwat02>	<mirr02>	<mira02>	<minr02>	<mina02>	<mdkr02>	<mdka02>	<menvr02>	<menva02>
2002-03	<mwat03>	<mirr03>	<mira03>	<minr03>	<mina03>	<mdkr03>	<mdka03>	<menvr03>	<menva03>
2003-04	<mwat04>	<mirr04>	<mira04>	<minr04>	<mina04>	<mdkr04>	<mdka04>	<menvr04>	<menva04>
2004-05	<mwat05>	<mirr05>	<mira05>	<minr05>	<mina05>	<mdkr05>	<mdka05>	<menvr05>	<menva05>
2005-06	<mwat06>	<mirr06>	<mira06>	<minr06>	<mina06>	<mdkr06>	<mdka06>	<menvr06>	<menva06>
2006-07	<mwat07>	<mirr07>	<mira07>	<minr07>	<mina07>	<mdkr07>	<mdka07>	<menvr07>	<menva07>

8. Irrigation Potential lost that might be recovered through different managerial corrections (in Hectares)

Action proposed	Likely expenditure (Rs. Lakh)	Potential Area to be recovered (hectare)	Observations and remarks on failure to initiate such action
<mact1>	<mexp1>	<marea1>	<mobs1>
<mact2>	<mexp2>	<marea2>	<mobs2>
<mact3>	<mexp3>	<marea3>	<mobs3>
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Annexure 2.3

SERIAL NO.

STUDY TO IDENTIFY THE CAUSES BEHIND INCREASING GAP BETWEEN IPC AND IPU

Sponsored by

Ministry of Water Resources, Government of India

SCHEDULE – III*

SELECTED DISTRIBUTARY DETAILS FOR MAJOR/MEDIUM PROJECTS

Code

Name of Project <pcode> ________________________

Name of Main/Branch Canal <mcode> _____________

Name of Distributary <dcode> ____________________

Location <dloc> 1 = Head; 2 = Tail ________________

State <scode> ______________________________

District <dstcode> _______________________________

Village <vcode>______________________________

River/reservoir <rcode>______________________________

Culturable Command Area <dcca> _____________________ (Ha)

Name & designation of the person interviewed:

Stages	Name & signature of team member	Date
1. Interview:	<diname>	<didt>
2. Schedule checking:	<dcname>	<dcdt>
3. Schedule re-checking:	<drname>	<drdt>
4. Data computerization:	<ddname>	<dddt>

Indian Institute of Management, Ahmedabad

** This questioner will be canvassed for distribytary with highest CCA – one at head end and another at tail end of selected branch canal of major/medium irrigation project. Technical forms like duty, F, DF etc. are described in schedules I and II.*

1.1 Technical Features at Inception (Minor wise): mention year <dinyr> _______________

Name of Minor	Year operation alized	Location on the main/bran ch canal	Length		Discharge (cumec)				Outlet		Area			Annual Duty (ha)
			Lined (Km)	Unlined (Km)	S	K	A	R	Total Number		CCA (ha)	Net Area Irrigated (ha)	Gross Area Irrigated (ha)	
									H	T				
<dmn1>	<dmope1>	<dmloc1>	<dmlin1 >	<dmunlin1 >	<dmds1>	<dmdk1 >	<dmda1>	<dmdr1>	<dmoth1>	<dmott1 >	<dmcca1>	<dmnig1>	<dmgig1>	<dmandt1>
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1.2 Technical Features at Present (Minor wise): mention year <dpryr>________________________

Name of Minor	Discharge (cumec)				Outlet		Area			Annual Duty (ha)
	S	K	A	R	Total Number		CCA (ha)	Net Area Irrigated (ha)	Gross Area Irrigated (ha)	
					F	DF				
<pn1>	<pndss1>	<pndsk1>	<pndsa1>	<pndsr1>	<pof1>	<podf1>	<pncca1>	<pnnig1>	<pngig1>	<pnandt1>
<pn2>	<pndss2>	<pndsk2>	<pndsa2>	<pndsr2>	<pof2>	<podf2>	<pncca2>	<pnnig2>	<pngig2>	<pnandt2>
<pn3>	<pndss3>	<pndsk3>	<pndsa3>	<pndsr3>	<pof3>	<podf3>	<pncca3>	<pnnig3>	<pngig3>	<pnandt3>
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1.3 Technical Features 5 Years ago (Minor wise): mention year <dyr5>________________________

Name of Minor	Discharge (cumec)				Outlet		Area			Annual Duty (ha)
	S	K	A	R	Total Number		CCA (ha)	Net Area Irrigated (ha)	Gross Area Irrigated (ha)	
					F	DF				
<fyn1>	<fyndcs1>	<fyndck1>	<fyndca1>	<fyndcr1>	<fyof1>	<fyodf1>	<fyncca1>	<fynnig1>	<fyngig1>	<fynandt1>
<fyn2>	<fyndcs2>	<fyndck2>	<fyndca2>	<fyndcr2>	<fyof2>	<fyodf2>	<fyncca2>	<fynnig2>	<fyngig2>	<fynandt2>
<fyn3>	<fyndcs3>	<fyndck3>	<fyndca3>	<fyndcr3>	<fyof3>	<fyodf3>	<fyncca3>	<fynnig3>	<fyngig3>	<fynandt3>
<fyn4>	<fyndcs4>	<fyndck4>	<fyndca4>	<fyndcr4>	<fyof4>	<fyodf4>	<fyncca4>	<fynnig4>	<fyngig4>	<fynandt4>
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1.4 Technical Features 10 Years ago (Minor wise): mention year <dyr10>________________________

Name of Minor	Discharge (cumec)				Outlet		Area			Annual Duty (ha)
	S	K	A	R	Total Number		CCA (ha)	Net Area Irrigated (ha)	Gross Area Irrigated (ha)	
					F	DF				
<tyn1>	<tyndcs1>	<tyndck1>	<tyndca1>	<tyndcr1>	<tyof1>	<tyodf1>	<tyncca1>	<tynnig1>	<tyngig1>	<tynandt1>
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2.1 Factors responsible for deviations in parameters during the last five years (if any):

Factors	Approximate loss/gain in Irrigation Potential Created (in Ha.)
Lack of availability of water at source	<davail>
Change in land use in CCA	<dlandus>
Lowered discharge capacity of minors at lower heads due to leakages/overuse at upper head	<dprobdc>
Lowered discharge capacity of minors due to lack of maintenance	<dlckmnt>
Unforeseen factors (mention if any)	
(i)	<dcont1>
(ii)	<dcont2>
(iii)	<dcont3>

3. Cropping Pattern in CCA of the selected Distributary (Area in hectares)

Crop	Season	At inception		Present		5 years ago		10 years ago	
		H	T	H	T	H	T	H	T
<dcr1>	<dsn1>	<dcpih1>	<dcpit1>	<dcpph1>	<dcppt1>	<dcph51>	<dcpt51>	<dcph101>	<dcpt101>
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Season codes: Kharif:1; Rabi:2; Summer:3; Autumn:4 & Perennial:5.

Crop codes: Groundnut:1; Cotton:2; Paddy:3; Bajra:4; Tur:5; Castor:6; Jowar:7; Maize:8; Sesamum:9; Gram:10; Wheat:11; Rapeseed & Mustard:12; Garlic:13; Onion:14; Tobacco:15; Urad:16; Potato:17; Sugercane:18; Banana:19; Sunflower:20 (add if required)

4. Management of the Minor/Sub-minor:

4.1: Staffing Pattern (Technical)

Designation	**Function**	**Required**	**Sanctioned**	**In Position (number)**		
				Present <dsftp> **(Year =)**	**5 year ago** <dsft5> **(Year =)**	**10 year ago** <dsft10> **(Year =)**
<dtdes1>	<dtfn1>	<dtreq1>	<dtsan1>	<dtpr1>	<dt51>	<dt101>
<dtdes2>	<dtfn2>	<dtreq2>	<dtsan2>	<dtpr2>	<dt52>	<dt102>
<dtdes3>	<dtfn3>	<dtreq3>	<dtsan3>	<dtpr3>	<dt53>	<dt103>
<dtdes4>	<dtfn4>	<dtreq4>	<dtsan4>	<dtpr4>	<dt54>	<dt104>

4.2: Staffing Pattern (Non-technical)

Designation	**Function**	**Required**	**Sanctioned**	**In Position (number)**		
				Present <dsfnp> **(Year =)**	**5 year ago** <dsfn5> **(Year =)**	**10 year ago** <dsfn10> **(Year =)**
<dntdes1>	<dntfnt1>	<dntreq1>	<dntsant1>	<dntpr1>	<dnt51>	<dnt101>
<dntdes2>	<dntfnt2>	<dntreq2>	<dntsant2>	<dntpr2>	<dnt52>	<dnt102>
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<dntdes4>	<dntfnt4>	<dntreq4>	<dntsant4>	<dntpr4>	<dnt54>	<dnt104>

5. Loss in CCA (in hectares) between inception of project and present

	Urbanization	**Industrialization**	**Salinity**	**Soil Degradation**	**Other (specify)**
Loss in CCA	<dlccau>	<dlccai>	<dlccas>	<dlccasd>	<dlccao>

6. Loss in Irrigation potential due to diversion of water meant for irrigation (in hectares) between inception of project and present

	Water diverted from irrigation purposes to			
	Drinking water purposes	**Industrial purposes**	**Environmental purposes**	**Other (specify)**
Loss in Irrigation Potential	<dlipdp>	<dlipip>	<dlipep>	<dlipop>

7.1 Revenue Realization

Year	**Average Irrigation Charges (Rs./ha)**	**Actual area irrigated (ha)**	**Assessed Revenue**	**Actual Revenue Collected**
2002-03	<drevr23>	<dairr23>	<darev23>	<drevc23>
2003-04	<drevr34>	<dairr34>	<darev34>	<drevc34>
2004-05	<drevr45>	<dairr45>	<darev45>	<drevc45>
2005-06	<drevr56>	<dairr56>	<darev56>	<drevc56>
2006-07	<drevr67>	<dairr67>	<darev67>	<drevc67>
2007- till date	<drevr78>	<dairr78>	<darev78>	<drevc78>

7.2 Revenue Realization across Sectors

Year	Total Availability of water for distribution (MCM)	Revenue Collected from Water Distributed for							
		Irrigation		Industrial purposes		Drinking water purposes		Environmental cleaning	
		Rate	Amount	Rate	Amount	Rate	Amount	Rate	Amount
		Rs./MCM	Rs. (000)	Rs./MCM	Rs. (000)	Rs./MCM	Rs. (000)	Rs./MCM	Rs. (000)
1991-92	<dwat92>	<dirr92>	<dira92>	<dinr92>	<dina92>	<ddkr92>	<ddka92>	<denvr92>	<denva92>
1996-97	<dwat97>	<dirr97>	<dira97>	<dinr97>	<dina97>	<ddkr97>	<ddka97>	<denvr97>	<denva97>
2001-02	<dwat02>	<dirr02>	<dira02>	<dinr02>	<dina02>	<ddkr02>	<ddka02>	<denvr02>	<denva02>
2002-03	<dwat03>	<dirr03>	<dira03>	<dinr03>	<dina03>	<ddkr03>	<ddka03>	<denvr03>	<denva03>
2003-04	<dwat04>	<dirr04>	<dira04>	<dinr04>	<dina04>	<ddkr04>	<ddka04>	<denvr04>	<denva04>
2004-05	<dwat05>	<dirr05>	<dira05>	<dinr05>	<dina05>	<ddkr05>	<ddka05>	<denvr05>	<denva05>
2005-06	<dwat06>	<dirr06>	<dira06>	<dinr06>	<dina06>	<ddkr06>	<ddka06>	<denvr06>	<denva06>
2006-07	<dwat07>	<dirr07>	<dira07>	<dinr07>	<dina07>	<ddkr07>	<ddka07>	<denvr07>	<denva07>

8. Irrigation Potential lost that might be recovered through different managerial corrections (in Hectares)

Action proposed	**Likely expenditure (Rs. Lakhs)**	**Potential Area to be recovered (hectare)**	**Observations and remarks on failure to initiate such action**
<dact1>	<dexp1>	<darea1>	<dobs1>
<dact2>	<dexp2>	<darea2>	<dobs2>
<dact3>	<dexp3>	<darea3>	<dobs3>
<dact4>	<dexp4>	<darea4>	<dobs4>
<dact5>	<dexp5>	<darea5>	<dobs5>

Annexure 2.4

SERIAL NO. [ ]

STUDY TO IDENTIFY THE CAUSES BEHIND INCREASING GAP BETWEEN IPC AND IPU

Sponsored by

Ministry of Water Resources, Government of India

SCHEDULE – IV*

SELECTED MINOR DETAILS FOR MAJOR/MEDIUM PROJECT

Code

Name of Project <pcode> _________________________

Name of Distrbutary <dcode>_______________________

Name of Minor <ncode>___________________________

Location <nloc> Head =1; Tail = 2 __________________

State <scode> ______________________________

District <dstcode> _______________________________

Village <vcode> _______________________________

River/reservoir <rcode>_______________________________

Culturable Command Area <ncca> _____________________ (Ha)

Name & designation of the person interviewed:

Stages	Name & signature of team member	Date
1. Interview:	<niname>	<nidt>
2. Schedule checking:	<ncname>	<ncdt>
3. Schedule re-checking:	<nrname>	<nrdt>
4. Data computerization:	<ndname>	<nddt>

विद्याविनियोगाद्विकासः

IIM AHMEDABAD

Indian Institute of Management, Ahmedabad

**This questionnaire is for head and tail and minor (chosen with highest CCA) corresponding to each selected Distributary.. This questionnaire will be suppressed if distributaries are directly connected to outlets. Technical terms used in earlier questionnaire (I-III) remain valid.*

1.1 Technical Features at Inception (Outlet wise): Mention year <mninyr>________________________________

Name of Outlet	Status*	Year operationalized	Location on the minor	Discharge (cumec)				Area			Annual Duty (ha)
				S	K	A	R	CCA (ha)	Net Area Irrigated (ha)	Gross Area Irrigated (ha)	
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* In status mention Functioning = 1, and Disfunctioning = 2

1.2 Technical Features at Present (Outlet wise): Mention year <mnpryr>_________________________________

Name of Outlet	Status*	Discharge (cumec)				Area			Annual Duty (ha)
		S	K	A	R	CCA (ha)	Net Area Irrigated (ha)	Gross Area Irrigated (ha)	
<po1>	<post1>	<podss1>	<podsk1>	<podsa1>	<podsr1>	<pocca1>	<ponig1>	<pogig1>	<poandt1>
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<po5>	<post5>	<podss5>	<podsk5>	<podsa5>	<podsr5>	<pocca5>	<ponig5>	<pogig5>	<poandt5>
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<po7>	<post7>	<podss7>	<podsk7>	<podsa7>	<podsr7>	<pocca7>	<ponig7>	<pogig7>	<poandt7>
<po8>	<post8>	<podss8>	<podsk8>	<podsa8>	<podsr8>	<pocca8>	<ponig8>	<pogig8>	<poandt8>
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<po10>	<post10>	<podss10>	<podsk10>	<podsa10>	<podsr10>	<pocca10>	<ponig10>	<pogig10>	<poandt10>
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* In status mention Functioning = 1, and Disfunctioning = 2

1.3 Technical Features 5 Years ago (Outlet wise): Mention year <mnyr5>__________________________________

Name of Outlet	Status	Discharge (cumec)				Area			Annual Duty (ha)
		S	K	A	R	CCA (ha)	Net Area Irrigated (ha)	Gross Area Irrigated (ha)	
<fyo1>	<fyost1>	<fyodcs1>	<fyodck1>	<fyodca1>	<fyodcr1>	<fyocca1>	<fyonig1>	<fyogig1>	<fyoandt1>
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<fyo3>	<fyost3>	<fyodcs3>	<fyodck3>	<fyodca3>	<fyodcr3>	<fyocca3>	<fyonig3>	<fyogig3>	<fyoandt3>
<fyo4>	<fyost4>	<fyodcs4>	<fyodck4>	<fyodca4>	<fyodcr4>	<fyocca4>	<fyonig4>	<fyogig4>	<fyoandt4>
<fyo5>	<fyost5>	<fyodcs5>	<fyodck5>	<fyodca5>	<fyodcr5>	<fyocca5>	<fyonig5>	<fyogig5>	<fyoandt5>
<fyo6>	<fyost6>	<fyodcs6>	<fyodck6>	<fyodca6>	<fyodcr6>	<fyocca6>	<fyonig6>	<fyogig6>	<fyoandt6>
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1.4 Technical Features 10 Years ago (Outlet wise): Mention year <mnyr10>_________________________________

Name of Outlet	Status	Discharge (cumec)				Area			Annual Duty (ha)
		S	K	A	R	CCA (ha)	Net Area Irrigated (ha)	Gross Area Irrigated (ha)	
<tyo1>	<tyost1>	<tyodcs1>	<tyodck1>	<tyodca1>	<tyodcr1>	<tyocca1>	<tyonig1>	<tyogig1>	<tyoandt1>
<tyo2>	<tyost2>	<tyodcs2>	<tyodck2>	<tyodca2>	<tyodcr2>	<tyocca2>	<tyonig2>	<tyogig2>	<tyoandt2>
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<tyo4>	<tyost4>	<tyodcs4>	<tyodck4>	<tyodca4>	<tyodcr4>	<tyocca4>	<tyonig4>	<tyogig4>	<tyoandt4>
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2.1 Factors responsible for deviations in parameters during the last five years (if any):

Factors	Approximate loss/gain in Irrigation Potential Created (in Ha.)
Lack of availability of water at source	<navail>
Change in land use in CCA	<nlandus>
Lowered discharge capacity of minors at lower heads due to leakages/overuse at upper head	<nprobdc>
Lowered discharge capacity of minors due to lack of maintenance	<nlckmnt>
Unforeseen factors (mention if any)	
(i)	<ncont1>
(ii)	<ncont2>
(iii)	<ncont3>

3. Cropping Pattern in CCA of the selected minor/sub-minor (Area in hectares)

Crop	Season	At inception		Present		5 years ago		10 years ago	
		H	T	H	T	H	T	H	T
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<mncr8>	<mnsnr8>	<ncpih8>	<ncpit8>	<ncpph8>	<ncppt8>	<ncph58>	<ncpt58>	<ncph108>	<ncpt108>
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Season codes: Kharif:1; Rabi:2; Summer:3; Autumn:4 & Perennial:5.

Crop codes: Groundnut:1; Cotton:2; Paddy:3; Bajra:4; Tur:5; Castor:6; Jowar:7; Maize:8; Sesamum:9; Gram:10; Wheat:11; Rapeseed & Mustard:12; Garlic:13; Onion:14; Tobacco:15; Urad:16; Potato:17; Sugercane:18; Banana:19; Sunflower:20; Soyabean:21 (add if required)

4. Management of the Minor/Sub-minor:

4.1: Staffing Pattern (Technical)

Designation	**Function**	**Planned**	**Sanctioned**	**In Position (number)**		
				Present <mnsftp> **(Year =)**	**5 year ago** <mnsft5> **(Year =)**	**10 year ago** <mnsft10> **(Year =)**
<ntdes1>	<ntfn1>	<ntreq1>	<ntsan1>	<ntpr1>	<nt51>	<nt101>
<ntdes2>	<ntfn2>	<ntreq2>	<ntsan2>	<ntpr2>	<nt52>	<nt102>
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<ntdes4>	<ntfn4>	<ntreq4>	<ntsan4>	<ntpr4>	<nt54>	<nt104>

4.2: Staffing Pattern (Non-technical)

Designation	**Function**	**Planned**	**Sanctioned**	**In Position (number)**		
				Present <mnsfnp> **(Year =)**	**5 year ago** <mnsfn5> **(Year =)**	**10 year ago** <mnsfn10> **(Year =)**
<nntdes1>	<nntfn1>	<nntreq1>	<nntsan1>	<nntpr1>	<nnt51>	<nnt101>
<nntdes2>	<nntfn2>	<nntreq2>	<nntsan2>	<nntpr2>	<nnt52>	<nnt102>
<nntdes3>	<nntfn3>	<nntreq3>	<nntsan3>	<nntpr3>	<nnt53>	<nnt103>
<nntdes4>	<nntfn4>	<nntreq4>	<nntsan4>	<nntpr4>	<nnt54>	<nnt104>

5. Loss in CCA (in hectares) between inception of project and present

	Urbanization	**Industrialization**	**Salinity**	**Soil Degradation**	**Other (specify)**
Loss in CCA	<nlccau>	<nlccai>	<nlccas>	<nlccasd>	<nlccao>

6. Loss in Irrigation potential due to diversion of water meant for irrigation (in hectares) between inception of project and present

	Water diverted from irrigation purposes to			
	Drinking water purposes	**Industrial purposes**	**Environmental purposes**	**Other (specify)**
Loss in Irrigation Potential	<nlipdp>	<nlipip>	<nlipep>	<nlipop>

7.1 Revenue Realization

Year	**Average Irrigation Rate (Rs./ha)**	**Actual area irrigated (ha)**	**Assessed Revenue**	**Actual Revenue Collected**
2002-03	<nrevr23>	<nairr23>	<narev23>	<nrevc23>
2003-04	<nrevr34>	<nairr34>	<narev34>	<nrevc34>
2004-05	<nrevr45>	<nairr45>	<narev45>	<nrevc45>
2005-06	<nrevr56>	<nairr56>	<narev56>	<nrevc56>
2006-07	<nrevr67>	<nairr67>	<narev67>	<nrevc67>
2007- till date	<nrevr78>	<nairr78>	<narev78>	<nrevc78>

7.2 Revenue Realization across Sectors

Year	Total Availability of water for distribution (MCM)	Revenue Collected from Water Distributed for							
		Irrigation		Industrial purposes		Drinking water purposes		Environmental cleaning	
		Rate	Amount	Rate	Amount	Rate	Amount	Rate	Amount
		Rs./MCM	Rs. (000)	Rs./MCM	Rs. (000)	Rs./MCM	Rs. (000)	Rs./MCM	Rs. (000)
1991-92	<nwat92>	<nirr92>	<nira92>	<ninr92>	<nina92>	<ndkr92>	<ndka92>	<nenvr92>	<nenva92>
1996-97	<nwat97>	<nirr97>	<nira97>	<ninr97>	<nina97>	<ndkr97>	<ndka97>	<nenvr97>	<nenva97>
2001-02	<nwat02>	<nirr02>	<nira02>	<ninr02>	<nina02>	<ndkr02>	<ndka02>	<nenvr02>	<nenva02>
2002-03	<nwat03>	<nirr03>	<nira03>	<ninr03>	<nina03>	<ndkr03>	<ndka03>	<nenvr03>	<nenva03>
2003-04	<nwat04>	<nirr04>	<nira04>	<ninr04>	<nina04>	<ndkr04>	<ndka04>	<nenvr04>	<nenva04>
2004-05	<nwat05>	<nirr05>	<nira05>	<ninr05>	<nina05>	<ndkr05>	<ndka05>	<nenvr05>	<nenva05>
2005-06	<nwat06>	<nirr06>	<nira06>	<ninr06>	<nina06>	<ndkr06>	<ndka06>	<nenvr06>	<nenva06>
2006-07	<nwat07>	<nirr07>	<nira07>	<ninr07>	<nina07>	<ndkr07>	<ndka07>	<nenvr07>	<nenva07>

8. Irrigation Potential lost that might be recovered through different managerial corrections (in Hectares)

Action proposed	Likely expenditure (Rs. Lakhs)	Potential Area to be recovered (hectare)	Observations and remarks on failure to initiate such action
<nact1>	<nexp1>	<narea1>	<nobs1>
<nact2>	<nexp2>	<narea2>	<nobs2>
<nact3>	<nexp3>	<narea3>	<nobs3>
<nact4>	<nexp4>	<narea4>	<nobs4>
<nact5>	<nexp5>	<narea5>	<nobs5>

Annexure 2.5

SERIAL NO.

STUDY TO IDENTIFY THE CAUSES BEHIND INCREASING GAP BETWEEN IPC AND IPU

Sponsored by

Ministry of Water Resources, Government of India

SCHEDULE – V*

SELECTED OUTLET DETAILS FOR MAJOR/MEDIUM PROJECT

Code

Name of Project <pcode>__________________________

Name of Distrbutary <dcode>_______________________

Minor <ncode>__________________________________

Outlet <ocode>__________________________________

Location <oloca> Head = 1; Tail = 2 ________________

State <scode>___________________________________

District <dstcode>________________________________

Village <vcode>__________________________________

River/reservoir <rcode>_____________________________

Culturable Command Area <occa>___________________ (Ha)

Name & designation of the person interviewed:

Stages	Name & signature of team member	Date
1. Interview:	<oiname>	<oidt>
2. Schedule checking:	<ocname>	<ocdt>
3. Schedule re-checking:	<orname>	<ordt>
4. Data computerization:	<odname>	<oddt>

Indian Institute of Management, Ahmedabad

** This questionnaire is for head and tail end outlets (with highest CCA) for each selected minor. Technical terms used in earlier questioner (I to IV) remain valid.*

1. Cropping Pattern in CCA of the selected outlet (Area in hectares)

Crop	Season	At inception		Present		5 years ago		10 years ago	
		H	T	H	T	H	T	H	T
<otcr1>	<otsn1>	<ocpih1>	<ocpit1>	<ocpph1>	<ocppt1>	<ocph51>	<ocpt51>	<ocph101>	<ocpt101>
<otcr2>	<otsn2>	<ocpih2>	<ocpit2>	<ocpph2>	<ocppt2>	<ocph52>	<ocpt52>	<ocph102>	<ocpt102>
<otcr3>	<otsn3>	<ocpih3>	<ocpit3>	<ocpph3>	<ocppt3>	<ocph53>	<ocpt53>	<ocph103>	<ocpt103>
<otcr4>	<otsn4>	<ocpih4>	<ocpit4>	<ocpph4>	<ocppt4>	<ocph54>	<ocpt54>	<ocph104>	<ocpt104>
<otcr5>	<otsn5>	<ocpih5>	<ocpit5>	<ocpph5>	<ocppt5>	<ocph55>	<ocpt55>	<ocph105>	<ocpt105>
<otcr6>	<otsn6>	<ocpih6>	<ocpit6>	<ocpph6>	<ocppt6>	<ocph56>	<ocpt56>	<ocph106>	<ocpt106>
<otcr7>	<otsn7>	<ocpih7>	<ocpit7>	<ocpph7>	<ocppt7>	<ocph57>	<ocpt57>	<ocph107>	<ocpt107>
<otcr8>	<otsn8>	<ocpih8>	<ocpit8>	<ocpph8>	<ocppt8>	<ocph58>	<ocpt58>	<ocph108>	<ocpt108>
<otcr9>	<otsn9>	<ocpih9>	<ocpit9>	<ocpph9>	<ocppt9>	<ocph59>	<ocpt59>	<ocph109>	<ocpt109>

Season codes: Kharif:1; Rabi:2; Summer:3; Autumn:4 & Perennial:5. **Crop codes:** Groundnut:1; Cotton:2; Paddy:3; Bajra:4; Tur:5; Castor:6; Jowar:7; Maize:8; Sesamum:9; Gram:10; Wheat:11; Rapeseed & Mustard:12; Garlic:13; Onion:14; Tobacco:15; Urad:16; Potato:17; Sugercane:18; Banana:19; Sunflower:20; Soybean:21 (add if required)

2. Operational area details (holding wise)

Holding Number	Name of owner	Name of Village	Area (Ha)	Distance from Outlet (metres)
<othol1>	<otname1>	<otvil1>	<otare1>	<otdist1>
<othol2>	<otname2>	<otvil2>	<otare2>	<otdist2>
<othol3>	<otname3>	<otvil3>	<otare3>	<otdist3>
<othol4>	<otname4>	<otvil4>	<otare4>	<otdist4>
<othol5>	<otname5>	<otvil5>	<otare5>	<otdist5>
<othol6>	<otname6>	<otvil6>	<otare6>	<otdist6>
<othol7>	<otname7>	<otvil7>	<otare7>	<otdist7>
<othol8>	<otname8>	<otvil8>	<otare8>	<otdist8>
<othol9>	<otname9>	<otvil9>	<otare9>	<otdist9>

3. Loss in CCA (in hectares) between inception of project and present

	Urbanization	Industrialization	Salinity	Soil Degradation	Other (specify)
Loss in CCA	<olccau>	<olccai>	<olccas>	<olccasd>	<olccao>

4. Loss in Irrigation potential due to diversion of water meant for irrigation (in hectares) between inception of project and present

	Water diverted from irrigation purposes to			
	Drinking water purposes	**Industrial purposes**	**Environmental purposes**	**Other (specify)**
Loss in Irrigation Potential	<olipdp>	<olipip>	<olipep>	<olipop>

5. **Revenue Realization**

Year	Average Irrigation Rate (Rs./ha)	Actual area irrigated (ha)	Assessed Revenue	Actual Revenue Collected
2002-03	<orevr23>	<oairr23>	<oarev23>	<orevc23>
2003-04	<orevr34>	<oairr34>	<oarev34>	<orevc34>
2004-05	<orevr45>	<oairr45>	<oarev45>	<orevc45>
2005-06	<orevr56>	<oairr56>	<oarev56>	<orevc56>
2006-07	<orevr67>	<oairr67>	<oarev67>	<orevc67>
2007- till date	<orevr78>	<oairr78>	<oarev78>	<orevc78>

6. Irrigation Potential lost that might be recovered through different managerial corrections (in Hectares)

Action proposed	Likely expenditure (Rs. Lakh)	Potential Area to be recovered (hectare)	Observations and remarks on failure to initiate such action (Describe)
<oact1>	<oexp1>	<oarea1>	<oobs1>
<oact2>	<oexp2>	<oarea2>	<oobs2>
<oact3>	<oexp3>	<oarea3>	<oobs3>
<oact4>	<oexp4>	<oarea4>	<oobs4>
<oact5>	<oexp5>	<oarea5>	<oobs5>

7.1 Demand Schedule for Water (Present) Year: <dwatpyr> ________________________

Holding No	Crop	Season	Irrigation Demanded (ha)	Number of Irrigation Cycles demanded	Time required to irrigate (hour/ha)
<opdhon1>	<ohcr11>	<ohsn11>	<odird11>	<odnir11>	<odtre11>
	<ohcr12>	<ohsn12>	<odird12>	<odnir12>	<odtre12>
	<ohcr13>	<ohsn13>	<odird13>	<odnir13>	<odtre13>
<opdhon2>	<ohcr21>	<ohsn21>	<odird21>	<odnir21>	<odtre21>
	<ohcr22>	<ohsn22>	<odird22>	<odnir22>	<odtre22>
	<ohcr23>	<ohsn23>	<odird23>	<odnir23>	<odtre23>
<opdhon3>	<ohcr31>	<ohsn31>	<odird31>	<odnir31>	<odtre31>
	<ohcr32>	<ohsn32>	<odird32>	<odnir32>	<odtre32>
	<ohcr33>	<ohsn33>	<odird33>	<odnir33>	<odtre33>
<opdhon4>	<ohcr41>	<ohsn41>	<odird41>	<odnir41>	<odtre41>
	<ohcr42>	<ohsn42>	<odird42>	<odnir42>	<odtre42>
	<ohcr43>	<ohsn43>	<odird43>	<odnir43>	<odtre43>
<opdhon5>	<ohcr51>	<ohsn51>	<odird51>	<odnir51>	<odtre51>
	<ohcr52>	<ohsn52>	<odird52>	<odnir52>	<odtre52>
	<ohcr53>	<ohsn53>	<odird53>	<odnir53>	<odtre53>
<opdhon6>	<ohcr61>	<ohsn61>	<odird61>	<odnir61>	<odtre61>
	<ohcr62>	<ohsn62>	<odird62>	<odnir62>	<odtre62>
	<ohcr63>	<ohsn63>	<odird63>	<odnir63>	<odtre63>
<opdhon7>	<ohcr71>	<ohsn71>	<odird71>	<odnir71>	<odtre71>
	<ohcr72>	<ohsn72>	<odird72>	<odnir72>	<odtre72>
	<ohcr73>	<ohsn73>	<odird73>	<odnir73>	<odtre73>
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	<ohcr82>	<ohsn82>	<odird82>	<odnir82>	<odtre82>
	<ohcr83>	<ohsn83>	<odird83>	<odnir83>	<odtre83>
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	<ohcr92>	<ohsn92>	<odird92>	<odnir92>	<odtre92>
	<ohcr93>	<ohsn93>	<odird93>	<odnir93>	<odtre93>

Season codes: Kharif:1; Rabi:2; Summer:3; Autumn:4 & Perennial:5. **Crop codes:** Groundnut:1; Cotton:2; Paddy:3; Bajra:4; Tur:5; Castor:6; Jowar:7; Maize:8; Sesamum:9; Gram:10; Wheat:11; Rapeseed & Mustard:12; Garlic:13; Onion:14; Tobacco:15; Urad:16; Potato:17; Sugercane:18; Banana:19; Sunflower:20; Soybean:21 (add if required)

7.2 Demand Schedule for Water (5 year ago) Year: <dwatfyr> ________________________

Holding No	Crop	Season	Irrigation Demanded (ha)	Number of Irrigation Cycles demanded	Time required to irrigate (hour/ha)
<odhon51>	<ohcr511>	<ohsn511>	<oird511>	<onir511>	<otre511>
	<ohcr512>	<ohsn512>	<oird512>	<onir512>	<otre512>
	<ohcr513>	<ohsn513>	<oird513>	<onir513>	<otre513>
<odhon52>	<ohcr521>	<ohsn521>	<oird521>	<onir521>	<otre521>
	<ohcr522>	<ohsn522>	<oird522>	<onir522>	<otre522>
	<ohcr523>	<ohsn523>	<oird523>	<onir523>	<otre523>
<odhon53>	<ohcr531>	<ohsn531>	<oird531>	<onir531>	<otre531>
	<ohcr532>	<ohsn532>	<oird532>	<onir532>	<otre532>
	<ohcr533>	<ohsn533>	<oird533>	<onir533>	<otre533>
<odhon54>	<ohcr541>	<ohsn541>	<oird541>	<onir541>	<otre541>
	<ohcr542>	<ohsn542>	<oird542>	<onir542>	<otre542>
	<ohcr543>	<ohsn543>	<oird543>	<onir543>	<otre543>
<odhon55>	<ohcr551>	<ohsn551>	<oird551>	<onir551>	<otre551>
	<ohcr552>	<ohsn552>	<oird552>	<onir552>	<otre552>
	<ohcr553>	<ohsn553>	<oird553>	<onir553>	<otre553>

<odhon56>	<ohcr561>	<ohsn561>	<oird561>	<onir561>	<otre561>
	<ohcr562>	<ohsn562>	<oird562>	<onir562>	<otre562>
	<ohcr563>	<ohsn563>	<oird563>	<onir563>	<otre563>
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	<ohcr572>	<ohsn572>	<oird572>	<onir572>	<otre572>
	<ohcr572>	<ohsn572>	<oird572>	<onir573>	<otre573>
<odhon58>	<ohcr581>	<ohsn581>	<oird581>	<onir581>	<otre581>
	<ohcr582>	<ohsn582>	<oird582>	<onir582>	<otre582>
	<ohcr583>	<ohsn583>	<oird583>	<onir583>	<otre583>
<odhon59>	<ohcr591>	<ohsn591>	<oird591>	<onir591>	<otre591>
	<ohcr592>	<ohsn592>	<oird592>	<onir592>	<otre592>
	<ohcr593>	<ohsn593>	<oird593>	<onir593>	<otre593>

Season codes: Kharif:1; Rabi:2; Summer:3; Autumn:4 & Perennial:5. **Crop codes:** Groundnut:1; Cotton:2; Paddy:3; Bajra:4; Tur:5; Castor:6; Jowar:7; Maize:8; Sesamum:9; Gram:10; Wheat:11; Rapeseed & Mustard:12; Garlic:13; Onion:14; Tobacco:15; Urad:16; Potato:17; Sugercane:18; Banana:19; Sunflower:20; Soybean:21 (add if required)

7.3 Demand Schedule for Water (10 year ago) get figures for approximation Year:

<dwattyr>______________________________

Holding No	Crop	Season	Irrigation Demanded (ha)	Number of Irrigation Cycles demanded	Time required to irrigate (hour/ha)
<odhon101>	<ohcr1011>	<ohsn1011>	<oird1011>	<onir1011>	<otre1011>
	<ohcr1012>	<ohsn1012>	<oird1012>	<onir1012>	<otre1012>
	<ohcr1013>	<ohsn1013>	<oird1013>	<onir1013>	<otre1013>
<odhon102>	<ohcr1021>	<ohsn1021>	<oird1021>	<onir1021>	<otre1021>
	<ohcr1022>	<ohsn1022>	<oird1022>	<onir1022>	<otre1022>
	<ohcr1023>	<ohsn1023>	<oird1023>	<onir1023>	<otre1023>
<odhon103>	<ohcr1031>	<ohsn1031>	<oird1031>	<onir1031>	<otre1031>
	<ohcr1032>	<ohsn1032>	<oird1032>	<onir1032>	<otre1032>
	<ohcr1033>	<ohsn1033>	<oird1033>	<onir1033>	<otre1033>
<odhon104>	<ohcr1041>	<ohsn1041>	<oird1041>	<onir1041>	<otre1041>
	<ohcr1042>	<ohsn1042>	<oird1042>	<onir1042>	<otre1042>
	<ohcr1043>	<ohsn1043>	<oird1043>	<onir1043>	<otre1043>
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	<ohcr1062>	<ohsn1062>	<oird1062>	<onir1062>	<otre1062>
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	<ohcr1082>	<ohsn1082>	<oird1082>	<onir1082>	<otre1082>
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	<ohcr1092>	<ohsn1092>	<oird1092>	<onir1092>	<otre1092>
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Season codes: Kharif:1; Rabi:2; Summer:3; Autumn:4 & Perennial:5. **Crop codes:** Groundnut:1; Cotton:2; Paddy:3; Bajra:4; Tur:5; Castor:6; Jowar:7; Maize:8; Sesamum:9; Gram:10; Wheat:11; Rapeseed & Mustard:12; Garlic:13; Onion:14; Tobacco:15; Urad:16; Potato:17; Sugercane:18; Banana:19; Sunflower:20; Soybean:21 (add if required)

8.1 Supply Schedule of Water (Present) Year: <swatpyr>___________________________

Holding No	Crop	Season	Irrigation Supplied (ha)	Number of Irrigation Cycles Supplied
<opshon1>	<ohcr11>	<ohsn11>	<osirs11>	<osnir11>
	<ohcr12>	<ohsn12>	<osirs12>	<osnir12>
	<ohcr13>	<ohsn13>	<osirs13>	<osnir13>
<opshon2>	<ohcr21>	<ohsn21>	<osirs21>	<osnir21>
	<ohcr22>	<ohsn22>	<osirs22>	<osnir22>
	<ohcr23>	<ohsn23>	<osirs23>	<osnir23>
<opshon3>	<ohcr31>	<ohsn31>	<osirs31>	<osnir31>
	<ohcr32>	<ohsn32>	<osirs32>	<osnir32>
	<ohcr33>	<ohsn33>	<osirs33>	<osnir33>
<opshon4>	<ohcr41>	<ohsn41>	<osirs41>	<osnir41>
	<ohcr42>	<ohsn42>	<osirs42>	<osnir42>
	<ohcr43>	<ohsn43>	<osirs43>	<osnir43>
<opshon5>	<ohcr51>	<ohsn51>	<osirs51>	<osnir51>
	<ohcr52>	<ohsn52>	<osirs52>	<osnir52>
	<ohcr53>	<ohsn53>	<osirs53>	<osnir53>
<opshon6>	<ohcr61>	<ohsn61>	<osirs61>	<osnir61>
	<ohcr62>	<ohsn62>	<osirs62>	<osnir62>
	<ohcr63>	<ohsn63>	<osirs63>	<osnir63>
<opshon7>	<ohcr71>	<ohsn71>	<osirs71>	<osnir71>
	<ohcr72>	<ohsn72>	<osirs72>	<osnir72>
	<ohcr73>	<ohsn73>	<osirs73>	<osnir73>
<opshon8>	<ohcr81>	<ohsn81>	<osirs81>	<osnir81>
	<ohcr82>	<ohsn82>	<osirs82>	<osnir82>
	<ohcr83>	<ohsn83>	<osirs83>	<osnir83>
<opshon9>	<ohcr91>	<ohsn91>	<osirs91>	<osnir91>
	<ohcr92>	<ohsn92>	<osirs92>	<osnir92>
	<ohcr93>	<ohsn93>	<osirs93>	<osnir93>

Season codes: Kharif:1; Rabi:2; Summer:3; Autumn:4 & Perennial:5. **Crop codes:** Groundnut:1; Cotton:2; Paddy:3; Bajra:4; Tur:5; Castor:6; Jowar:7; Maize:8; Sesamum:9; Gram:10; Wheat:11; Rapeseed & Mustard:12; Garlic:13; Onion:14; Tobacco:15; Urad:16; Potato:17; Sugercane:18; Banana:19; Sunflower:20; Soybean:21 (add if required)

8.2 Supply Schedule of Water (5 year ago) Year: <swatfyr>__________________________

Holding No	Crop	Season	Irrigation Supplied (ha)	Number of Irrigation Cycles Supplied
<oshon51>	<ohcr511>	<ohsn511>	<osirs511>	<osnir511>
	<ohcr512>	<ohsn512>	<osirs512>	<osnir512>
	<ohcr513>	<ohsn513>	<osirs513>	<osnir513>
<oshon52>	<ohcr521>	<ohsn521>	<osirs521>	<osnir521>
	<ohcr522>	<ohsn522>	<osirs522>	<osnir522>
	<ohcr523>	<ohsn523>	<osirs523>	<osnir523>
<oshon53>	<ohcr531>	<ohsn531>	<osirs531>	<osnir531>
	<ohcr532>	<ohsn532>	<osirs532>	<osnir532>
	<ohcr533>	<ohsn533>	<osirs533>	<osnir533>
<oshon54>	<ohcr541>	<ohsn541>	<osirs541>	<osnir541>
	<ohcr542>	<ohsn542>	<osirs542>	<osnir542>
	<ohcr543>	<ohsn543>	<osirs543>	<osnir543>
<oshon55>	<ohcr551>	<ohsn551>	<osirs551>	<osnir551>
	<ohcr552>	<ohsn552>	<osirs552>	<osnir552>

	<ohcr553>	<ohsn553>	<osirs553>	<osnir553>
<oshon56>	<ohcr561>	<ohsn561>	<osirs561>	<osnir561>
	<ohcr562>	<ohsn562>	<osirs562>	<osnir562>
	<ohcr563>	<ohsn563>	<osirs563>	<osnir563>
<oshon57>	<ohcr571>	<ohsn571>	<osirs571>	<osnir571>
	<ohcr572>	<ohsn572>	<osirs572>	<osnir572>
	<ohcr572>	<ohsn572>	<osirs573>	<osnir573>
<oshon58>	<ohcr581>	<ohsn581>	<osirs581>	<osnir581>
	<ohcr582>	<ohsn582>	<osirs582>	<osnir582>
	<ohcr583>	<ohsn583>	<osirs583>	<osnir583>
<oshon59>	<ohcr591>	<ohsn591>	<osirs591>	<osnir591>
	<ohcr592>	<ohsn592>	<osirs592>	<osnir592>
	<ohcr593>	<ohsn593>	<osirs593>	<osnir593>

Season codes: Kharif:1; Rabi:2; Summer:3; Autumn:4 & Perennial:5. **Crop codes:** Groundnut:1; Cotton:2; Paddy:3; Bajra:4; Tur:5; Castor:6; Jowar:7; Maize:8; Sesamum:9; Gram:10; Wheat:11; Rapeseed & Mustard:12; Garlic:13; Onion:14; Tobacco:15; Urad:16; Potato:17; Sugercane:18; Banana:19; Sunflower:20; Soybean:21 (add if required)

8.3 Supply Schedule of Water (10 year ago) Year: <swattyr>___________________________

Holding No	Crop	Season	Irrigation Supplied (ha)	Number of Irrigation Cycles Supplied
<oshon101>	<ohcr1011>	<ohsn1011>	<osirs1011>	<osnir1011>
	<ohcr1012>	<ohsn1012>	<osirs1012>	<osnir1012>
	<ohcr1013>	<ohsn1013>	<osirs1013>	<osnir1013>
<oshon102>	<ohcr1021>	<ohsn1021>	<osirs1021>	<osnir1021>
	<ohcr1022>	<ohsn1022>	<osirs1022>	<osnir1022>
	<ohcr1023>	<ohsn1023>	<osirs1023>	<osnir1023>
<oshon103>	<ohcr1031>	<ohsn1031>	<osirs1031>	<osnir1031>
	<ohcr1032>	<ohsn1032>	<osirs1032>	<osnir1032>
	<ohcr1033>	<ohsn1033>	<osirs1033>	<osnir1033>
<oshon104>	<ohcr1041>	<ohsn1041>	<osirs1041>	<osnir1041>
	<ohcr1042>	<ohsn1042>	<osirs1042>	<osnir1042>
	<ohcr1043>	<ohsn1043>	<osirs1043>	<osnir1043>
<oshon105>	<ohcr1051>	<ohsn1051>	<osirs1051>	<osnir1051>
	<ohcr1052>	<ohsn1052>	<osirs1052>	<osnir1052>
	<ohcr1053>	<ohsn1053>	<osirs1053>	<osnir1053>
<oshon106>	<ohcr1061>	<ohsn1061>	<osirs1061>	<osnir1061>
	<ohcr1062>	<ohsn1062>	<osirs1062>	<osnir1062>
	<ohcr1063>	<ohsn1063>	<osirs1063>	<osnir1063>
<oshon107>	<ohcr1071>	<ohsn1071>	<osirs1071>	<osnir1071>
	<ohcr1072>	<ohsn1072>	<osirs1072>	<osnir1072>
	<ohcr1072>	<ohsn1072>	<osirs1073>	<osnir1073>
<oshon108>	<ohcr1081>	<ohsn1081>	<osirs1081>	<osnir1081>
	<ohcr1082>	<ohsn1082>	<osirs1082>	<osnir1082>
	<ohcr1083>	<ohsn1083>	<osirs1083>	<osnir1083>
<oshon109>	<ohcr1091>	<ohsn1091>	<osirs1091>	<osnir1091>
	<ohcr1092>	<ohsn1092>	<osirs1092>	<osnir1092>
	<ohcr1093>	<ohsn1093>	<osirs1093>	<osnir1093>

Season codes: Kharif:1; Rabi:2; Summer:3; Autumn:4 & Perennial:5. **Crop codes:** Groundnut:1; Cotton:2; Paddy:3; Bajra:4; Tur:5; Castor:6; Jowar:7; Maize:8; Sesamum:9; Gram:10; Wheat:11; Rapeseed & Mustard:12; Garlic:13; Onion:14; Tobacco:15; Urad:16; Potato:17; Sugercane:18; Banana:19; Sunflower:20; Soybean:21 (add if required)

9.1 Information on Revenue (Present): Year: <rpyr>__________________________

Holding No	Irrigation Charges (Rs. Per ha)	Total Assessed Revenue (Rs.)[5]	Realized Revenue (Rs.)
<oprhon1>	<orirc1>	<orasr1>	<orre1>
<oprhon2>	<orirc2>	<orasr2>	<orre2>
<oprhon3>	<orirc3>	<orasr3>	<orre3>
<oprhon4>	<orirc4>	<orasr4>	<orre4>
<oprhon5>	<orirc5>	<orasr5>	<orre5>
<oprhon6>	<orirc6>	<orasr6>	<orre6>
<oprhon7>	<orirc7>	<orasr7>	<orre7>
<oprhon8>	<orirc8>	<orasr8>	<orre8>
<oprhon9>	<orirc9>	<orasr9>	<orre9>

9.2 Information on Revenue (5 years ago): Year: <rfyr>__________________________

Holding No	Irrigation Charges (Rs. Per ha)	Total Assessed Revenue (Rs.)	Realized Revenue (Rs.)
<oprhon51>	<orirc51>	<orasr51>	<orre51>
<oprhon52>	<orirc52>	<orasr52>	<orre52>
<oprhon53>	<orirc53>	<orasr53>	<orre53>
<oprhon54>	<orirc54>	<orasr54>	<orre54>
<oprhon55>	<orirc55>	<orasr55>	<orre55>
<oprhon56>	<orirc56>	<orasr56>	<orre56>

[5] *Assessed revenue is charge/ha. multiplied by area in ha.*

<oprhon57>	<orirc57>	<orasr57>	<orre57>
<oprhon58>	<orirc58>	<orasr58>	<orre58>
<oprhon59>	<orirc59>	<orasr59>	<orre59>

9.3 Information on Revenue (10 years ago): Year: <rtyr>__________________________

Holding No	Irrigation Charges (Rs. Per ha)	Total Assessed Revenue (Rs.)	Realized Revenue (Rs.)
<oprhn101>	<orirc101>	<orasr101>	<orre101>
<oprhn102>	<orirc102>	<orasr102>	<orre102>
<oprhn103>	<orirc103>	<orasr103>	<orre103>
<oprhn104>	<orirc104>	<orasr104>	<orre104>
<oprhn105>	<orirc105>	<orasr105>	<orre105>
<oprhn106>	<orirc106>	<orasr106>	<orre106>
<oprhn107>	<orirc107>	<orasr107>	<orre107>
<oprhn108>	<orirc108>	<orasr108>	<orre108>
<oprhn109>	<orirc109>	<orasr109>	<orre109>

Annexure 2.6A

SERIAL NO. [ ]

STUDY TO IDENTIFY THE CAUSES BEHIND INCREASING GAP BETWEEN IPC AND IPU

Sponsored by

Ministry of Water Resources, Government of India

SCHEDULE – VI (Part – A)*

SELECTED VILLAGE DETAILS

Code

Name of Project <projcode>____________________________ [|]

Name of Main/Branch Canal <maincode>_________________ [|]

Distributary <disbcode>__________________________________ [|]

Minor/sub-minor <mcode>______________________________ [|]

Outlet <outcode>______________________________________ [|]

Name of Village <vilcode>_______________________________ [|]

Gram Panchayat <pancode>_____________________________ [|]

Block/taluka <talcode>__________________________________ [|]

District <distcode>____________________________________ [|]

Name & designation of the person interviewed:

Stages	Name & signature of team member	Date
1. Interview:	<viname>	<vidt>
2. Schedule checking:	<vcname>	<vcdt>
3. Schedule re-checking:	<vrname>	<vrdt>
4. Data computerization:	<vdname>	<vddt>

विद्याविनियोगाद्विकासः

IIM AHMEDABAD

Indian Institute of Management, Ahmedabad

** The revenue village having maximum CCA in the selected outlet should be chosen for canvassing village questionnaire.*
Part – A pertains to data to be collected from offices at village/block level.

VILLAGE SCHEDULE

1.1 Name of Sarpanch <sarpanch>______________________

1.2 Name of Sachiv <sachiv>_________________________

1.3 Name of knowledgeable Respondent <respond>________________________

2. Population Details[1]

S. No.	Characteristic	Male	Female	Total
1.	Total household	NAP	NAP	<hhtot>
2.	Total Population	<popm>	<popf>	<poptot>
3.	General caste population	<gcasm>	<gcasf>	<gcastot>
4.	General caste household	NAP	NAP	<gcastot>
5.	SC population	<scpopm>	<scpopf>	<scpoptot>
6.	SC household	NAP	NAP	<schhtot>
7.	ST population	<stpopm>	<stpopf>	<stpoptot>
8.	ST household	NAP	NAP	<vsthhtot>
9.	OBC population	<obpopm>	<vobcf>	<vobctot>
10.	OBC household	NAP	NAP	<obhhtot>
11.	Literacy (%)	<litmpc>	<litfpc>	<littotpc>

1 Information generally available from block/village panchayat office.

3. Land Use Classification[2]: (Area in ha.)

Sl. No.	**Items (ha)**	**Present <yearp>**	5 years ago <year5>	10 years ago **<year10>**
1	Geographical Area	<geop>	NA	NA
2	Net sown area	<nasp>	<nas5>	<narea10>
3	Area sown more than once (physically maximum cultivated area in a year)	<multyp>	<multy5>	<multy10>
4	Gross cropped area[3] (GCA)	<gcap>	<gca5>	<gca10>
5	Land under miscellaneous tree crops / groves not included under net sown area.	<miscp>	<misc5>	<misc10>
6	Current fallows	<fallop>	<fallo5>	<fallo10>
7	Culturable land (but not hitherto used)	<nusep>	<nuse5>	<nuse10>
8	Barren and un-culturable land	<barrnp>	<barrn5>	<barrn10>
9	Forest Area	<forestp>	<forest5>	<forest10>
10	Area under nalahs, streams, water bodies	<nalahp>	<nalah5>	<nalah10>
11	Area under roads/ buildings and other non-agriculture use	<roadsp>	<roads5>	<roads10>
12	Net irrigated area	<nirrp>	<nirr5>	<nirr10>
13	Gross irrigated area[4]	<girrp>	<girr5>	<girr10>

2 This Information is available from village panchayat office (Talati).
3 GCA = Area under kharif + autumn+ rabi+ summer + 4 times perennial
4 Area under perennial crop to be counted four times.

4. Farmers by Size of Operational Land Holdings[5]

Sr. No	Size of land holding (Ha.)	No. of Farmers					
		Present		5 years ago		10 years ago	
		No.	Area	No.	Area	No.	Area
1	0-1 (Marginal)	<marpn>	<marpa>	<mar5n>	<mar5a>	<mar10n>	<mar10a>
2	1-2 (Small)	<smallpn>	<smallpa>	<small5n>	<small5a>	<small10n>	<small10a>
3	2-4 (Medium)	<medipn>	<medipa>	<medi5n>	<medi5a>	<medi10n>	<medi10a>
4	> 4 (Large)	<largpn>	<largpa>	<larg5n>	<larg5a>	<larg10n>	<larg10a>

5 This information is available from village panchayat office

5.1 Irrigation Sources:

Sl. No.	Sources	**Present** <yearp> =				**5 years ago** <year5> =				**10 years ago** *(get rough idea)* <year10> =			
		Number		**Command area (ha.)**		**Number**		**Command area (ha.)**		**Number**		**Command area (ha.)**	
		F	DF	F	DF	F	DF	F	DF	F	DF	F	DF
1	Canal												
a.	Major irrigation system	<majpnf>	<majpndf>	<majpaf>	<majpadf>	<maj5nf>	<maj5ndf>	<maj5af>	<maj5adf>	<maj0nf>	<maj0ndf>	<maj0af>	<maj0adf>
b.	Medium irrigation system	<medpnf>	<medpndf>	<medpaf>	<medpadf>	<med5nf>	<med5ndf>	<med5af>	<med5adf>	<med0nf>	<med0ndf>	<med0af>	<med0adf>
2	Dug well	<dugpnf>	<dugpndf>	<dugpaf>	<dugpadf>	<dug5nf>	<dug5ndf>	<dug5af>	<dug5adf>	<dug0nf>	<dug0ndf>	<dug0af>	<dug0adf>
3	Deep Tube well	<dtwpnf>	<dtwpndf>	<dtwpaf>	<dtwpadf>	<dtw5nf>	<dtw5ndf>	<dtw5af>	<dtw5adf>	<dtw0nf>	<dtw0ndf>	<dtw0af>	<dtw0adf>
4	Shallow Tube well	<stwpnf>	<stwpndf>	<stwpaf>	<stwpadf>	<stw5nf>	<stw5ndf>	<stw5af>	<stw5adf>	<stw0nf>	<stw0ndf>	<stw0af>	<stw0adf>
5	Surface flow scheme	<sfpnf>	<sfpndf>	<sfpaf>	<sfpadf>	<sf5nf>	<sf5ndf>	<sf5af>	<sf5adf>	<sf0nf>	<sf0ndf>	<sf0af>	<sf0adf>
6	Surface lift scheme	<slpnf>	<slpndf>	<slpaf>	<slpadf>	<sl5nf>	<sl5ndf>	<sl5af>	<sl5adf>	<sl0nf>	<sl0ndf>	<sl0af>	<sl0adf>
7	Other (specify)	<othpnf>	<othpndf>	<othpaf>	<othpadf>	<oth5nf>	<oth5ndf>	<oth5af>	<oth5adf>	<oth0nf>	<oth0ndf>	<oth0af>	<oth0adf>

F: Functional, DF: Dysfunctional (means: Physically system exists but not giving service) Information available from irrigation operator.

5.2 Reason(s) for dysfunctionalities and sub-optimal use.

Sl. No.		Potential lost (in hectares up to one decimal point) due to								
		Salinity/ Alkalinity	Soil erosion	Water logging	Dried up sources	Destruction of sources	Scarcity of energy	Lack of maintenance	Diversion/ unauthorized use	Other (specify)
1	Canal	<NAP>	<NAP>	<NAP>	<NAP>	<NAP>	<NAP>	<NAP>	<NAP>	<NAP>
	Major irrigation system	<majsal>	<majero>	<majwlog>	<majdry>	<majdes>	<majeng>	<majman>	<majdiv>	<majoth>
	Medium irrigation system	<medsal>	<medero>	<medwlog>	<meddry>	<meddes>	<medeng>	<medman>	<meddiv>	<medoth>
2	Dug well	<dugsal>	<dugero>	<dugwlog>	<dugdry>	<dugdes>	<dugeng>	<dugman>	<dugdiv>	<dugoth>
3	Deep Tube well	<dtwsal>	<dtwero>	<dtwwlog>	<dtwdry>	<dtwdes>	<dtweng>	<dtwman>	<dtwdiv>	<dtwoth>
4	Shallow Tube well	<stwsal>	<stwero>	<stwwlog>	<stwdry>	<stwdes>	<stweng>	<stwman>	<stwdiv>	<stwoth>
5	Surface flow	<sfsal>	<sfero>	<sfwlog>	<sfdry>	<sfdes>	<sfeng>	<sfman>	<sfdiv>	<sfoth>
6	Surface lift	<slsal>	<slero>	<slwlog>	<sldry>	<sldes>	<sleng>	<slman>	<sldiv>	<sloth>
7	Other (specify)	<othsal>	<othero>	<othwlog>	<othdry>	<othdes>	<otheng>	<othman>	<othdiv>	<othoth>

Irrigation area recovered if any, through conversion <recover> ____________________ Explain/Describe how recovered _____________

6. Major Crops[6] and Cropping Pattern (area in Hectares):

Crop	Season	At inception of most important irrigation mode <incpyr>	Present	5 years ago	10 years ago
<crp1>	<ses1>	<cpi1>	<cpp1>	<cp51>	<cp101>
<crp2>	<ses2>	<cpi2>	<cpp2>	<cp52>	<cp102>
<crp3>	<ses3>	<cpi3>	<cpp3>	<cp53>	<cp103>
<crp4>	<ses4>	<cpi4>	<cpp4>	<cp54>	<cp104>
<crp5>	<ses5>	<cpi5>	<cpp5>	<cp55>	<cp105>
<crp6>	<ses6>	<cpi6>	<cpp6>	<cp56>	<cp106>
<crp7>	<ses7>	<cpi7>	<cpp7>	<cp57>	<cp107>
<crp8>	<ses8>	<cpi8>	<cpp8>	<cp58>	<cp108>

6 Only crops covering more then 10% area in GCA should be included in the above list, unless the crops are very high valued once (e.g., cumin seed in Gujarat). *Season Codes:* ***Kharif:1; Autumn:2 Rabi:3; Summer:4; & Perennial:5.*** *Crop codes:* ***Groundnut:1; Cotton:2; Paddy:3; Bajra:4; Tur:5; Castor:6; Jowar:7; Maize:8; Sesamum:9; Gram:10; Wheat:11; Rapeseed & Mustard:12; Garlic:13; Onion:14; Tobacco:15; Urad:16; Potato:17; Sugarcane:18; Banana:19; Sunflower:20; Soyabean:21. Add new crops if required. Information generally available from talati or agricultural department.***

Annexure 2.6B

SERIAL NO.

STUDY TO IDENTIFY THE CAUSES BEHIND INCREASING GAP BETWEEN IPC AND IPU

Sponsored by

Ministry of Water Resources, Government of India

SCHEDULE – VI (Part – B)*

SELECTED VILLAGE DETAILS

Code

Name of Project <projcode>____________________________

Name of Main/Branch Canal <maincode>________________

Distributary <disbcode>________________________________

Minor/sub-minor <mcode>_____________________________

Outlet <outcode>_____________________________________

Name of Village <vilcode>______________________________

Gram Panchayat <pancode>_____________________________

Block/taluka <talcode>_________________________________

District <distcode>____________________________________

Name & designation of the person interviewed:

Stages	Name & signature of team member	Date
1. Interview:	<viname>	<vidt>
2. Schedule checking:	<vcname>	<vcdt>
3. Schedule re-checking:	<vrname>	<vrdt>
4. Data computerization:	<vdname>	<vddt>

Indian Institute of Management, Ahmedabad

** The revenue village having maximum CCA in the selected outlet should be chosen for canvassing village questionnaire. This part of the questionnaire must be canvassed to a suitable village gathering to get approximate figures.*

1. Average Level of Water Table (in feet) in the Village

Present (in feet)	<wattabp>	Five years ago (in feet)	<wattab5>

2. Occupational Profile: percentage of households whose primary occupation[1] are

Farming <farm>	Agricultural wage labour <awage>	Non agri. Wage lab. <nawage>	Trade and business <ocutb>	Service against salary	
				Organized <ocusro>[2]	Un-organized <ocusru>

This Information is available from block or village panchayat office (Talati).
1 Primary occupation is one wherefrom a household derives the maximum % of income.
2 Organized service has social security/post retirement benefits (not generally available to servants, for example)

3. Incidence of major disease during the last 5 years
(rank 1 to 5 with 1 for the worst disease from both categories inclusive)

Communicable		Non-communicable	
Human Disease			
Disease	**Rank**	**Disease**	**Rank**
Tuberculosis	<tb>__________	Dengue fever	<dengue>______________
Malaria	<malaria> _____	Gastroenteritis	<gastro> ______________
Typhoid Fever	<typhoid> _____	Pneumonia	<pnemu> ______________
Polio	<polio> ________	Cancer	<cancer> ______________
Plague	<plague> ______	Diabetes	<diabetes> _____________
Cholera	<cholera> _____	High BP	<bp> ________________
AIDS	<aids> _________	Cardinal Diseases	<cardinal> _____________
Influenza (Flu)	<flu> __________		
Chickenpox	<cp> __________		
Measles	<measles> _____		
Diphtheria	<dipthe> ______		
Gonorrhea	<gonorr> ______		
Syphilis	<syphil> ______		
Whooping Cough	<cough> ______		
Urinary Tract Infections	<urinary> _____		
Filariasis	<filari> ________		
Kala-azar	<kala> _________		
Candidiasis	<candid> ______		

4. Information about water related institutions:

i. Does a WUA exist? <wua> Yes = 1 and No = 0

ii. Is it effective in

Creating rules in water use? <rule> Yes = 1 and No = 0
Changing rules in water use as and when necessary? <change> Yes = 1 and No = 0
Monitoring compliance of rules by members? <monit> Yes = 1 and No = 0
Punishing rule breakers? <punish> Yes = 1 and No = 0
Resolving water use related conflicts? <confli> Yes = 1 and No = 0

iii. **How do you rate the performance of irrigation department officials in solving of irrigation related problems** <perform>
   a. **Good** = 1
   b. **Bad** = 0

iv. Reasons (Describe):

5. Information about infrastructural facilities:

i. **Does an all-weather road exist linking the village with the nearest market?** <linkroad> Yes = 1 and No = 0

ii. **Distance of the nearest market from the village (in Km)** <mky> _

iii. **Distance of the nearest commercial bank/primary cooperative society (in Km)** <bank> ____

iv. **Distance (in Km) of nearest outlet that sells (a) fertilizers (b) certified seeds (c) insecticides** <input> _____

v. **Are agricultural implements available on hire? (a) Tractor (b) Thresher** <hire> Yes = 1 and No = 0

vi. **Are there facilities available in the locality for repairing agricultural implements (e.g., pump set)?** <repair> Yes = 1 and No = 0

vii. **Distance of the nearest primary health center (Km)** <pac> _____

viii. **Distance of the nearest veterinary health care clinic (Km)** <vet> ____

ix. **Number of individuals from the village selling water for irrigation from own minor irrigation system?** <salwat> _____________

6. Price of land (Rs. per hectare):

Type of Land	**Present**	**5yearAgo**	**10yearago**
Agricultural Irrigated	<irrip>	<irri5>	<irri10>
Agricultural Unirrigated	<unirrip>	<unirri5>	<unirri10>
Waste land	<wastp>	<wast5>	<wast10>
Non-Agricultural Land	<nonalp>	<nonal5>	<nonal10>

7. Conversion of land (put tick mark):

Type of Land	To	Irrigated Agricultural Land		Unirrigated Agricultural Land		Wasteland		Non-Agricultural Land	
From		In recent time	10yearsago	In recent time	10yearsago	In recent time	10yearsago	In recent time	10yearsago
Irrigated Agricultural Land		NAP	NAP	<iunip>	<iuni10>	<iwastp>	<iwast10>	<inonap>	<inona10>
Unirrigated Agricultural Land		<unirrp>	<unirr10>	NAP	NAP	<unwastp>	<unwast10>	<unnonp>	<unnon10>
Wasteland		<wagirp>	<wagir10>	<wagunp>	<wagun10>	NAP	NAP	<wnonap>	<wnona10>
Non-Agricultural Land		<nagirp>	<nagir10>	<nunirp>	<nunir10>	<nwastp>	<nwast10>	NAP	NAP

8. Irrigation Potential lost that might be recovered through different actions[3] (in Hectares) (arrange in order of priority)

Action proposed (describe) to be coded later	**Potential Area to be recovered (hectare)**	**Observations and remarks on failure to initiate such action (describe)**
<act1>	<harea1>	
<act2>	<harea2>	
<act3>	<harea3>	
<act4>	<harea4>	
<act5>	<harea5>	

3 Get approximate figures from a knowledgeable group of villagers.

9. Respondent's perception about WUA

Sl. No.	**Activities**	**Score Points**
1	**Maintenance of the System (Minors/Structures)**	
	A. Removal of Silt and Vegetation <silt> i. **Properly cleaned before the rainy season** ii. **Somewhat cleaned before the rainy season** iii. **Not cleaned before the season** iv. **Not Cleaned for many seasons**	**3** **2** **1** **0**
	B. Maintenance of Structure <ment> i. **All structures are periodically observed and regular maintenance is done, preventive measures taken, if there is danger of damage in near future.** ii. **Maintenance is done only when major damage is noticed** iii. **Maintenance is done occasionally** iv. **No notice is taken and no measures are taken to prevent damage**	**3** **2** **1** **0**
	C. Protection of Structures <pstruct> i. **All structures are protected and there has been no damage in this year** ii. **Most structures are protected and there has been only minor damage in this year to some structures** iii. **Some structure are protected, there has been some damage to the structure** iv. **A few structures are protected, there has been major damage to the structures in this year**	**3** **2** **1** **0**
	D. Voluntary Group Labour <pvolun> i. **All members participate in group work**	**3**

	ii. Most of members participate in group work **iii. Some of members participate in group work** **iv. No member participates in group work**	**2** **1** **0**
2	**Water Management**	
	A. Management of water sharing <wshar> **i. All farmers in the area always get their fair share of water** **ii. Most farmer usually get their fair share of water** **iii. Some farmers sometimes get their fair share of water** **iv. No farmer even gets a fair share of water**	 **3** **2** **1** **0**
	B. Knowledge of water distribution <watdist> **i. All farmers know in advance when they will get water and when there is change in schedule** **ii. Most farmers know in advance when they will get water and when there is change in schedule** **iii. Some farmers know in advance when they will get water and when there is change in schedule** **iv. No farmer knows in advance when they will get water and when there is change in schedule**	 **3** **2** **1** **0**
	C. **Water saving efforts** <watsav> **i. All farmers make efforts to save water and close their offtake soon after their time or quota is over** **ii. Most farmers make efforts to save water and close their offtake soon after their time or quota is over** **iii. Some farmers make efforts to save water and close their off-take soon after their time or quota is over** **iv. No farmer makes efforts to save water and close their off-take soon after their time or quota is over**	 **3** **2** **1** **0**

10.1 Listing of farming households using irrigation in selected villages[4]

Sl. No.	Name of head of household <hhname>	Size of operational holding[5] <size>	Main source of irrigation[6] <msource>	Whether making conjunctive use of water: 0 = No and 1 = Yes <conjunt>
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				

4 For major/medium irrigation, list only those household which are enjoying the benefits of selected outlets available from outlet operator. For minor irrigation, enlist all farming household in the village through group discussion.

5 1. Small = 0 to 2 ha; 2. Medium = 2 to 4 ha; 3. Large = more then 4 ha.

6 1. major/medium; 2. minor: dugwell; 3. minor shallow tubewell; 4. minor deep tubewell; 5. minor surface flow; 6. minor surface lift. If minor, mention in bracket whether owned by a. govt; b. panchayat; c. coop/NGO; d. group of individuals; e. single household.

Cont…….

Sl. No.	**Name of head of household** <hhname>	**Size of operational holding** <size>	**Main source of irrigation** <msource>	**Whether making conjunctive use of water: 0 = No and 1 = Yes** <conjunt>
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
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66				
67				
68				
69				
70				
71				
72				
73				
74				
75				

10.2 Distribution of farming household by size of operational holding and irrigational attributes (put household serial number in each cell)[7]

Particulars	Main source of irrigation						Making conjunctive use of water
	1	2	3	4	5	6	
Small							
Medium							
Large							

7 This table will be used by IIMA study team or field supervisor to draw a stratified random sample of farming household from selected village.

Annexure 2.7

SERIAL NO. [ ]

STUDY TO IDENTIFY THE CAUSES BEHIND INCREASING GAP BETWEEN IPC AND IPU

Sponsored by

Ministry of Water Resources, Government of India

SCHEDULE – VII#

HOUSEHOLD DETAILS

Code

Name of Project <projcode>____________________________

Name of Main/Branch Canal <maincode>_____________________

Distributory/Main Minor <disbcode>_____________________

Minor/sub-minor <miocode>____________________________

Outlet<outcode>______________________________________

Gram Panchayat <pancode>__________________________________

Block/taluka <talcode>____

District_<distcode>____

Village <vilcode>__________________________________

Head of Household <headcode>___________________

Name & designation of the person interviewed:

Stages	Name & signature of team member	Date
1. Interview:	<hiname>	<hidt>
2. Schedule checking:	<hcname>	<hcdt>
3. Schedule re-checking:	<hrname>	<hrdt>
4. Data computerization:	<hdname>	<hddt>

Indian Institute of Management, Ahmedabad

 # For major/medium irrigation projects, choose 8 households at random from each selected village, after stratifying households as per their operational landholding status i.e. from small, medium and large groups. In case no household making conjunctive use of irrigation gets selected, choose one such household at random from the group of such households to replace one (again to be selected at random) from the same landholding group. Thus, before this selection, a comprehensive listing of village households is necessary as per their landholding status and conjunctive use of irrigation water. For minor irrigation projects, 16 or 24 households are to be selected (depending on whether 3 or 2 villages are chosen per state/UT) using the same stratified random sampling procedure, except for the fact that there is no need to pick up any household making conjunctive use of irrigation water.

2. Particulars of the Individual Household (Adult respondent)

2.1 Total members in the household: a) between 15-60 yrs <membet> ☐ b) others<memoth> ☐

2.2 Religion (Code Hindu-1, Muslim-2, Christian-3, Sikh-4, Others-5)<rel> ☐

1.2 Caste (Code SC-1, ST-2. OBC-3 Others –4)<caste> ☐

1.4 Whether member of: (**Code**: Yes –1, No-0)

a) Panchayati Raj Institution <panch>: ☐

b) Water Users Association <wua>: ☐

c) Primary Co-operative Society <pacs>: ☐

d) Any other Relevant Institution <rother>: ☐

1.5 Sub-categorization of the household (Only one cell, which is the most appropriate, to be ticked ( ) against items at Sl. Nos. 1 to 13) *(Easier to check most questions from right to left*

Sl.no.	Characteristics	Scores				
		0	**1**	**2**	**3**	**4**
1	Size group of **operational holding** of land <sizehold>	Nil	Less than 1 ha. of un-irrigated land (or less than 0.5 ha. of irrigated land)	1 ha. - 2ha. Or un-irrigated land (or 0.5-1.0 ha. of irrigated land)	2 ha. – 5ha. of un-irrigated land (or 1.0-2.5 ha. of irrigated land)	More than 5 ha. of un-irrigated land (or 2.5-ha. of irrigated land
2	Type of house <thouse>	Houseless	Kutcha	Semi-Pucca	Pucca	Urban type
3	Average availability of normal wear clothing (per person in pieces) <nwear>	Less than 2	2 or more, but less than 4	4 or more, but less than 6	6 or more, but less than 10	10 or more
4	Food Security <fsecure>	Less than one square meal per day for major part of the year	Normally, one square meal per day, but less than one square meal occasionally	One square meal per day throughout the year	Two square meals per day, with occasional shortage	Enough food throughout the year

5	Sanitation <sanit>	Open defecation	Group latrine with **irregular** water supply	Group latrine with **regular** water supply	Group latrine with regular water supply and regular sweeper	Private latrine
6	Ownership of consumer durables e.g., TV, radio, electric fan, kitchen appliances like pressure cooker <condur>	Nil	Any one	Two items only	Any three or all items	All items **and/or** ownership of any one of the following[6]:
7	Literacy status of the highest literate adult <lstatus>	Illiterate to just literate	Up to primary (Class V)	Completed secondary (passed class X)	Graduate/ professional diploma	Post-Graduate/Professional graduate
8	Status of the household labor force <stlab>	Bonded labor (Any member of the house hold)	Female & child labor	Only adult females & no child labour	Adult males only	No labor in household
9	Status of children (5-14 years – child) <stchild>	Non going to school, working	Some going to school and others working	Some going to school, but also working	Some going to school, and none working	All going to school and <u>NOT</u> working
10	Type of indebtedness <indebt>	For daily consumption purposes from informal sources	For production purpose from informal sources	For other purpose[7] from informal sources	Borrowing only from institutional agencies	No indebtedness and possess assets
11	Reason for migration from household[8] <migrate>	Casual work	Seasonal employment	Other forms of livelihood[9]	Non-migrant	Migrant for higher status

[6] *Computer, Refrigerator, Telephone, Furniture like Sofa Set, Cupboard, LMV/LCV, Tractor, Mechanized Two-wheeler/Three-wheeler, Power tiller, Combined Thresher/Harvester, 4-Wheeled Mechanized Vehicle*

[7] *For example, for marriage, education, medical purposes.*

[8] *Ask this question for last 5 years.*

[9] *In this case, there's no improvement in status, unlike in case the last one on right hand side.*

	Drinking water facility		
12	Distance from source in Km	For hilly areas <wathill>	For plain areas <watpln>

1.6 Source wise annual household income (Rs.)

Agriculture	Allied activities	Wage labor	Trade & business	Service & profession[10]	Remittances
<agy>	**<aly>**	**<wgy>**	**<try>**	**<sry>**	**<rmy>**

[10] *Includes lawyers, doctors, pensioners.*

2.1 Land Holding Details *(Area in hectares.)*

Particulars	**Present (mention year) <lhpyr>**	**No. of Parcels**	**5 years ago (mention year) <lh5yr>**	**No. of Parcels**	**10 years ago (mention year) <lh10yr>**	**No. of Parcels**
Total land holding	<totp>	-NAP-	<tot5>	-NAP-	<tot10>	-NAP-
Arable and cultivated land	<arap>	<arapno>	<ara5>	<ara5no>	<ara10>	<ara10no>
Arable but not cultivated for some reason – temporarily / permanently	<arncap>	-NAP-	<arnca5>	-NAP-	<arnca10>	-NAP-
Non-arable land	<narap>	-NAP-	<nara5>	-NAP-	<nara10>	-NAP-
Area irrigated	<irrp>	<irrpno>	<irr5>	<irr5no>	<irtr10>	<irr10no>

Area Irrigated by Source

	Present Year =	**5 years ago Year =**	**10 years ago Year =**	**Farmer's explanation in world of deviation, if any**
Major irrigation canal	<majp>	<maj5>	<maj10>	<hmincade>
Medium irrigation canal	<medp>	<med5>	<med10>	<hmedcade>
Dug Well	<dugp>	<dug5>	<dug10>	<hdugwde>
Shallow Tube well	<stwp>	<stw5>	<stw10>	<hstwde>
Deep Tube well	<dtwp>	<dtw5>	<dtw10>	<hdtwde>
Surface Flow System	<sfsp>	<sfs5>	<sfs10>	<hsfwde>

Surface Lift System	<slsp>	<sls5>	<sls10>	<hslwde>
Others (specify)	<othp>	<oth5>	<oth10>	<hothwde>

2.2 Breakup of Operational Land Holding (2007-08)

Sl. No.	Particulars	Irrigated	Un-irrigated
(i)	**Own Land (Ha.)**	**<iownlan>**	**<uownlan>**
(ii)	**Leased in Land (Ha) (+)**	**<iarlin>**	**<uarlin>**
(iii)	**Leased Out (Ha) (–)**	**<iarlout>**	**<uarlout>**
(iv)	**Operational Holding (Ha)**	**<itotlan>**	**<utotlan>**

2.3 Reasons for cultivated and cultivable area within irrigation command remaining un-irrigated (Tick the appropriate factors – maybe more than one and describe other reasons)

Reasons	**Irrigated command area remaining un-irrigated**
Unleveled land	<uunleva>
Absence of irrigation channels	<uchana>
Scarcity of water	<uscara>
Uncertainty about supply	<usupa>
Unresolved conflicts with fellow farmers	<ucona>
Bleak prospects of remunerative returns	<urema>
Financial incapability	<ufina>
Physical incapability	<uphya>
Other reasons - describe	<uotha>

2.4.1[11] Information about ownership profile of minor irrigation sources used by household (put numbers of sources with year of launching in suitable cells):

Source	Ownership Status					
	Government	Cooperatives	Panchayats/ NGOs	Group of farmers	Owned by this household (mention year here)	Owned by other household
Dugwell	<dwgov>	<dwcop>	<dwpan>	<dwgof>	<dwindn> <dwindy>	<dwoth>
Shallow Tubewell	<stgov>	<stcop>	<stpan>	<stgof>	<stindn> <stindy>	<stoth>
Deep Tubewell	<dtgov>	<dtcop>	<dtpan>	<dtgof>	<dtindn> <dtindy>	<dtoth>
Surface flow system[12]	<sfgov>	<sfcop>	<sfpan>	<sfgof>	<sfindn> <sfindy>	<sfoth>
Surface lift system	<slgov>	<slcop>	<slpan>	<slgof>	<slindn> <slindy>	<sloth>

2.4.2[13] Information about working status of minor irrigation sources you are associated with during the last 5 years (put numbers of sources in suitable cells):

Source	In use	Not in use				
		Temporarily	Permanently due to			
			Salinity	Dried up	Destroyed	Other
Dugwell	<dwinus>	<dwntemp>	<dwnsal>	<dwndry>	<dwndest>	<dwnoth>
Shallow Tubewell	<stinus>	<stntemp>	<stnsal>	<stndry>	<stndest>	<stnoth>
Deep Tubewell	<dtinus>	<dtntemp>	<dtnsal>	<dtndry>	<dtndest>	<dwnoth>
Surface flow system	<sfinus>	<sfntemp>	<sfnsal>	<sfndry>	<sfndest>	<dwnoth>
Surface lift system	<slinus>	<slntemp>	<slnsal>	<slndry>	<slndest>	<dwnoth>

---

[11] *Tables 2.4.1 to 2.4.5 are relevant for households having some kind of dependency on minor irrigation (either making conjunctive use of irrigation water or exclusively dependent on minor irrigation)*

[12] *e.g., a check dam, working on hydrological pressure w/o use of any lifting device.*

[13] *Totals in Tables 2.4.1 and 2.4.2 must match.*

2.4.3 (a) Information about lifting devise used in minor irrigation sources at present (put tick mark in suitable cells):

Source	Lifting devise					
	Electric pump	**Diesel pump**	**Wind mills**	**Solar pump**	**Manual/animal operated lift**	**Others** (Describe)
Dugwell	<dwepum>	<dwdpum>	<dwwin>	<dwsol>	<dwman>	<dwothr>
Shallow Tubewell	<stepum>	<stdpum>	<stwin>	<stsol>	<stman>	<stothr>
Deep Tubewell	<dtepum>	<dtdpum>	<dtwin>	<dtsol>	<dtman>	<dtothr>
Surface flow system	<NAP>	<NAP>	<NAP>	<NAP>	<NAP>	<NAP>
Surface lift system	<slepum>	<sldpum>	<slwin>	<slsol>	<slman>	<slothr>

2.4.3 (b) Information about running cost of minor irrigation incurred/paid by household at present (write cost in Rs./Ha in suitable cells):

Source	Running Cost of Irrigation					
	Electric pump	**Diesel pump**	**Wind mills**	**Solar pump**	**Manual/animal operated lift**	**Others**
Dugwell	<dwepuc>	<dwdpuc>	<dwwinc>	<dwsolc>	<dwmanc>	<dwothc>
Shallow Tubewell	<stepuc>	<stdpuc>	<stwinc>	<stsolc>	<stmanc>	<stothc>
Deep Tubewell	<dtepuc>	<dtdpuc>	<dtwinc>	<dtsolc>	<dtmanc>	<dtothc>
Surface flow system	<NAP>	<NAP>	<NAP>	<NAP>	<NAP>	<NAP>
Surface lift system	<slepuc>	<sldpuc>	<slwinc>	<slsolc>	<slmanc>	<slothc>

2.4.4: Information about potential of minor irrigation sources

Source	Number/ Length (mts.)	Irrigation potential actually created at inception [mention year] (ha) <ipcdyr>_________________				Potential realized (present) [mention year] <ipcpyr> =2008			
		K	A	R	S	K	A	R	S
Dugwell	<dwpotn>	<dwipck>	<dwipca>	<dwipcr>	<dwipcs>	<dwipuk>	<dwipua>	<dwipur>	<dwipus>
Shallow Tubewell	<stpotn>	<stipck>	<stipca>	<stipcr>	<stipcs>	<stipuk>	<stipua>	<stipur>	<stipus>
Deep Tubewell	<dtpotn>	<dtipck>	<dtipca>	<dtipcr>	<dtipcs>	<dtipuk>	<dtipua>	<dtipur>	<dtipus>
Surface flow system	<sfpotn>	<sfipck>	<sfipca>	<sfipcr>	<sfipcs>	<sfipuk>	<sfipua>	<sfipur>	<sfipus>
Surface lift system	<slpotn>	<slipck>	<slipca>	<slipcr>	<slipcs>	<slipuk>	<slipua>	<slipur>	<slipus>

Note: K: Kharif, R: Rabi, S: Summer, A: Autumn . Put numbers in case of ground water systems (dugwells, shallow/deep tubewells) and length in metres for surface water systems

2.4.5 Tick as relevant *(more than one may be ticked)*

For groundwater schemes *(i.e., dugwell, shallow/deep tubewell)***:**

a. decline in water table
b. lack of availability of energy – electricity or diesel
c. increased price of energy – electricity or diesel
d. decreased efficiency of lifting devise
e. water available not fit for irrigation – pollution
f. lack of maintenance due to unaffordable maintenance cost (in case of individually owned system)
g. ownership dispute (in case owned by a group of farmers)
h. lack of maintenance (in case owned by government agency, panchayat or cooperative
a. shift from low water-intensive crop to high water intensive crop, please mention the nature of shift
b. conversion of agricultural land to non-agricultural purposes, please mention the amount of land converted and the nature of conversion <gwcona>
c. conversion of culturable wastes to agricultural purposes, please mention the amount of land converted and the nature of conversion <gwrcona>

For surface water schemes *(i.e., surface flow/lift system)***:**

a. decline of water available at source
b. lack of availability of energy – electricity or diesel (for surface lift scheme)
c. increased price of energy – electricity or diesel (for surface lift scheme)
d. water available not fit for irrigation – pollution
e. lack of maintenance due to unaffordable maintenance cost (in case of individually owned system)
f. ownership dispute (in case owned by a group of farmers)
g. lack of maintenance (in case owned by government agency, panchayat or cooperative
h. non-receipt of water at time when required
i. non-receipt of water in required quantity
j. shift from low water-intensive crop to high water intensive crop, please mention the nature of shift
k. conversion of agricultural land to non-agricultural purposes, please mention the amount of land converted and the nature of conversion <swcona>
l. conversion of culturable wastes to agricultural purposes, please mention the amount of land converted and the nature of conversion <swrcona>

In case there is a gap between the actual creation of potential and present potential realized, the reasons thereof (rank 3 in order of importance: write a, b, c etc., besides tick-marking all relevant ones):

<gwat1>______________________<gwat2>__________________<gwat3>_________________

<swat1>______________________<swat2>__________________<swat3>______________

2.5: Perception of household about supply side failure (i.e., information about potential created and actual utilization) in major/medium irrigation sources

Outlet (name, if any)	Length of water course leading to the plot (mts.)	Irrigation potential as per project design (ha)				Irrigation water actually available (ha)			
		K	A	R	S	K	A	R	S
<hout1>	<hlenwc1>	<hipck1>	<hipca1>	<hipcr1>	<hipcs1>	<hipuk1>	<hipua1>	<hipur1>	<hipus1>
<hout2>	<hlenwc2>	<hipck2>	<hipca2>	<hipcr2>	<hipcs2>	<hipuk2>	<hipua2>	<hipur2>	<hipus2>
<hout3>	<hlenwc3>	<hipck3>	<hipca3>	<hipcr3>	<hipcs3>	<hipuk3>	<hipua3>	<hipur3>	<hipus3>

Note: K: Kharif, R: Rabi, S: Summer, A: Autumn,

In case there is a gap between the designed creation of potential and actual utilization of potential, tick-mark *(more than one, if found relevant)* **the reasons thereof:**

- **a.** water course not constructed,
- **b.** water course damaged
- **c.** discharge capacity of minor reduced due to poor maintenance
- **d.** excess tapping of water at the high end
- **e.** non-receipt of water at time when required
- **f.** non-receipt of water in required quantity
- **g.** shift from low water-intensive crop to high water intensive crop, please mention the nature of shift
- **h.** conversion of agricultural land to non-agricultural purposes, please mention the amount of land converted and the nature of conversion
- **i.** conversion of culturable wastes to agricultural purposes, please mention the amount of land converted and the nature of conversion

Also rank the top 3 reasons thereof (write a, b, c etc., besides tick-marking all relevant ones):

<mmwat1>______________________<mmwat2>__________________<mmwat3>_________________

3. Farm-based Production

3.1.1 Major[14] Crops (Present)

Sl. No.	Season[15]	Crop[16]	Variety	Area (ha)		Production (qtl)		Output sold (qtl)	Price/qtl	
				Irr.	Unirr.	Irr.	Unirr.		FG	M
1.	<hsesn1>	<hcrop1>	<hvar1>	<hirra1>	<hurra1>	<hirrp1>	<hurrp1>	<houtq1>	<houtfg1>	<houtm1>
2.	<hsesn2>	<hcrop2>	<hvar2>	<hirra2>	<hurra2>	<hirrp2>	<hurrp2>	<houtq2>	<houtfg2>	<houtm2>
3.	<hsesn3>	<hcrop3>	<hvar3>	<hirra3>	<hurra3>	<hirrp3>	<hurrp3>	<houtq3>	<houtfg3>	<houtm3>
4.	<hsesn4>	<hcrop4>	<hvar4>	<hirra4>	<hurra4>	<hirrp4>	<hurrp4>	<houtq4>	<houtfg4>	<houtm4>
5.	<hsesn5>	<hcrop5>	<hvar5>	<hirra5>	<hurra5>	<hirrp5>	<hurrp5>	<houtq5>	<houtfg5>	<houtm5>
6.	<hsesn6>	<hcrop6>	<hvar6>	<hirra6>	<hurra6>	<hirrp6>	<hurrp6>	<houtq6>	<houtfg6>	<houtm6>
7.	<hsesn7>	<hcrop7>	<hvar7>	<hirra7>	<hurra7>	<hirrp7>	<hurrp7>	<houtq7>	<houtfg7>	<houtm7>

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[14] *Pick up only those crops whose share are more than 10% of GCA.*
[15] *kharif=1; autumn=2; rabi=3; summer=4; perennial=5.*
FG= farm gate, M= mandi
[16] *Use the same crop codes as used in village schedule. Write variety explicitly, which will be coded later.*

4. Farmers' reaction to present nature of supply of irrigation:

Issues		Note down farmer's remarks in words
Advance knowledge about irrigation availability	<advkno> Yes=1, No=0	
Mode of payment of irrigation revenue	<modepay> Pre-supply=0 Post-supply=1 Installments=2	
Are you a member of WUA?	<wuamem> Yes=1, No=0	

6. Respondent's perception about WUA

Sl. No.	Activities	Score Points
1	Maintenance of the System (Minors/Structures)	
	A. Removal of Silt and Vegetation <silt>	
	v. Properly cleaned before the rainy season	3
	vi. Somewhat cleaned before the rainy season	2
	vii. Not cleaned before the season	1
	viii. Not Cleaned for many seasons	0
	B. Maintenance of Structure <mstruc>	
	v. All structures are periodically observed and regular maintenance is done, preventive measures taken, if there is danger of damage in near future.	3
	vi. Maintenance is done only when major damage is noticed	2
	vii. Maintenance is done occasionally	1
	viii. No notice is taken and no measures are taken to prevent damage	0
	C. Protection of Structures <pstruc>	
	v. All structures are protected and there has been no damage in this year	3
	vi. Most structures are protected and there has been only minor damage in this year to some structures	2
	vii. Some structure are protected, there has been some damage to the structure	1
	viii. A few structures are protected, there has been major damage to the structures in this year	0
	D. Voluntary Group Labour <vollab>	
	v. All members participate in group work	3
	vi. Most of members participate in group work	2
	vii. Some of members participate in group work	1
	viii. No member participates in group work	0

2.	**Participation <parti>** **A. participation** **i. All members participate in meetings, feel free to speak and participate in activities** **ii. Most members participate in meetings and group activities. Most feel free to speak up** **iii. Some members participate in meeting and group activities. Some feel free to speak up** **iv. A few members participate in meeting and group activities. Only a few feel free to speak up**	 **3** **2** **1** **0**
	B. Conflict Management <conman> **i. There are no conflict among members or any such conflict that arises are always and amicably resolved** **ii. There are a few conflicts among members and they are usually fairly and quickly resolved** **iii. There are occasional conflicts among members and the committee is not effective in resolving them** **iv. There are many conflicts among members and the committee is not effective in resolving them**	 **3** **2** **1** **0**
3.	**Water Management**	
	A. Management of water sharing <wshare> **v. All farmers in the area always get their fair share of water** **vi. Most farmer usually get their fair share of water** **vii. Some farmers sometimes get their fair share of water** **viii. No farmer even gets a fair share of water**	 **3** **2** **1** **0**
	B. Knowledge of water distribution <wdist> **v. All farmers know in advance when they will get water and when there is change in schedule** **vi. Most farmers know in advance when they will get water and when there is change in schedule** **vii. Some farmers know in advance when they will get water and when there is change in schedule** **viii. No farmer knows in advance when they will get water and when there is change in schedule**	 **3** **2** **1** **0**
	D. Water saving efforts <wsave> **i. All farmers make efforts to save water and close their offtake soon after their time or quota is over** **ii. Most farmers make efforts to save water and close their offtake soon after their time or quota is over** **iii. Some farmers make efforts to save water and close their offtake soon after their time or quota is over** **iv. No farmer makes efforts to save water and close their offtake soon after their time or quota is over**	 **3** **2** **1** **0**

ANNEXURE 3

Selection of branch, distributaries, minors, outlets and villages in Daman Ganga Project of Dadra & Nagar Havali

Name of branch with highest CCA	Name of distributaries with highest CCA	Name of minors with highest CCA	Name of outlets with highest CCA	Name of village getting maximum benefit from chosen outlet
	Head R – 1	Head R – 1/3 (Syailli)	Head :- R3	Syalli
			Tail:- L4	Syalli
		Tail R – 1/6 (Athola)	Head :- R2	Athola
Right bank canal			Tail:- R3	Athola
Name of branch with highest CCA	Tail R – 3	Head Silly	Head :- L3	Silly
Right bank canal			Tail:- L7	
	Name of distributaries with highest CCA	Name of minors with highest CCA	Name of outlets with highest CCA	
	Head R – 1	Head R – 1/3 (Syailli)	Head :- R3	Silly

Name of selected project: Daman Ganga Project

<table>
<tr><th>Name of branch with highest CCA</th><th>Name of distributaries with highest CCA</th><th>Name of minors with highest CCA</th><th>Name of outlets with highest CCA</th><th>Name of village getting maximum benefit from chosen outlet</th></tr>
<tr><td rowspan="8">Left bank canal</td><td rowspan="4">Head

L – 5</td><td rowspan="2">Head

Athal</td><td>Head :- R2</td><td>Athal</td></tr>
<tr><td>Tail:- 2/6</td><td>Athal</td></tr>
<tr><td rowspan="2">Tail

Kanadi</td><td>Head :- 1/1</td><td>Kanadi</td></tr>
<tr><td>Tail:- R/1</td><td>Kanadi</td></tr>
<tr><td rowspan="4">Tail

L – 11</td><td rowspan="2">Head

Vasona</td><td>Head :- R2</td><td>Vasona</td></tr>
<tr><td>Tail:- R6</td><td>Vasona</td></tr>
<tr><td rowspan="2">Tail

Chinchpada</td><td>Head :- L1</td><td>Chinchpada</td></tr>
<tr><td>Tail:- R6</td><td>Chinchpada</td></tr>
</table>

<u>Sample Projects in Gujarat</u> : Ukai – Kakrapar (Major)

Name of branch with highest CCA and RD	**Name of distributaries with highest CCA and RD**	**Name of minors with highest CCA and RD**	**Name of outlets with highest CCA and RD**	**Name of village getting maximum benefit from chosen outlet**	**Name of Taluka to which Village belong**	**Name of District to which village belong**
Name: Chalthan Branch Length: 25 kM RD: 0 to 82.00 CCA: 21122 Ha.	**Head: Udhana Distry** **CCA= 1307.54 Ha.** **Length= 17.38 (0 to 57 RD)**	**Head: 4L Sub-minor** **CCA= 353.90 Ha. Length= 3.53 (0 to 11.60 RD)**	**H: 4L4, 27.7 Ha., RD: 3.60**	Vankaneda	Palsana	Surat
			T: 4L, 51.34 Ha. RD: 11.60	Niyol	Palsana	Surat
		Tail: 8L sub-minor CCA= 182.62 Ha. **Length= 2.50 (0 to 8.20 RD)**	**H: 8L-3, 29.48 Ha. RD: 2.20**	Devadh	Choryasi	Surat
			T: 8L-4, 23.05 Ha. RD: 4.40	Devadh	Choryasi	Surat
	Tail: Lajpore Distry **CCA= 4039.89 Ha** **Length= 10.67 (0 to 35 RD)**	**Head: Vanz Minor CCA= 830.62 Ha. Length= 7.75 (0 to 25.40 RD)**	**H: DR-3, 30.34 Ha. RD: 0.82**	Timbarva	Choryasi	Surat
			T: DR-9, 26.37 Ha. RD: 24.119	Vanz	Choryasi	Surat
		Tail: 4R Sub-Minor CCA= 118.99 Ha. Length= 2.44 (0 to 8.00 RD)	**H: 4R-B, 17.33 Ha. RD: 0.264**	Vadala	Palsana	Surat
			T: 4R-F, 30.02 Ha. RD: 8.00	Vaktana	Choryasi	Surat

Concern Officer: S. B. DESHMUKH, Dy Ex. Engg., Rander Irrigation Surat. Mob: 9825058021.

Name of selected project in Gujarat State: Dantiwada (Major)

Name of branch with highest CCA and RD	Name of distributaries with highest CCA and RD	Name of minors with highest CCA and RD	Name of outlets with highest CCA and RD	Name of village getting maximum benefit from chosen outlet	Name of Taluka to which Village belong	Name of District to which village belong
Name: GADH Branch canal	**Head:** **3L, 5.365km, 4.111Acre**	**Head:** **M3,**	**Head: 1H**	Madana	Palanpur	Banaskantha
			Tail:	Madana	Palanpur	Banaskantha
		Tail: **Salla**	**Head:**	Salla	Palanpur	Banaskantha
			Tail:	Salla	Palanpur	Banaskantha
Length:17.07km	**Tail:** **16L, 30.75km, 1108hact**	**Head:** **Morpa**	**Head: Vagdad / No 3**	Morpa	Patan	Patan
			Tail:	Naita Mota	Patan	Patan
		Tail: **Aghar**	**Head:**	Aghar	Patan	Patan
CCA:37414 Acre			**Tail: No 2**	Aghar	Patan	Patan

Concern Officer: Z.G. Bhemal (Executive Engineer) Disa Irrigation Dept. Disa, Dist: Banaskantha (O) (02744)-220071. Fax: 02744)-220071. Mob:9825543295

Name of selected project in Gujarat State: Jojwa – Wadhwan (Medium)

Name of branch with highest CCA and RD	Name of distributaries with highest CCA and RD	Name of minors with highest CCA and RD	Name of outlets with highest CCA and RD	Name of village getting maximum benefit from chosen outlet	Name of Taluka to which Village belong	Name of District to which village belong
Name: Dabhoi main canal Length: CCA:2398 ha	**Head: Name, RD & CCA** **Dabhoi main canal** **/ (Dis – 5)** **1407 hact**	**Head: Name, RD & CCA** **Revapura /** **(Dis – 3)** **(106 hact)**	**Head: Name, RD & CCA : OR-2 (5-83-00)** **/ OL-1**	Akotadar	Dabhoi	Vadodara
			Tail: Name, RD & CCA: OR-10 **(13-78-00)**	Pansoli	Dabhoi	Vadodara
		Tail: Name, RD & CCA **Distributory No-8 (121hact)**	**Head: Name, RD & CCA: OL-1 (28.16)**	Dabhoi	Dabhoi	Vadodara
			Tail: Name, RD & CCA: OR-8 (4.32.00)	Dabhoi	Dabhoi	Vadodara
	Tail: Name, RD & CCA **Trasana main canal** **991 hact**	**Head: Name, RD & CCA** **Distributory No-4 (125hact)**	**Head: Name, RD & CCA: OL-1 (18.86)**	Pansoli	Dabhoi	Vadodara
			Tail: Name, RD & CCA: **OR-8 (5-36-00)**	Timbi	Dabhoi	Vadodara
		Tail: Name, RD & CCA. **Distributory No-7 (97hact)**	**Head: Name, RD & CCA: OL-2 (14-21-00)**	Tarsana	Dabhoi	Vadodara
			Tail: Name, RD & CCA: OR-9 (17-20-00)	Kajapur	Dabhoi	Vadodara

Concern Officer: Executive Engineer, Vadodara Irrigation Division Kuber Bhavan-7th Floor, RoomNo-717, Vadodara.-01

Name of selected project in Gujarat State: Umaria (Medium)

Name of branch with highest CCA and RD	Name of distributaries with highest CCA and RD	Name of minors with highest CCA and RD	Name of outlets with highest CCA and RD	Name of village getting maximum benefit from chosen outlet	Name of Taluka to which Village belong	Name of District to which village belong
Name: LBMC Length:7.95Km CCA:1341 ha	**Head: Name, RD & CCA** **NO**	**Head:** **SM 3L, 2.07Km, 88.66Hact**	**Head: Name, RD & CCA: R3,9.31hact**	Amba	Limkheda	Dahod
			Tail: Name, RD & CCA: L5, 7.29hact	Amba	Limkheda	Dahod
		Tail: **SM 5L** **4.02Km, 202.42hact**	**Head: Name, RD & CCA:L3,7.28hact**	Agara	Limkheda	Dahod
			Tail: Name, RD & CCA:L23, 8.90 hact	Kundali	Limkheda	Dahod
	Tail: Name, RD & CCA **NO**	**Head:** **SM 7L** **1.47km** **75.30hact**	**Head: Name, RD & CCA: L4 8.90**	Agara	Limkheda	Dahod
			Tail: Name, RD & CCA: L5	Agara	Limkheda	Dahod
		Tail: **SM 12L** **3.18km, 240.49hact**	**Head: Name, RD & CCA: L5, 7.28**	Kundha	Limkheda	Dahod
			Tail: Name, RD & CCA:9R, 4.79	Kundha	Limkheda	Dahod

Concern Officer: D.C.Soni, (Ex. Engineer) and R.T. Jethnani (AAE), Dahod Irrigation Division, Dahod. 9924497881 and Mob:9427078059.

Name of selected project in Gujarat State: Und (Medium)

Name of branch with highest CCA and RD	Name of distributaries with highest CCA and RD	Name of minors with highest CCA and RD	Name of outlets with highest CCA and RD	Name of village getting maximum benefit from chosen outlet	Name of Taluka to which Village belong	Name of District to which village belong
Name: **Left branch canal** **Length:** **27.8** **CCA:10568hact:**	**Head: Name, RD & CCA:** **Directly linked to minors**	**Head: Name = M5R,** **RD = 6.18 Km.** **CCA = 323 Ha**	**H: Name, RD & CCA = WC-1, 85.37 Ha.**	Rojiya (WUA)	Dhrol	Jamnagar
			T: Name, RD & CCA = WC-5, 51.10 Ha.	Rojiya	Dhrol	Jamnagar
		Tail: Name = M17L, **RD = 13.26 Km.** **CCA: 420 Ha.**	**H: Name, RD & CCA = WC-2, 27.35 Ha.**	Dhramgda	Jamnagar	Jamnagar
			T: Name, RD & CCA = WC-6, 16.55 Ha.	Khambhalida	Jamnagar	Jamnagar
	Tail: Name, RD & CCA **Directly linked to minors**	**Head: Name = M27R,** **RD = 23.41 Km.** **CCA = 260 Ha**	**H: Name, RD & CCA = WC-1 (H), 52.27 Ha.**	Soyal	Dhrol	Jamnagar
			T: Name, RD & CCA = WC-7, 38.15 Ha.	Soyal	Dhrol	Jamnagar
		Tail: Name = M34R, **RD = 27.0 Km.** **CCA: 113 Ha.**	**H: Name, RD & CCA = WC-1, 35.67 Ha.**	Hadiyana Vavdi (WUA)	Jodia	Jamnagar
			T: Name, RD & CCA = WC-3, 40.23 Ha.	Vavdi	Jodia	Jamnagar

Concern Officer: *B.P.Chovatiya (Executive Engineer, Jamnagar, Irrigation Division Jamnagar) 0288-2670688, Fax-0288-2678106, Mob:9825158577. bpchovatiya@yahoo.co.in,jidnjam@yahoo.co.in.*

Name of selected project in Gujarat State: Rudramata[1] (Medium)

Name of branch with highest CCA and RD	Name of distributaries with highest CCA and RD	Name of minors with highest CCA and RD	Name of outlets with highest CCA and RD	Name of village getting maximum benefit from chosen outlet	Name of Taluka to which Village belong	Name of District to which village belong
L.B.M.C. (2997 Ha)	**Head** L.B.M.C. (294 Ha)	**Head** Nokhaniya Minor (150 Ha)	**Head :**			
			Tail End (150 Ha)	Nokhaniya (150 Ha)	Bhuj	Kachchh
		Tail Sumrasar Branch (1240 Ha)	**Head** RD 1100 m (R) (122 Ha)	Sumrasar (122 Ha)	Bhuj	Kachchh
			Tail RD 3170 m (R) (106 Ha)	Sumrasar (106 Ha)	Bhuj	Kachchh
	Tail Loriya Distri. (1052 Ha)	**Head** Minor M/L (250 Ha)	**Head** RD 890 m (R) (55 Ha)	Loriya (55 Ha)	Bhuj	Kachchh
			Tail RD 2255 m (R) (40 Ha)	Loriya (40 Ha)	Bhuj	Kachchh
		Tail Minor M/L (252 Ha)	**Head** RD 500 m (L) (168 Ha)	Loriya (168 Ha)	Bhuj	Kachchh
			Tail End (56 Ha)	Loriya (56 Ha)	Bhuj	Kachchh

Concern Officer: M. D. Patel, Sup. Eng. K. I. C., Sinchai Sadan, Near Jubilee Circle, Bhuj. Mo:- 9978405400

1 Rudramata is a replacement sample of Mitti from the same agro climatic region, as the latter is undergoing rehabilitation work after massive earthquake in Kuchh region of Gujarat several year ago.

SYSTEM: GURGAON CANAL SERVING HARYANA (NUH), CCA=305344 ACRS.

BRANCH	DISTRIBUTORY	MINOR	OUTLET	VILLAGE
GURGAONCANAL, CCA=305344ACR	CHHAINSA,H, CCA=35919	KHERI KALAN,H CCA=8447ACRS.	RD12220,L,H,	FARIDPUR
			RD18350,R,T.	NEEMKA
	UTTAWAR,T, CCA=30982ACRS.	NO MINOR GIVEN	RD4080,L,H	KIRING,468ACRS.
			RD63020,L,T	GARHI VINODA

NAME OF SELECTED PROJECT IN HARYANA STATE : NAGGAL LIFT IRRIGATION SCHEME

Name of branch with highest CCA and RD	Name of distributaries with highest CCA and RD	Name of minors with highest CCA and RD	Name of outlets with highest CCA and RD (in acres)	Name of village getting maximum benefit from chosen outlet	Name of Taluka to which village belong	Name of District to which village belong
Narwana Branch Carrier Channel	Kanawala Disty.	Head Naggal Minor	Head 2.700/R CCA= 184 h.a	Amilpur CCA= 184 h.a.	Ambala City	Ambala
			Tail 5.800/R CCA= 180 h.a	Sakron 80.8 h.a.	Ambala City	Ambala
		Tail Panjobhara Minor	Head 4.120/L CCA= 306 h.a	Kalan 178 h.a.	Ambala City	Ambala
			Tail 10.235/L CCA= 282.8 h.a	Kakroo 205.6 h.a.	Ambala City	Ambala

NAME OF PROJECT: **TAIL BML** SYSTEM, SIRSA WATER SERVICES DIVISION, SIRSA, HARYANA

BRANCH	DITRIBUTORY	MINOR	OUTLET	VILLAGE / DIST : SIRSA
RORI [0-109500] CCA = 49856 Ha.	GUDHA [0-78023] [H] CCA = 8145 Ha.	Directly connected to outlets	Name = 21408 RD 21408 [H] L CCA = 522 Ha	RORI
			Name = 70750 RD 70750 [T] L CCA = 477 Ha.	Dhaban
	BANI [0-129500] [T] CCA = 21123 Ha	NANUANA [0-1500], [H] CCA = 968	Name = 7500 RD 7500 [H] R CCA = 301 Ha	SULTANPURIA
			Name = 13600 RD 13600,T, CCA= 208 Ha	SULTANPURIA
		BALASAR [0-29000] [T] CCA = 982	Name = 9000 RD 9000 [H]L CCA = 382 Ha	Mahammad Puria (RANIA)
			Name = 29000 RD 29000 [T] CCA = 370 Ha	BHAROLIAWALI

<u>NAME OF SELECTED PROJECT IN HARYANA STATE : JLN</u>

Name of branch with highest CCA and RD	Name of distributaries with highest CCA and RD	Name of minors with highest CCA and RD	Name of outlets with highest CCA and RD	Name of village getting maximum benefit from chosen outlet	Name of Taluka to which village belong	Name of District to which village belong
JLN Feeder Length: 23.00KM CCA:8700 ACRE	H: JAKHALA Length = 10.930KM CCA = 7033 AC	H: BLIND CHANNEL RD: = 14000 feet CCA = 1432.4 AC	-BLIND CHANNEL	MUNDRA	MATAN HAIL	RIWARI
			TF:1.810 321CCA	MUNDRA	MATAN HAIL	RIWARI
		T: MUNDRA RD = 1116 CCA = 1.80 AC	TL=1.810KM CCA = 10	MUNDRA	MATAN HAIL	RIWARI
			TR = 1.810KM CCA=428acre	MUNDRA	MATAN HAIL	RIWARI
	T: RAJIAKA Length = 74500 feet CCA = 14.088KM	H: BHARAWAS RD = 9000 CCA = 4090.4 AC	H: 5.770/R CCA = 309	BHARAWAS	BADHARA	RIWARI
			RD=5500/R CCA=160Acre	JETHARAWAS	BADHARA	RIWARI
		T: BHARAWAS 1 RD=10000 CCA =4.159	H: RD = 0.360/R CCA = 1944acre	BHARAWAS	BADHARA	RIWARI
			T: RD =4.159R CCA = 961 acre	BHARAWAS	TOSHAM	RIWARI

CCA in Acres and Lengh or RD 0 to in KM. L: left and R means Right.

NAME OF SELECTED PROJECT IN HARYANA STATE : LOHARU LIFT

Name of branch with highest CCA and RD	Name of distributaries with highest CCA and RD	Name of minors with highest CCA and RD	Name of outlets with highest CCA and RD	Name of village getting maximum benefit from chosen outlet	Name of Taluka to which village belong	Name of District to which village belong
Loharu Feeder Length: 97000 CCA:8700 ACRE	H: Badhwana Length = 102500feet CCA = 3529.6 AC	H: Khari Buru RD: = 14000 feet CCA = 1432.4 AC	H : RD 370/R CCA = 145.2 Acre	Charkhi Dadri	Charkhi Dadri	Bhiwani
			T : RD=2000/R CCA = 141.6 AC	Charkhi Dadri	Charkhi Dadri	Bhiwani
		T: Kheri Sanwal RD = 10000 feet CCA = 1049.2 AC	H: RD=4750/L CCA = 104.8 Acre	GHASOLA	Charkhi Dadri	Bhiwani
			T: RD = 8275/L CCA=100 acre	TIKAN	Charkhi Dadri	Bhiwani
	T: Kural Length = 74500 feet CCA = 4090.4AC	H: Kaluwada RD = 9000 feet CCA = 4090.4 AC	H: RD = 6550/L CCA = 87.6	DOHKA HARYA	BADHARA	Bhiwani
			RD=10700 CCA=190Acre	DOHKA HARYA	BADHARA	Bhiwani
		T: Bhariwas RD=10000 feet CCA = 398.4 AC	H: RD = 8000/L CCA = 172.4 acre	LADAWAS	BADHARA	Bhiwani
			T: RD =9200/R CCA = 265 acre	JUI KHURAD	TOSHAM	Bhiwani

CCA in Acres and Lengh or RD 0 to in feet. L: left and R means Right.

NAME OF SELECTED PROJECT IN HARYANA STATE : JIND SYSTEM-WESTERN JAMUNA CANAL SYSTEM, HARYANA

Name of branch with highest CCA and RD	Name of distributaries with highest CCA and RD	Name of minors with highest CCA and RD	Name of outlets with highest CCA and RD	Name of village getting maximum benefit from chosen outlet	Name of Taluka to which village belong	Name of District to which village belong
SUNDAR **SUB-BRANCH,** **CCA=24665ACRS** **LENGTH:121361**	H: KARSOLA Length = 72854feet CCA = 18754 AC	H: JULANA RD: = 20610 feet CCA = 2980 AC	H : RD 10260 CCA = 410 Acre	KARSOLA	JULANA	JIND
			T : RD=20610 TC CCA = 141.6 AC	BRAHMANWAS	JULANA	JIND
		T: KAMAS KHEDA RD = 10250 CCA = 2594 AC	H: RD=6700/L CCA = 472 Acre	BRAHMANWAS	JULANA	JIND
			T: RD = 7700 CCA=1066 acre	KAMASKHEDA	JULANA	JIND
	T: MSL Length = 41000 feet CCA = 7341 ACRE	H: RD 20500 feet CCA = 4090.4 AC	H: RD = 8950/R CCA = 325AC	BACHAPAR	BAS	HISSAR
			H: RD = 15100/L CCA = 438AC	MALVI	JULANA	JIND
		T: RD 41000 FEET	H: RD = 28550/L CCA = 785 acre	SEMAN	MEHAM	ROHTAK
			T: RD =41000/R CCA = 701 acre	SEMAN	MEHAM	ROHTAK

CCA in Acres and Lengh or RD 0 to in feet. L: left and R means Right.

SELECTED SAMPLE UNITS FOR BAL VALLEY PROJECT, HIMACHAL PRADESH (05.05.2008)[1]

Main/branch chosen: Right Bank Canal[2]

Distributary.	Sub-minors	Outlets	Standby Outlets	Villages
HH : D1 - RD 1200 m-CCA 130.8 Ha	H : SM1- (D1-D12)-CCA 61.59 Ha	D3, RD-342m (L-H)-CCA 4.28 Ha	D4,RD-478	**KEHAR**
		D11, RD-1470M (L-T)-CCA 8.64 Ha	D12,RD-1352	**STOH**
	T : SM2- (D1-D28)- CCA 63.696 Ha	D21, RD-530M,CCA 7.2 Ha (R-H)	D22,RD-530/150	**KEHAR**
		D-26,RD-1450M-CCA 7.2 Ha (R-T)	D-27,RD-1330	**STOH**
HT : D2 - RD 4918m-CCA 64.32 Ha	H : SM3- (0-OL5)- CCA 14.88 Ha	OL2-RD-252M (H-L) CCA 2.64 Ha	OL3,RD-416	SAKROHA
		OL4- RD-554M (R-T) CCA 3.68 Ha	OL5,RD-668	SAKROHA
	T : SM4- (OL5-OL19)- CCA 36.76 Ha	OL10, RD-121M (L-H) CCA 2.36 Ha	OL-8,RD-972	**CHATRAUR**
		OL-17, RD150M (L-T) CCA 3.2 Ha	OL-16,RD-390	**CHATRAUR**
TH : D3- (9195-10680)-CCA 95.26 Ha	H : SM5-,Y0-RD 9195m- CCA 26.98 Ha	(Y0-OL3) RD15M /170 CCA 2.72 Ha (H)	OL-2,RD15/0	**CHANDYAL**
		OL4, RD 700M –CCA 5.56 Ha (T)	OL-7,RD-700/180	**CHANDYAL**
	T : SM6- (B0-OL-8)-) CCA 28.36 Ha	OL-3, RD450M –CCA 3.44 Ha (H)	OL-4,RD450/170	RATHOAHA
		OL-8,RD-780M –CCA 3.2 Ha	OL-7,RD-655	RATHOAHA
TT : D4- RD 15065m CCA 57.7 Ha	H : SM7- (L1) RD 535m CCA 14.4 Ha	OL-2- RD CCA 6.4 Ha.	OL-3,RD-535	**BEHNA**
		OL-7, RD 535/130; CCA 4.56 Ha	OL-9,535/95	**BEHNA**
	T : SM8-RD 535m / 0to270 (?) (CCA 13.4 Ha)	OL-7;RD-535/165 ;CCA 4.4 Ha	OL-9,535/50	**BEHNA**
		OL-12,RD-270M – CCA 4.56 Ha	OL-11,RD-195	**BEHNA**

Notes 1. This is a very long piped canal system with branches having low discharges. Branches are, therefore, treated as distributaries. The first column entries refer to 4 Distributaries. The branch questionnaires need not be canvassed for this system.

2. Villages are placed against distributaries to avoid repetition.

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[1] *Data received from Mr. Chaman Lal Saini, Additional AE: M:9418038980; O: 01905-245225.Executive Engineer for this system is Mr. ND Vadiya, M:09418160875.*

[2] *HH(head-head), HT(head-tail), TH(tail-head) and TT(tail-tail) indicate location of a sub-system on the next larger unit in hierarchy of a canal network.*

SELECTED SAMPLE UNITS FOR BHABOUR SAHIB IRRIGATION SYSTEM, HIMACHAL PRADESH

Gravity Main I – back side						
Distributary.	**Minors/Sub-minors**	**Outlets**	**Standby Outlets**	**Villages**	**Notes, if any**	
Head: (RD=0 mt, cca=928 ha)	Directly connected to outlets; so, minors can be ignored	Head: G-2 (RD= 560mt, cca=7.7 ha)	G-3 (RD= 1085mt, cca=6.52 ha)	**BANGASH**		
		Tail: G-9 (RD=1555mt, cca=11ha)	G-8 (RD=1315mt, cca=5.7)	**BANGASH**		
Gravity Main I – Front side						
Head: (RD=1600 mt)	Directly connected to outlets; so, minors can be ignored	Head: G-20 (RD=120mt, cca=5.5ha)	G-21 (RD=450mt, cca=4.5)	**BANGASH**		
		Tail: J-11 (RD=1640mt, cca=8.7ha)	J-12 (RD=1790mt, cca=3.75ha)	**JAKHERA**		
Tail-1: (RD=5035mt)	Directly connected to outlets; so, minors can be ignored	Head: B-36 (RD=345mt, cca=6.45ha)	B-37 (RD=360mt, cca=3.62ha)	**BEHDALA**		
		Tail: B-50 (RD=1990mt, cca=6.48ha)	B-51 (RD=2550mt, cca=5.88ha) (Not Used)	**BEHDALA**		
Tail-2: (RD=6240mt)	Directly connected to outlets; so, minors can be ignored	Head: C-9 (RD=90mt, cca=4.25ha)	C-10 (RD=300mt, cca=7.5ha)	**CHATTARA**		
		Tail: C-26 (RD=1714mt, cca=6.7ha)	C-27 (RD=1875mt, cca=6.5ha)	**CHATTARA**		

Note 1. This system emerges from Nangal Dam on river Satluj. The branch chosen is Gravity Main I with a relatively short backside and a long front side, while Gravity Main II & III are other branches. Given the long stretch of Gravity Main I on the front side, on the one hand, and the need to match the requirement to meet the stipulated number of households for this state as much as possible, three distributaries are selected from the front side of Gravity Main I – one at the head, and two from the tail side.

SELECTED SAMPLE UNITS FOR GIRI (SURFACE) IRRIGATION SYSTEM, HIMACHAL PRADESH(05.05.2008)[3]				
		Left Bank Canal		
Distributaries.	**Minors/Sub-minors**	**Outlets**	**Standby Outlets**	**Villages**
Head: D2[4](RD=8 km, cca=230 ha)	Directly connected to outlets; so, minors can be ignored	Head: OL-5 (RD= 400mt, cca=6.37 ha)	OL-6 (RD 550 mt, cca=4.54 ha)	**Biyas**
		Tail: OL-12 (RD=1600mt)	OL-11 (RD=1780 mt, cca=3.82)	**Biyas**
Tail: D8[5] (RD=22km, cca=165 ha)	Directly connected to outlets; so, minors can be ignored	Head: OL-1 (RD=0mt, cca=4.3ha)	OL-2 (RD=180mt, cca=8.6ha)	**BHUNGRNI**
		Tail: OL-6 (RD=660mt, cca=14.3ha)	OL-7 (RD=810mt, cca=7.5ha)	**BHERWALA**
		Right Bank Canal		
Head: D3[6](RD=4 km, cca=271 ha)	Directly connected to outlets; so, minors can be ignored	Head: OL-2 (RD= 225mt, cca=7 ha)	OL-4 (RD=418mt, cca=5 ha)	**MALIAN**
		Tail: OL-9 (RD=2785mt, cca=6.5ha)	OL-11 (RD=2785mt, cca=6.5)	**Jagatpur**
Tail: D7[7] (RD=7.5km, cca=118 ha)	Directly connected to outlets; so, minors can be ignored	Head: OL-1 (RD=0mt, cca=3ha)	OL-7 (RD=165mt, cca=2.5ha)	**SURJAPUR**
		Tail: OL-15 (RD=810mt, cca=10.8ha)	OL-16 (RD=930mt, cca=3.5ha)	**SURJAPUR**

Notes: 1. This system has two canals – right bank and left bank, both of which are chosen to match the requirement to meet the stipulated number of households for this state as much as possible.

[3] *Data received from Mr. IA Ansari, Additional AE: M:09805298099; O: 01704-222350. Ex. Engineer for this system is Mr. KL Thakur, M:09418467282.*

[4] *Only the right bank is chosen as cca of the right bank is larger than the left bank.*

[5] *Only the right bank is taken as the left one is of equal cca*

[6] *Only the right bank is chosen as cca of the right bank is larger than the left bank.*

[7] *Only the right bank is chosen as cca of the right bank is larger than the left bank*

Jammu & Kashmir

MARWAL LIFT IRRIGATION SCHEME, PALWAMA

Name of Branch with Highest CCA & RD	Name of Distributaries with Highest CCA & RD	Name of Minor with Highest CCA & RD	Name of Outlets with Highest CCA & RD	Name of Villages getting Maximum benefit from chosen outlet	Name of Taluka to village belongs	Name of District to village belongs
Marwal Main Canal Length = 11.5 Km Untimate CCA = 4858 Hects.	Head Regulator = Kadalabal Dist. RD =915 Mts. CCA = 566.80 Hect.	Head Name: Kandizal Minor RD = 915 Mts. CCA =202.42 Hect.		Khidermoh,	Pulwama	Pulwama
				Kandiza	Pulwama	Pulwama
		Tail Name: Command Channel near Pahro RD =1997 Mts. CCA =5633 Acres		Khidermoh	Pulwama	Pulwama
				Kandizal	Pulwama	Pulwama
	Tail Regular: Himchipora Dist./Khul RD= 11.50 Kms. CCA=967.61 Ha.	At Head :- Zintake Barai CCA = 28.34 Ha. RD= 183 Mts		Kaisermullah	Chadoora	Budgam
				Bugam	Chodoora	Budgam

ZAINGEER CANAL , J & K

Name of Branch with Highest CCA & RD	Name of Distributaries with Highest CCA & RD	Name of Minor with Highest CCA & RD	Name of Outlets with Highest CCA & RD	Name of Villages getting Maximum benefit from chosen outlet	Name of Taluka to village belongs	Name of District to village belongs
Distributory- II RD = 32317 Mts. CCA = 840 Mts.	Head Botengo Minor RD =914 Mts.	Janwara Water Course RD = 1850 Mts CCA =212 Ha.	Janwara Bala RD= 50 Mts. CCA= 30 Ha.	Janwara	Sopore	Baramulla
			Janawara Payeen RD = 150 Mts. CCA =35 Ha.	Janwara	Sopore	Baramulla
		Hatlangoo Channel RD =3500 Mts CCA =180 Ha.	Malmapanpora RD = 30 Mts. CCA = 38 Ha.	Malmapanpora	Sopore	Baramulla
			Hatlangoo RD = 220 Mts. CCA = 28 Ha.	Hatlangoo	Sopore	Baramulla
	Nowpora Minor RD= 6402 Mts	Hansi Khul RD= 1230 Mts CCA= 80 Ha.	Nowpora Bala RD = 110 Mts. CCA = 35 Ha. Nowpora Payeen RD = 730 Mts. CCA = 35 Ha.	Nowpora Nowpora	Soporo Soporo	Baramulla Baramulla
		Saif Khul RD= 6102 Mts. CCA=120 Ha.	Mazbugh Bala RD= 89 Mts. CCA= 20 Ha. Budmarg Payeen RD=615 Mts. CCA=42 Ha.	Mazbugh Mazbugh	Sopore Sopore	Baramulla Baramulla

BIST DOAB CANAL DIVISION, JALNDHAR, PUNJAB

Name of Branch with Highest CCA & RD	**Name of Distributaries with Highest CCA & RD**	**Name of Minor with Highest CCA & RD**	**Name of Outlets with Highest CCA & RD**	**Name of Villages getting Maximum benefit from chosen outlet**	**Name of Taluka to village belongs**	**Name of District to village belongs**
Nawanshahar Branch Canal Length = 275.35 Km CCA = 185476 Acres	Phillaur Disty. Off -taking at RD =75000 CCA = 64591 Acres	At Head Jaja Minor Off – taking at RD = 32875/R CCA =1545 Acres	At Head :- No Outlet	N.A	N.A	N.A
			At Tail :- RD = 11000/ TR CCA =866 Acres	Jaja Kalan	Phillaur	Jalandhar
		At Tail Sidhwan Minor Off-taking at RD =85000 CCA =5633 Acres	At Head :- RD = 9080/R CCA = 609 Acres	Nurmahal	Phillaur	Jalandhar
			At Tail :- RD = 28160/L CCA = 559 Acres	Sidhwan (***DEAD***)	Nakodar	Jalandhar
	Apra Disty. off-taking at RD= 31500 CCA = 14890 Acres	At Head :- No Minor	At Head :- RD = 500/R CCA = 213 Acres	Mahi Ditta	Nawanshahar	Nawanshahar
		At Tail No minor	At tail :- RD = 6500/R CCA = 545 Acres	Pragpur	Nawanshahar	Nawanshahar

SIRHIND CANAL CIRCLE, LUDHIANA, PUNJAB

Name of Branch with Highest CCA & RD	**Name of Distributaries with Highest CCA & RD**	**Name of Minor with Highest CCA & RD**	**Name of Outlets with Highest CCA & RD**	**Name of Villages getting Maximum benefit from chosen outlet**	**Name of Taluka to village belongs**	**Name of District to village belongs**
Bathinda Branch Canal Length = 131.10 Km CCA = 774970 Acres	At Head :- Raikot Disty. Off -taking at RD = 127500/R CCA = 30503 Acres	At Head: Jatpura Minor Off – taking at RD = 36780/R CCA =3930 Acres	At Head :- RD =21495/L CCA= 843 Acres	Bassian	Jagraon	Ludhiana
			At Tail :- RD = 32198/ R CCA =769 Acres	Jatpura	Jagraon	Ludhiana
		At Tai Khai Minor Off-taking at RD =139510/R CCA =2360 Acres	At Head :- RD = 5000/R CCA = 423Acres	Gaziana (***DEAD***)	Nihalsingh Wala	Moga
			At Tail :- RD = 14156/TL CCA = 1309 Acres	Dina (***DEAD***)	Nihalsingh Wala	Moga
	At Tail :- Teona Disty. off-taking at RD= 447800/L CCA = 20122 Acres	At Head :- Doomwali Minor Off takes at RD = 13496/R CCA= 21495 Acres	At Head :- RD = 8712/R, CCA = 971 Acres	Ghudo	Bathinda	Bathinda
			At tail :- RD = 79000/R , CCA = 545 Acres	Doomwali	Bathinda	Bathinda
		At Tail Gumiara minor Off takes at RD= 105500/L CCA= 3065 Acres	At Head :- RD = 8080/L, CCA = 687 Acres	Ghumiara	Malout	Mukatsar
			At tail :- RD = 14291/TF , CCA = 693 Acres	Fatta Kera	Malout	Mukatsar

UPPER BARI DOAB CANAL (UBDC) CIRCLE, AMRITSAR, PUNJAB

<table>
<tr><th>Name of Branch with Highest CCA & RD</th><th>Name of Distributaries with Highest CCA & RD</th><th>Name of Minor with Highest CCA & RD</th><th>Name of Outlets with Highest CCA & RD</th><th>Name of Villages getting Maximum benefit from chosen outlet</th><th>Name of Taluka to village belongs</th><th>Name of District to village belongs</th></tr>
<tr><td rowspan="8">Sabraon Branch

Length = 78.78Km

CCA = 307722 Acres</td><td rowspan="4">At Head :-
Riarki Disty.
Off -taking at
RD = 33950 /L
CCA = 18061
Acres</td><td rowspan="2">At Head: Bhagtupur Minor
Off – taking at
RD = 7300/R, CCA =6685 Acres</td><td>At Head :- RD =5870/R
CCA= 231 Acres</td><td>Harchowal</td><td>Batala</td><td>Gurdaspur</td></tr>
<tr><td>At Tail :- RD = 47858/ TL
CCA =407Acres</td><td>Barrar
Nandwala
Balrampur</td><td>Batala (DEAD)</td><td>Gurdaspur</td></tr>
<tr><td rowspan="2">At Tail; Chaochak Minor
Off-taking at
RD = 32175/R, CCA = 5553 Acres</td><td>At Head :- RD = 2830/R
CCA = 555Acres</td><td>Mari Panwan</td><td>Batala</td><td>Gurdaspur</td></tr>
<tr><td>At Head :- RD = 35386/TL
CCA = 771 Acres</td><td>Dakoha</td><td>Batala (DEAD)</td><td>Gurdaspur</td></tr>
<tr><td rowspan="4">At Tail :-
Patti Disty.
off-taking at
RD= 199200/R
CCA = 23877 Acres</td><td rowspan="2">At Head :- Usman Minor
Off takes at
RD =36855/R, CCA= 9595 Acres</td><td>At Head :- RD = 26969/R
CCA = 535 Acres</td><td>Banwalipur</td><td>Tarntaran (DEAD)</td><td>Tarntaran</td></tr>
<tr><td>At tail :- RD = 26900/L
CCA =951Acres</td><td>Nowshehra Pannuan</td><td>Tarntaran (DEAD)</td><td>Tarntaran</td></tr>
<tr><td rowspan="2">At Tail:- Patti Chownki minor
Off takes at
RD= 111492/R, CCA= 2014 Acres</td><td>At Head :- RD = 7685/R
CCA = 257 Acres</td><td>Patti</td><td>Tarntaran (DEAD)</td><td>Tarntaran</td></tr>
<tr><td>At tail :- RD = 9712 / TL
CCA = 309Acres</td><td>Batho Bhaini</td><td>Tarntaran (DEAD)</td><td>Tarntaran</td></tr>
</table>

FEROZEPUR CANAL CIRCLE, FEROZEPUR, PUNJAB

Name of Branch with Highest CCA & RD	Name of Distributaries with Highest CCA & RD	Name of Minor with Highest CCA & RD	Name of Outlets with Highest CCA & RD	Name of Villages getting Maximum benefit from chosen outlet	Name of Taluka to village belongs	Name of District to village belongs
Sirhind Feeder Length = 136.56 Km CCA = 57150 Acres	At Head :- Kasubegu Disty. Off -taking at RD = 68783/R CCA = 12758 Acres	At Head: Sappanwali Minor Off – taking at RD = 24515 /L CCA =12824 Acres	At Head :- RD =800/R CCA= 145 Acres	Badni Gulab Singh	Ferozepur	Ferozepur
			At Tail :- RD = 59000/ TF CCA =238 Acres	Gulam Patra	Ferozepur	Ferozepur
		At Tail: Mehma Minor Off-taking at RD =83400 /L CCA =1866 Acres	At Head :- RD = 180 /R CCA = 56 Acres	Nasira Khilchi	Ferozepur	Ferozepur
			At Tail :- RD = 14500 /TF CCA = 467 Acres	Arian Wala Khurd & Chak Sadhu Wala	Ferozepur	Ferozepur
	At Tail :- Lambi Disty. off-taking at RD= 386332/R CCA = 1118 Acres	At Head :- Meeharajpur Minor Off takes at RD = 10867/R CCA= 15931 Acres	At Head :- RD = 1917 /R CCA = 1251 Acres	Sehna Khera	Malout	Mukatsar
			At tail :- RD = 47885 CCA = 1298 Acres	Sitoguno	Abohar	Ferozepur
		At Tail Tarmala minor Off takes at RD= 37227/R CCA= 11695 Acres	At Head :- RD = 1268 /R CCA = 529 Acres	Phittiwal	Malout	Mukatsar
			At tail :- RD = 53130/L CCA = 718 Acres	Bishanpura	Abohar	Ferozepur

FEROZEPUR CANAL CIRCLE, FEROZEPUR

EASTERN CANAL SYSTEM :-

Name of Branch with Highest CCA & RD	**Name of Distributaries with Highest CCA & RD**	**Name of Minor with Highest CCA & RD**	**Name of Outlets with Highest CCA & RD**	**Name of Villages getting Maximum benefit from chosen outlet**	**Name of Taluka to village belongs**	**Name of District to village belongs**
MAIN BRANCH	At Head :- Nizamwah Disty.. Off -taking at RD = 88370/R CCA = 18216 Acres	At Head: Nidhana Minor Off – taking at RD = 30345 /R CCA =3097 Acres	At Head :- RD =2660/R CCA= 741 Acres	Bhungi Bhora	Guru Harshai	Ferozepur
			At Tail :- RD = 17600 /TR CCA =250 Acres	Sarupewala Guru Harshai	Guru Harshai	Ferozepur
		At Tail: Barkatwah Minor Off-taking at RD =78385 /R CCA =8422 Acres	At Head :- RD = 1684/R CCA = 201Acres	Dhab Gharial	Jallalabad	Ferozepur
Length = 55.37 Km			At Tail :- RD = 58915/TL CCA = 486 Acres	Khudwala Sanian	Jallalabad	Ferozepur
	At Tail :- Southern Disty. off-taking at RD= 239000 /L CCA = 9541Acres	At Head :- Hiranwali Minor Off takes at RD = 28700 /R CCA= 1686 Acres	At Head :- RD = 509/R CCA = 202 Acres	Tahliwala Bodala	Fazilka	Ferozepur
CCA = 27757 Acres			At tail :- RD = 19120/R CCA = 230 Acres	Sajarana	Fazilka	Ferozepur
		At Tail: New Lakheke minor Off takes at RD= 75500 /L CCA= 3795 Acres	At Head :- RD = 1000 /L CCA = 160 Acres	Kabulshah Dhab	Fazilka	Ferozepur
			At tail :- RD = 24125/TF CCA = 435Acres	Kheowali	Fazilka	Ferozepur

BAHKRA MAIN LINE CIRCLE, PATIALA

<table>
<tr><th>Name of Branch with Highest CCA & RD</th><th>Name of Distributaries with Highest CCA & RD</th><th>Name of Minor with Highest CCA & RD</th><th>Name of Outlets with Highest CCA & RD</th><th>Name of Villages getting Maximum benefit from chosen outlet</th><th>Name of Taluka to village belongs</th><th>Name of District to village belongs</th></tr>
<tr><td rowspan="8">BAHKRA MAIN LINE

Length = 161.40 Km

CCA = 560936 Acres</td><td rowspan="4">At Head :-

Govindgarh Disty.

Off -taking at

RD = 58270/R

CCA = 14692 Acres</td><td rowspan="2">At Head: Bhamian Minor

Off – taking at

RD = 5515 /R

CCA =8087 Acres</td><td>At Head :- RD =2575 /L

CCA= 304 Acres</td><td>PremPura</td><td>Khamano</td><td>Fatehgarh Sahib</td></tr>
<tr><td>At Tail :- RD = 32110 /TL

CCA =903 Acres</td><td>Dulwana</td><td>Khamano</td><td>Fatehgarh Sahib</td></tr>
<tr><td rowspan="2">At Tail

No Minor off –takes in tail reach. Hence Directly Two Outlets from Disty. has been selected</td><td>At Head:- RD = 6530/R

CCA = 760 Acres</td><td>Latheri</td><td>Chamkaur Sahib</td><td>Ropar</td></tr>
<tr><td>At Tail :- RD = 72500 /L

CCA = 947 Acres</td><td>Kotla Dadheri</td><td>Gobindgarh</td><td>Fatehgarh Sahib</td></tr>
<tr><td rowspan="4">At Tail :-

Samrala Major & Samrala Disty.

off-taking at

RD= 58970 /R

CCA = 8897Acres</td><td rowspan="2">At Head :- Kokrala Minor

Off takes at

RD = 23000 /R

CCA= 4060 Acres</td><td>At Head :- RD = 3500 /R

CCA = 364 Acres</td><td>Nanowal</td><td>Khamano</td><td>Fatehgarh Sahib</td></tr>
<tr><td>At tail :- RD = 35000/R

CCA = 564 Acres</td><td>Todarpur</td><td>Samrala</td><td>Ludhiana</td></tr>
<tr><td rowspan="2">At Tail:- Pial minor

Off takes at

RD= 53300 /L

CCA= 7699 Acres</td><td>At Head :- RD = 31000 /R
CCA = 774 Acres</td><td>Loopahon</td><td>Samrala</td><td>Ludhiana</td></tr>
<tr><td>At tail :- RD = 58505/TR
CCA = 554Acres</td><td>Gobindpura</td><td>Pial</td><td>Ludhiana</td></tr>
</table>

Name of selected project in Rajashthan State: Baretha Bandh

Name of branch with highest CCA and RD	**Name of distributaries with highest CCA and RD**	**Name of minors with highest CCA and RD**	**Name of outlets with highest CCA and RD**	**Name of village getting maximum benefit from chosen outlet**	**Name of Taluka to which Village belong**	**Name of District to which village belong**
Name: Main Canal Length: 6550 m CCA: (1500 Ha.)	**Head:** **Mehmadpura** **Distributary,** **RD 1958 m, CCA (453.87 Ha)**	**Head:** **Direct to Outlet**	**1-R Mahmadpura, RD (517m), CCA 14.165 Ha**	**Mahmadpura**	Bayana	Bharatpur
		Tail: **Barakhamba sub-minor, RD (1950 m), CCA (157.19 Ha.)**	**Head: :** **OL-1 & 2 R, RD (810 m), CCA 20 ha**	**Mahmadpura**	Bayana	Bharatpur
			Tail: OL-5R, RD (1785 m), CCA 38 ha	**Mahmadpura**	Bayana	Bharatpur
	Tail : **Direct to outlet**	**Direct to outlet**	**Head: Name, RD & CCA: 12-L of main canal 1, RD (3090 m), CCA 54 ha**	**Mahmadpura**	Bayana	Bharatpur
			Tail: 25-R of main canal no 1, RD (6550 m) **CCA 101 ha**	**Khatka**	Bayana	Bharatpur

Name of selected project in Rajashthan State: Sidhmukh Nahar*

<table>
<tr><th>Name of branch with highest CCA and RD</th><th>Name of distributaries with highest CCA and RD</th><th>Name of minors with highest CCA and RD</th><th>Name of outlets with highest CCA and RD</th><th>Name of village getting maximum benefit from chosen outlet</th><th>Name of Taluka to which Village belong</th><th>Name of District to which village belong</th></tr>
<tr><td rowspan="4">No Branch</td><td rowspan="4">Head:
Raslana
Branch canal
Length: 64.1km
Length: 64.1km</td><td rowspan="2">Head:
Dobi Minor, RD 5.508 km, CCA 3438 ha</td><td>Head: 1 DBM, CCA 301.63 ha</td><td>Amarpura</td><td>Ajitpura</td><td>Hanumangarh</td></tr>
<tr><td>Tail: 9 DBM, RD 13.4 km, CCA 378.6 ha</td><td>Dobi</td><td>Badra</td><td>Hanumangarh</td></tr>
<tr><td rowspan="2">Tail:
Badbirana, RD 46.8 km, CCA 3962 ha</td><td>Head: 1-2 BDRM, CCA 274.8 ha</td><td>Lalana</td><td>Nohar</td><td>Hanumangarh</td></tr>
<tr><td>Tail: 13 BDRM, CCA 368 ha</td><td>Badbirana</td><td>Nohar</td><td>Hanumangarh</td></tr>
</table>

- *Sidhmukh Nahar is fed from two points. Both from Punjab (BML) via Haryana. This project is located mostly in Hanumangarh district.*

Name of selected project in Rajashthan State: Sardar Samand Project, Pali

Name of branch with highest CCA and RD	**Name of distributaries with highest CCA and RD**	**Name of minors with highest CCA and RD**	**Name of outlets with highest CCA and RD**	**Name of village getting maximum benefit from chosen outlet**	**Name of Taluka to which Village belong**	**Name of District to which village belong**
Name: L B Canal Length: 7.50 km CCA:9240.23 ha	**Head:** **Linked directly to Minors**	**Head:** **Mandali Minor, km, CCA 851.08 ha**	**Head: Ch 40 R**	**Jhintra**	**Rohat**	Pali
			Tail: Ch 115 R	Mandali Darjeeyan	**Rohat**	Pali
		Tail: **Dhabar Canal, CCA 2072.20 ha**	**Head:** **22.00R, RD 0.67 km, CCA 130.00 ha**	Mandali Darjeeyan	**Rohat**	Pali
			Tail: **290.60L, RD 8.86 km, CCA 124 ha**	Dhabar	**Rohat**	Pali

Name of selected project in Rajashthan State: Chhapi

Name of branch with highest CCA and RD	Name of distributaries with highest CCA and RD	Name of minors with highest CCA and RD	Name of outlets with highest CCA and RD	Name of village getting maximum benefit from chosen outlet	Name of Taluka to which Village belong	Name of District to which village belong
Name: Right Main Canal Length: 24.43km CCA: 6616 ha	**Head:** **Directly connected to Minors**	**Head:** Naya Gaon Minor, RD 1.65 km, CCA (155.5 Ha)	**Head: H-1, RD (90 m) & CCA** (32 Ha)	Dalanpur	Akelera	Jhalavad
			Tail: T-1, RD (2400) & CCA (80 Ha)	Naya gaon	Akelera	Jhalavad
		Tail: Amritkheri Minor-I, RD 16.41 km, CCA (189.41 Ha)	**Head: Name** (R1)**, RD** (210 m) **& CCA** (23.57 Ha)	Amrit kheni	Akelera	Jhalavad
			Tail: Name (Tail)**, RD** (2205) **& CCA** (37.91 Ha)	Bilonia	Akelera	Jhalavad
	Tail: Name, RD & CCA **Aklera,** **19422 m,** **5738.64 A,** **Length: 24.403 km**	**Head** **Directly to outlets**	**Head: ADL-5, RD 3920m,CCA 95.42 ACR**	Kharpa	Akelera	Jhalavad
			Tail: ADL-11, RD-6930M,	Richhwa	Akelera	Jhalavad
		Tail: **Patanuda, CCA 1521.90 ACR**	**Head: Name (PR1), RD (450 m) & CCA (59.97)**	Richhwa	Akelera	Jhalavad
			Tail: Name (P tail), RD (3450 m) & CCA (37.94 Ha)	Patanuda	Akelera	Jhalavad

Name of selected project in Rajashthan State: West Banas

Name of branch with highest CCA and RD	**Name of distributaries with highest CCA and RD**	**Name of minors with highest CCA and RD**	**Name of outlets with highest CCA and RD**	**Name of village getting maximum benefit from chosen outlet**	**Name of Taluka to which Village belong**	**Name of District to which village belong**
Name: Right Branch Canal Length: (34.74 Km.) CCA: 16318 A	**Directly to minors**	**Head: Achpura, RD 13.98 km, CCA 1570 ACR**	**Head: 1L** **RD-900m, CCA 484 ACR**	Achpura	Pindwada	Sirohi
			Tail: Last Tail R **RD 3840m, CCA 421 ACR**	Sangwara	Pindwada	Sirohi
		Tail: **Moongthala, RD 29280 m, CCA 1295 ACR**	**Head: 2L** **RD 1065 m, CCA 123 ACR**	Ganka	Abu Road	Sirohi
			Tail: Tail Last **RD 3420m, CCA 256 ACR**	Talvar Ka Naka	Abu Road	Sirohi

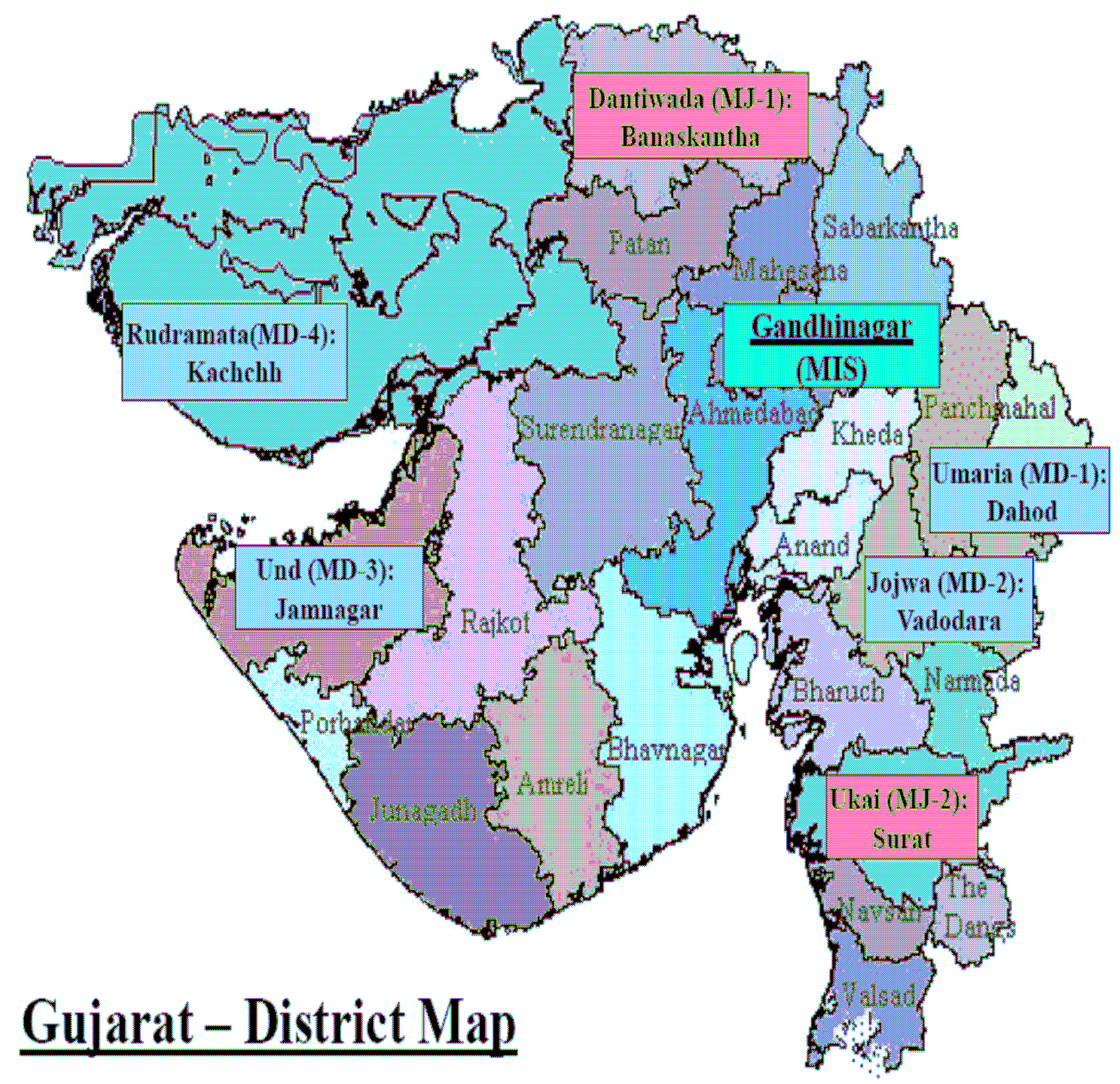
Name of selected project in Rajashthan State: Parwati Canal Systm

Name of branch with highest CCA and RD	**Name of distributaries with highest CCA and RD**	**Name of minors with highest CCA and RD**	**Name of outlets with highest CCA and RD**	**Name of village getting maximum benefit from chosen outlet**	**Name of Taluka to which Village belong**	**Name of District to which village belong**
Name: Rajwah Branch Length: 11.887 km CCA:4000 ha	**Directly connected to Minors**	**Head:** **Dhakra, RD 6.67km, CCA 418 Ha**	**Head: RD** **Ch-40,**	Patheda	Baran	Baran
			Tail: RD **Ch-220,**	Nareda	Baran	Baran
		Tail: Kodiya Wali, RD 11.77km, CCA 388 Ha	**Head: RD** **Ch-8,**	Fatehpur	Baran	Baran
			Tail: RD **Ch-190,**	Raroti	Baran	Baran

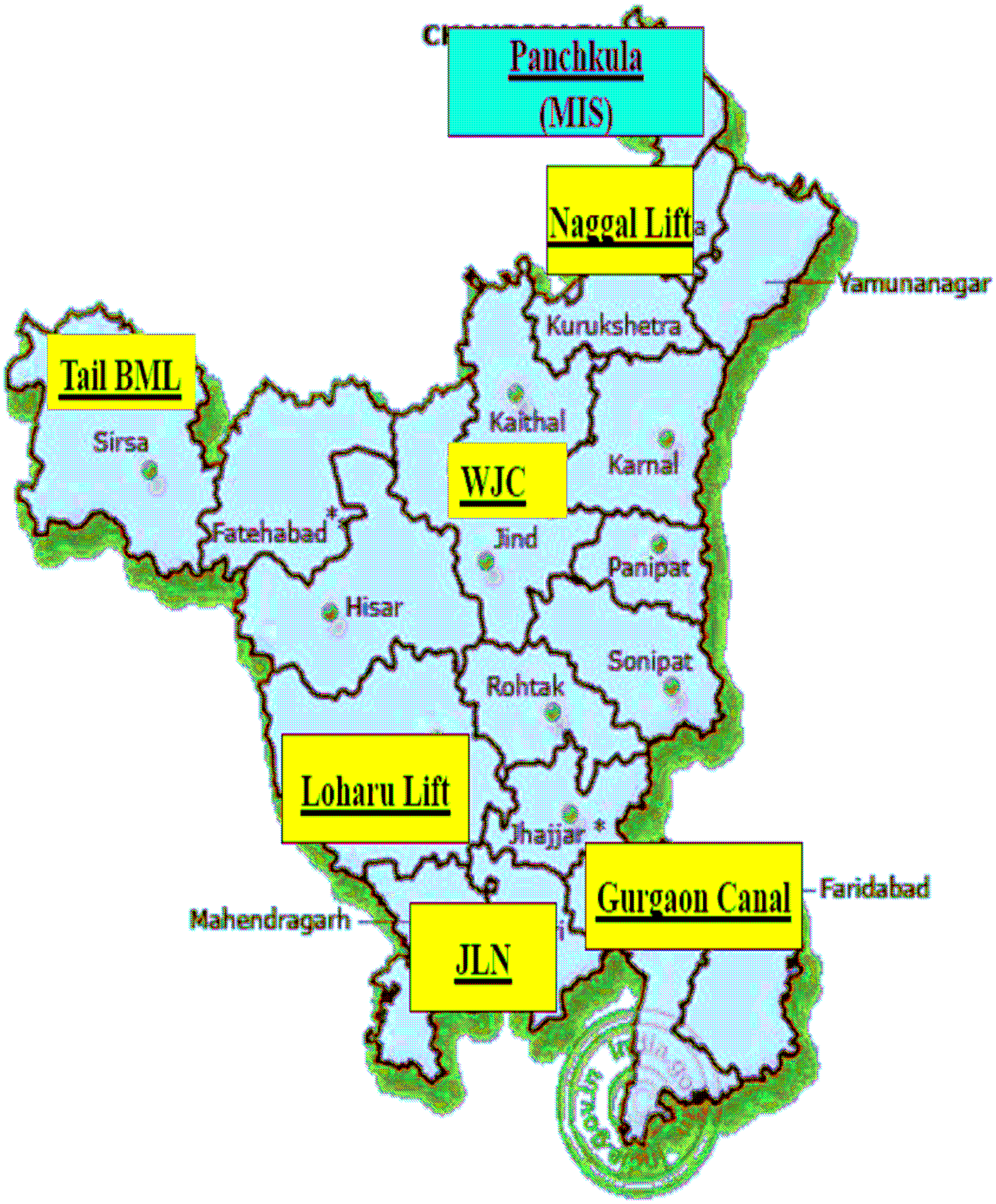
ANNEXURE 4

Annexure 4

Selected Projects, Gujarat

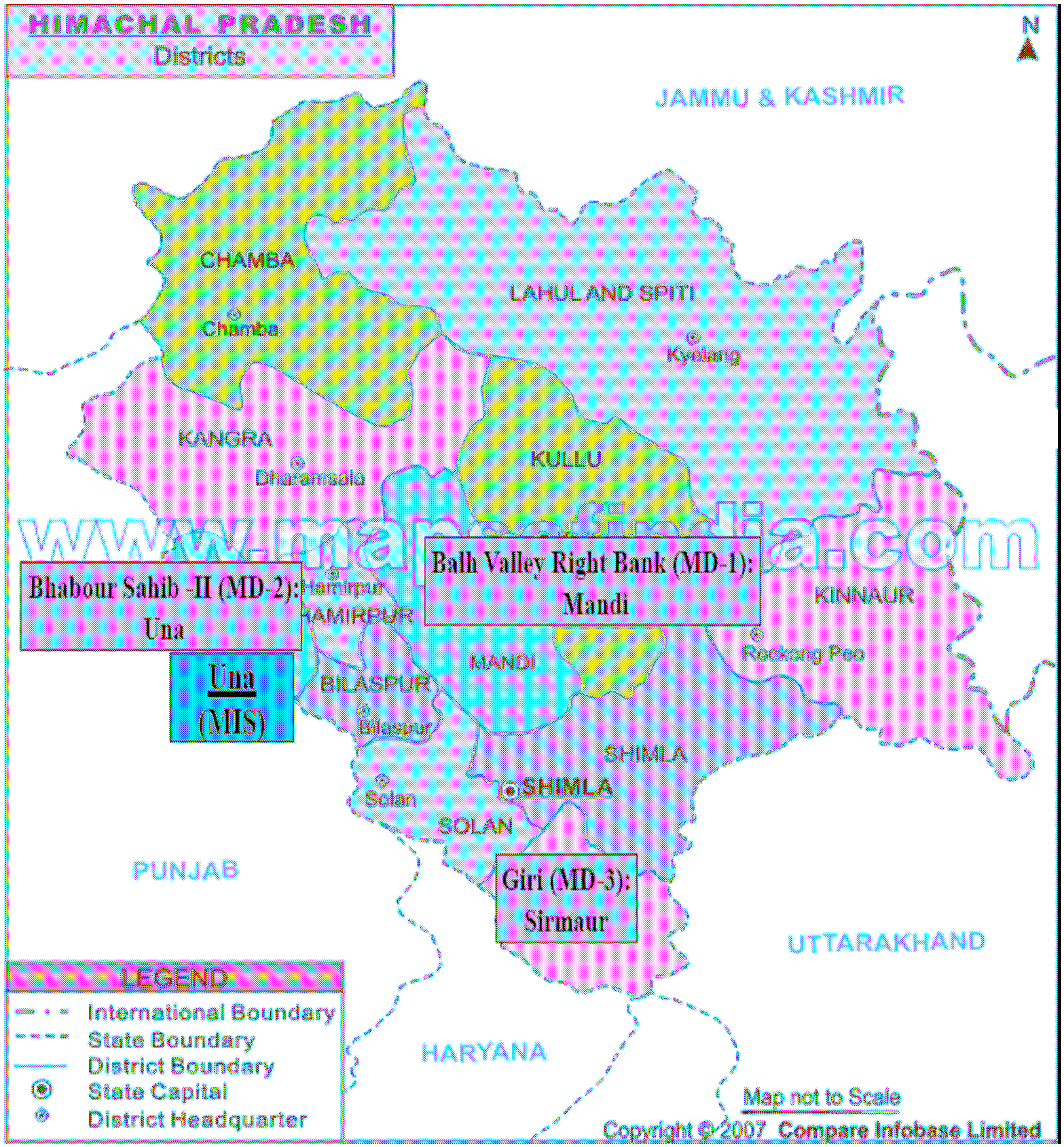


Selected Projects, Haryana

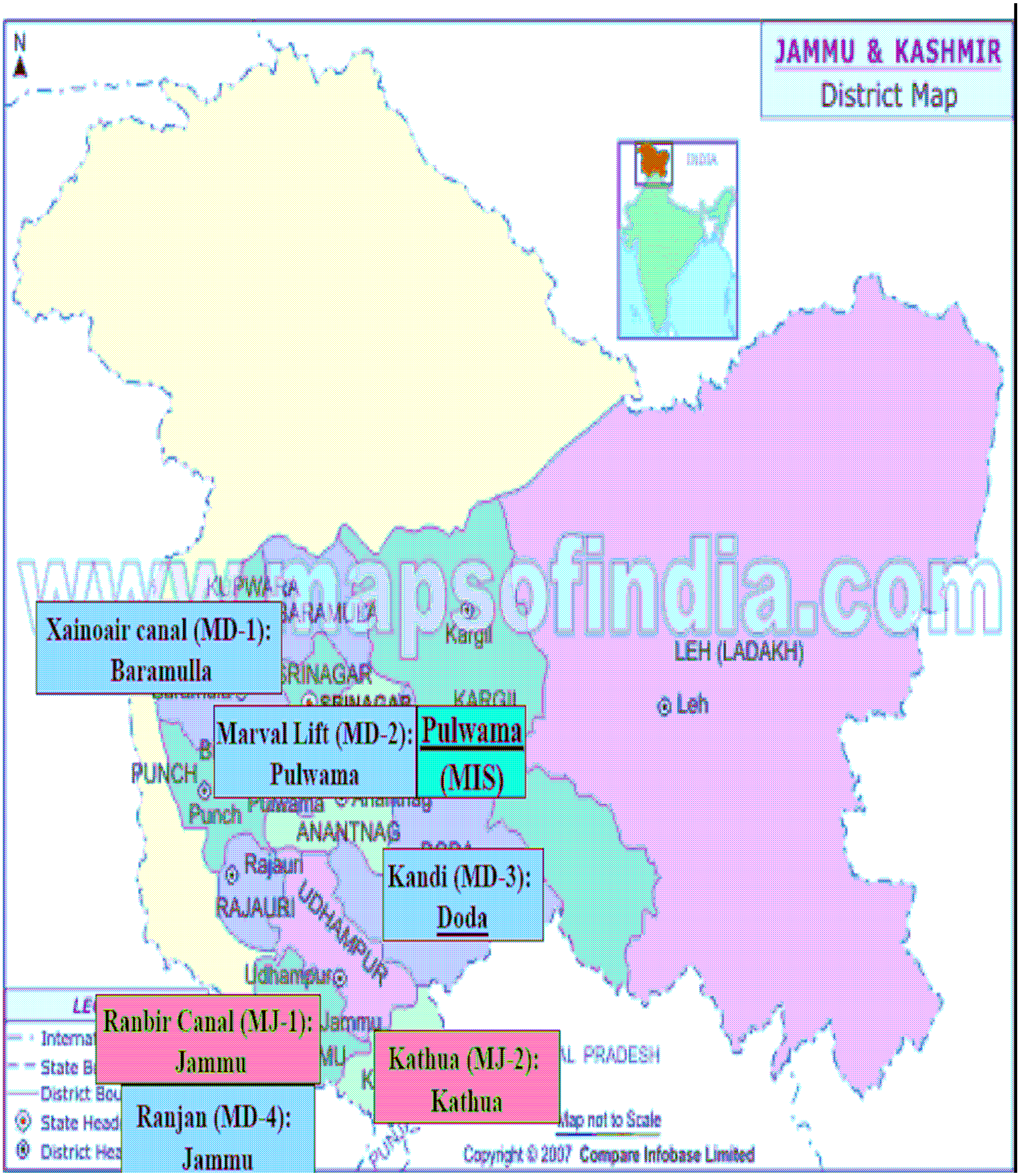


Haryana – District Map

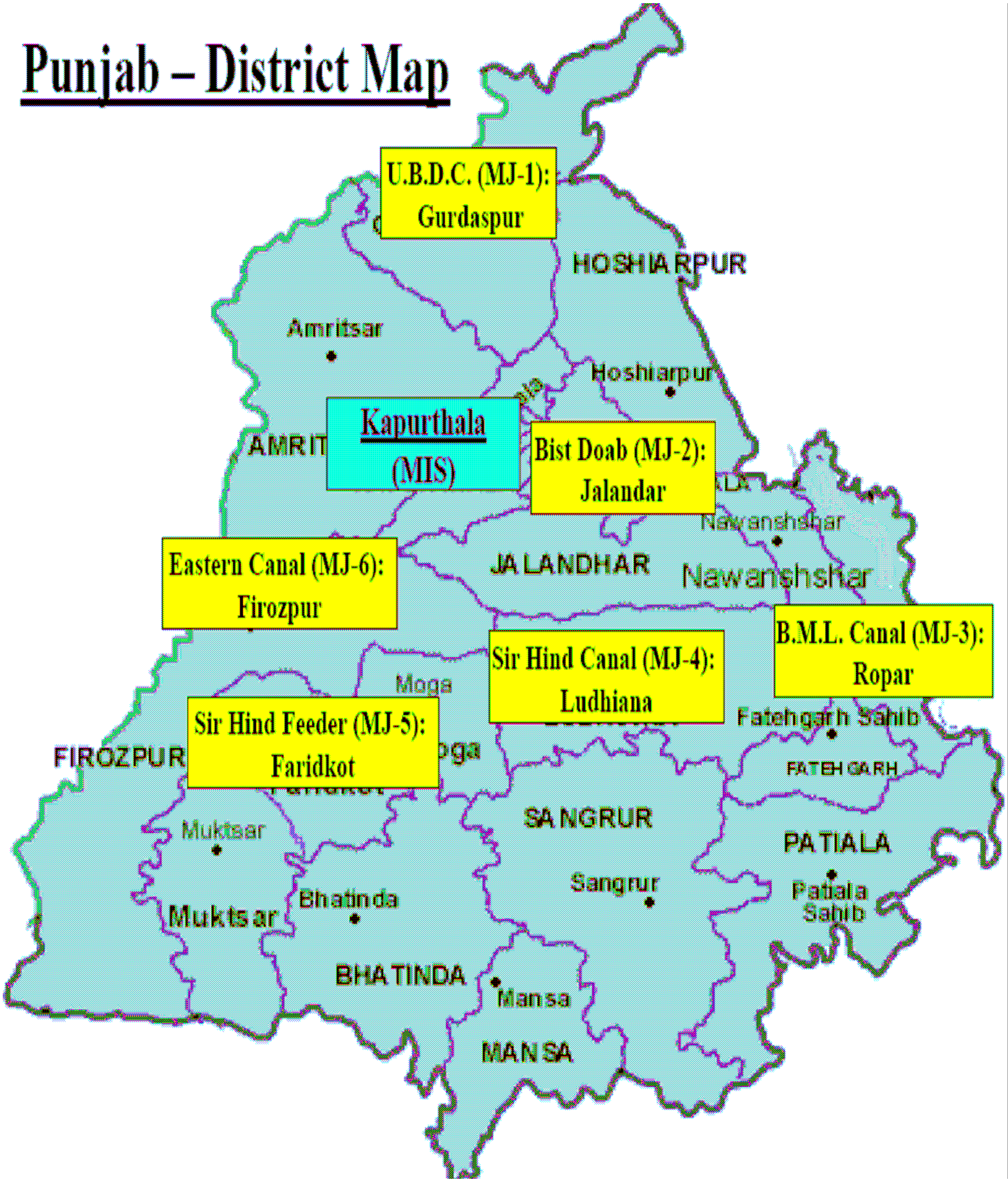
Selected Projects, Himachal Pradesh



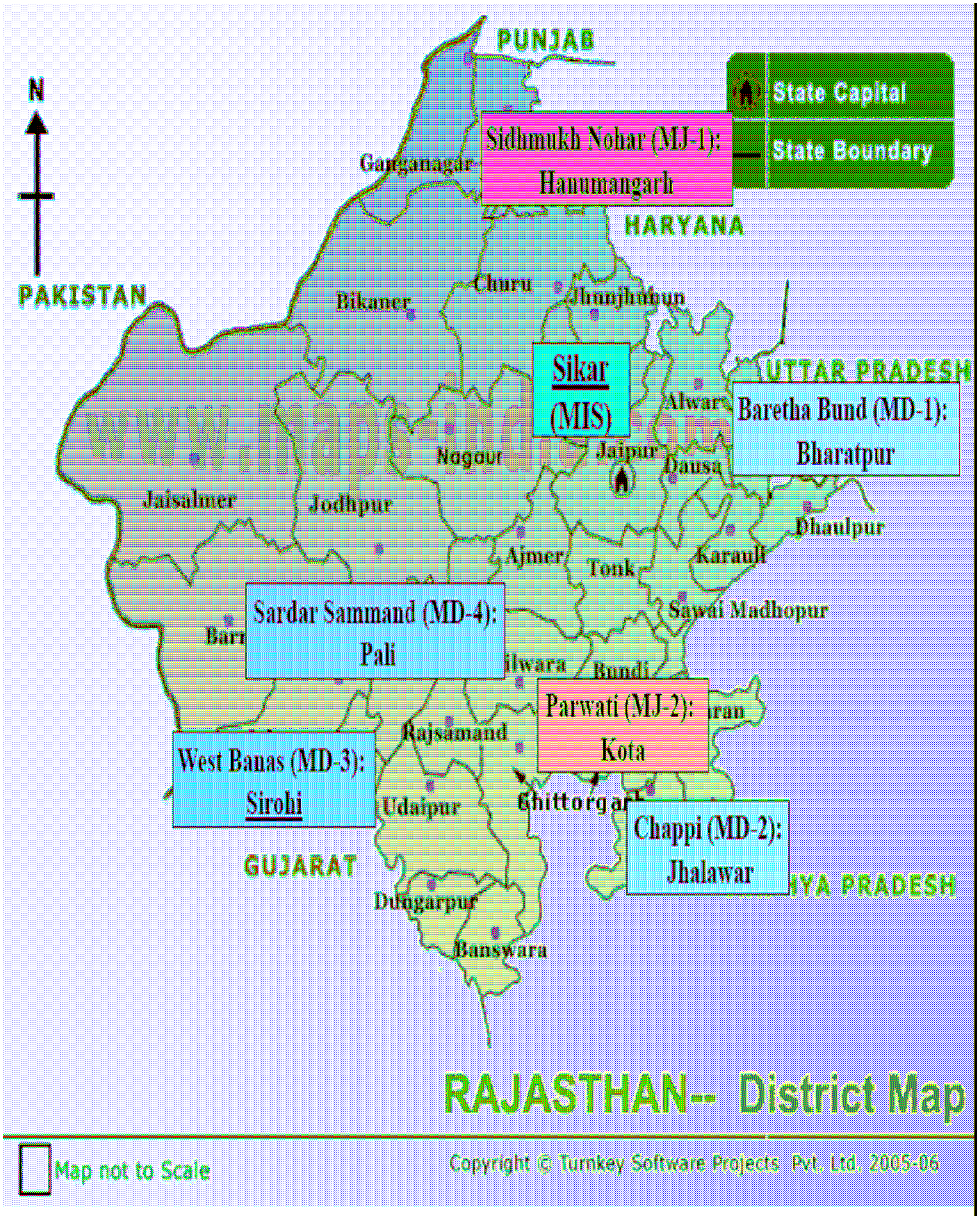
Selected Projects, J & K



Selected Projects, Punjab



Selected Projects, Rajasthan



ANNEXURE 5

Annexure 5

Details of secondary data collection

Code	State	Total Number	Data received	Last date of data received	Computerization	Partially processed till (15th Aug, 2008)
1.	Chandigarh	NAP	NAP	NAP	NAP	NAP
2.	Dadra & Nagar Havalli	1	1	09-10-2007	14-10-2007	1
3.	Delhi	NAP	NAP	NAP	NAP	NAP
4.	Gujarat	161	151	19-04-2008	25-04-2008	**173**
5.	Haryana	4	0	NAV	NAV	NAV
6.	HP	3	3	06-10-2007	16-10-2007	3
7.	J & K	9	9	18-10-2007	22-10-2007	9
8.	Punjab	7	6	04-05-2007	05-05-2007	6
9.	Rajasthan	113	100	05-10-2007	15-10-2007	100

ANNEXURE 6

Annexure 6

Status of primary data collection (as on 15/08/2008)

Total schedules canvassed till date

Code	State	I	II	III	IV	V	VIA	VIB	VII
1.	Chandigarh	NAP	NAP	NAP	NAP	NAP	NAP	2 (16/06/08)	48 (16/06/08)
2.	Dadra & Nagar Havalli	1 (24/04/08)	2 (24/04/08)	4 (24/04/08)	7 (24/04/08)	14 (24/04/08)	9 (24/04/08)	9 (28/04/08)	118 (28/04/08)
3.	Delhi	NAP	NAP	NAP	NAP	NAP	NAP	3 (08/07/08)	49 (08/07/08)
4.	Gujarat	6 (13/05/08)	6 (13/05/08)	8 (13/05/08)	24 (13/05/08)	47 (13/05/08)	30 (13/05/08)	29 (18/07/08)	406 (18/07/08)
5.	Haryana	6 (08/03/08)	6 (08/03/08)	12 (08/03/08)	19 (08/03/08)	40 (08/03/08)	28 (08/03/08)	31 (26/06/08)	439 (26/06/08)
6.	HP	3 (28/04/08)	5 (28/04/08)	12 (28/04/08)	8 (28/04/08)	32 (28/04/08)	17 (28/04/08)	19 (17/06/08)	438 (17/06/08)
7.	J & K	-	-	-	-	-	-	-	-
8.	Punjab	6 (19/04/08)	6 (19/04/08)	12 (19/04/08)	24 (19/04/08)	48 (19/04/08)	48 (19/04/08)	48 (05/07/08)	416 (05/07/08)
9.	Rajasthan	6 (29/04/08)	5 (29/04/08)	3 (29/04/08)	12 (29/04/08)	29 (29/04/08)	25 (29/04/08)	28 (12/07/08)	432 (12/07/08)

Total schedules received till: 15.08.2008

Code	State	I	II	III	IV	V	VIA	VIB	VII
1.	Chandigarh	NAP	NAP	NAP	NAP	NAP	NAP	2 (29/06/08)	48 (29/06/08)
2.	Dadra & Nagar Havalli	NAV	NAV	NAV	NAV	NAV	NAV	9 (28/04/08)	118 (28/04/08)
3.	Delhi	NAP	NAP	NAP	NAP	NAP	NAP	3 (28/07/08)	49 (28/07/08)
4.	Gujarat	6 (05/08/08)	6 (05/08/08)	8 (05/08/08)	24 (05/08/08)	47 (05/08/08)	30 (05/08/08)	29 (15/07/08)	406 (15/07/08)
5.	Haryana	NAV	NAV	NAV	NAV	NAV	NAV	31 (29/06/08)	439 (29/06/08)
6.	HP	NAV	NAV	NAV	NAV	NAV	NAV	19 (24/06/08)	438 (24/06/08)
7.	J & K	-	-	-	-	-	-	-	-
8.	Punjab	2 18/07/08	2 18/07/08	4 18/07/08	4 18/07/08	8 18/07/08	12 18/07/08	48 (16/07/08)	416 (16/07/08)
9.	Rajasthan	NAV	NAV	NAV	NAV	NAV	NAV	28 (16/07/08)	432 (16/07/08)

ANNEXURE 7

Annexure 7.1

Finalized Minutes of 1st Brain-storming Session on 'Studying Gap between Irrigation Potential Created and Utilized'

Venue: IIM, Ahmedabad. Seminar Room No. 5
Date: 14th September, 2007
Time: - 2.30 pm. to 6.00 pm

The meeting was held under the chairmanship of Mr. S. K. Das, former Chairman, Central Water Commission (CWC), New Delhi. A list of participants is given below.

Professor S. K. Datta welcomed from IIMA side all the participants, who could make it convenient to attend this meeting in spite of a very short notice. He expressed his deep gratitude to Mr. S. K. Das, who agreed to act as a national expert to guide the IIMA study team and chair this first brain-storming session. He told the gathering that he had extended invitation to all known official and non-official participants in the states of Gujarat and Rajasthan and the union territory of Dadra and Nagar Haveli, considering their proximity. He expressed the fear that probably due to very short notice, the invitees from Rajasthan and Dadra and Nagar Haveli could not attend the meeting. However, he expressed the hope that this initial brain storming session with a small gathering could still be a useful starting point, which he would like to pursue further through a second brain storming session he wants to hold at MoWR, New Delhi on 21st of this month with the help of participants from other States/UTs and the Central Ministry itself.

The deliberations started with a brief power point presentation by Prof. Milindo Chakravati who posed the problem of a widening gap between irrigation potential created and utilized in this country since 1950, using data and graphs provided by MoWR. He wondered whether such a gap was normal like a percentage buffer, or whether it was because of overstatement of potential created or understatement of potential utilized or both. He pointed out that the aim of the study was to identify the reasons behind the observed gap and provide a road map of measures to minimize that gap. He sought the cooperation and help from the participants in coming out with correct and operationally meaningful definitions of the terms used in collecting and reporting of data by the Government authorities, besides seeking suggestions on how to get a reasonable amount of secondary data from Government Departments and how to draw a sample of irrigation projects as per the Ministry stipulations to collect primary data for this study. He displayed in his presentation wide divergence in data as reported by the Ministries of Irrigation and agriculture, on the one hand, and those by the Planning Commission and NRSA's satellite data, on the other. He sought help of the group in suitably estimating the 'engineering' concept of supply of irrigation in terms of water availability and potential commend area created, while differentiating this 'engineering' concept of supply irrespective of price paid by the users of irrigation water from supply and demand for irrigation water against a price by the farmers at his door steps. He argued that through identification of various parameters determining these three concepts he hoped to bring out various policy measures to minimize this gap. Against this background the participants provided the followings clues:

1. Command area is decided by the engineers on the basis of availability of water on the one hand and the designated cropping pattern as suggested by the Ministry of Agriculture on the other. Since major and medium irrigation project takes several years for construction of the necessary irrigation channels and water delivery system, Irrigation Potential Created (IPC) cannot reach the ultimate irrigation potential level before full completion of an irrigation project. Since cropping pattern changes over time in response to the market situation, IPC ought to undergo revision every 5-10 years, which it does not. Moreover, since no irrigation system can work on 100% capacity, that factor too needs to be taken into consideration.

2. While reporting IPC, MoWR considers all small, medium and major projects, but the Ministry of Agriculture does not include irrigation provided by the private wells as part of Irrigation Potential Utilized (IPU), while the entire minor irrigation system is captured by satellite data.

3. Supply of irrigation to the farmers at his doorsteps is not merely dependent on the price he pays (often subsidized) and modality of pricing (e.g., whether on cropping pattern basis or on volumetric basis), but also on whether or not the delivery system including field channels to be constructed by the farmers themselves, are properly constructed and maintained. The quality of construction work has also important bearing on the longevity and efficiency of irrigation projects which in turn depends on the integrity and dedication of the concerned contractors.

4. Since demand for irrigation is a derived demand, any change in the output and/or input market, as confronted by the farmer, changes the demand for water. Growth in demand for water for drinking and industrial purpose has also an effect on availability of water for irrigation purposes. The participants felt that although the Departments of irrigation and agriculture can provide some data on cropping pattern in response to changes in the market situations, the demand side of irrigation cannot properly be captured without going for primary data collection on sample basis.

5. When attention was drawn to a Task Force report for correcting and straightening out the process of collection and reporting of data by various state governments, it was pointed out that this report was neither accepted nor rejected and hence never implemented in practice.

6. The representative from Irrigation Department of Government of Gujarat assured sharing of all data available to them for each major and medium project on availability of water, the pricing of water, maintenance of delivery system and utilization of potential on the basis of demand registered with them by the farmers at the beginning of each crop season. However, the data on minor irrigation need to be procured from elsewhere – e.g., the Censes of Minor Irrigation projects.

7. Since conjunctive use of different sources of irrigation is hardly kept track of (in spite of minor irrigation capturing a 60% share in total irrigation in the country), it is necessary to capture this point with appropriate choice of sample villages and drawing of suitable households therein.

8. The group suggested procuring the list of all major and medium irrigation projects in a State/UT before picking a suitable sample keeping in mind representation of all agro-climatic zones, coverage of old as well as new projects, presence/absence of WUAs and other important stratifying variables. The group advised against collection of data from failed or partially completed projects.

The meeting ended with a vote of thanks to the Chairman.

List of participants:

Sr. No.	Name	Designation	Address
1	S.K.Das	Chairman (Ex), CWC	R.K.Puram, New Delhi
2	V.B.Patel	Chairman (Ex), CWC	Nehru Nagar, Ahmedabad
3	Mohan Sharma	Programme Officer	DSC, Bopal, Ahmedabad
4	Aditya Sharma	Dy. Director, CWC	Sec 10 A, Gandhinagar
5	Rajesh G Bhatt	OSD (IP)	9/1, New Sachibalaya, Gandhinagar
6	S.D.Vora	CF (Env. Cell)	12/9, Sachibalaya, SSNNL, Gandhinagar
7	Prof. S. K. Datta	Professor	CMA, IIM, Ahmedabad
8	Prof. Milindo Chakrabarti	Director, CREATE	ST. Joseph's college, Darjeeling
9	Bharat Dudhat	Research Associate	IIM, Ahmedabad
10	Saurabh C. Datta	Ph. D. Student	Oregon State University, Corvallis, US.

Annexure 7.2

MINUTES FOR 2nd BRAIN-STORMING SESSION IN NEW DELHI ON 21ST SEPTEMBER 2007
Venue: Sewa Bhawan, MoWR

The second brain-storming (BS) session in connection with the study assigned by MoWR was organized by Indian Institute of Management, Ahmedabad (IIMA) on 21st of September at Sewa Bhawan, New Delhi. Representatives from Ministry of Water Resources (MoWR), different State/UT Government officials from Irrigation Department and representatives from three IIM's (Ahmedabad, Bangalore & Lucknow) shared their views and many issues came out that are to be considered carefully, while implementing this study. Mr. M. L. Goyal, Member (River Management) presided over the meeting. The list of the participants is enclosed below as Annexure I.

Mr. Goyal, in the welcome note, mentioned that IIMA team under leadership of Prof. Samar K. Datta already organized a BS at IIM, Ahmedabad with officials from Department of Irrigation, Govt. of Gujarat and local NGOs. The basic need of the study was addressed and a rapport with the state level officers established. As a follow up Government of Gujarat appointed a nodal officer to facilitate the study. He mentioned about the jurisdiction of IIMA study and expressed his happiness to see representatives from other two IIMs in the session. He stressed on the uniformity of data collection modalities and requested Prof. Datta to attend other BS that would be conducted by other IIMs. The need for organizing a joint BS in Delhi with MoWR and all the IIMs was also emphasized in his speech. He felt that on the basis of recommendations emerging from such a session (by four IIMs) follow up action should be undertaken by the MoWR.

Mr. Goyal requested Prof. Milindo Chakrabarti to present the issues to the house. Prof. Chakrabarti posed the problem of a widening gap between irrigation potential created and utilized in this country since 1950, using data and graphs provided by MoWR. He wondered whether such a gap was normal like a percentage buffer, or whether it was because of overstatement of potential created or understatement of potential utilized or both. He pointed out that the aim of the study was to identify the reasons behind the observed gap and provide a road map of measures to minimize that gap. He sought the cooperation and help from the participants in coming out with correct and operationally meaningful definitions of the terms used in collecting and reporting of data by the Government authorities, besides seeking suggestions on how to get a reasonable amount of secondary data from Government Departments and how to draw a sample of irrigation projects as per the Ministry stipulations to collect primary data for this study. He displayed wide divergence in data as reported by the Ministries of Irrigation and Agriculture, on the one hand, and those by the Planning Commission and NRSA's satellite data, on the other. He sought help of the group in suitably estimating the 'engineering' concept of supply of irrigation in terms of water availability and potential commend area created, while differentiating this 'engineering' concept of supply irrespective of price paid by the users of irrigation water from supply and demand for irrigation water against a price by the farmers at his door steps. He argued that through identification of various parameters determining these three concepts he hoped to bring out various policy measures to minimize this gap.

Mr. Goyal opened the session for discussion by the participants.

Mr. Dhingra, Commissioner (CADA), MoWR made a thought-provoking presentation as a part of the BS. The basic arguments emerging out of his presentation are:

- The estimates of ultimate irrigation potential is relevant for a particular point of time since the estimate is derived on the basis of a number of assumptions about cropping pattern and water allowance, which undoubtedly vary over time, leading to changes in the estimated value of ultimate irrigation potential over time.
- The estimate of gross irrigated area is a possible under-estimate as areas under two-seasonal and perennial crops are counted only once. On the other hand, it may be over-estimated if areas under other projects from the new command area are added.
- Estimates of CCA are often arbitrarily arrived at without carrying out any survey.
- IPC of a new project is the aggregate of all areas at the end of water courses where water could be delivered from the project and IPU is the total gross area actually irrigated during the year under consideration. There is often a possibility that the water-courses – to be developed by the farmers – are not in place.
- IPC and IPU are parameters developed by the Planning Commission for monitoring a project and are to be compared in a project-specific manner. They perhaps cannot be aggregated at a regional level and compared.
- Estimates of IPC and IPU being dependent on a number of parameters that change over time, the aggregation of IPC over time is also methodologically unsound.
- There are possibilities in variations in estimates of IPC and IPU as different organizations compute them with different objectives.
- The gap should be tried to be bridged through micro level infrastructure development and efficient farm-level water management practices.

The following issues emerged from the house in course of discussion. Thematically, the issues may be grouped into four groups: Logistics, Methodology, Conceptual issues and Others.

Logistics of the Study

1. Uniformity should be maintained in the study;
2. Data format should be simple and understandable to the officials, because the state officials are the initial data provider.
3. Nomenclature of the format should be clear to ease the process.
4. Joint BS involving all the IIMs and representatives from MoWR should be periodically organized in Delhi.
5. Follow up actions should be taken on the basis of recommendations by four IIMs.

6. Data collection should begin after discussion with State Deptts.
7. Information should be compiled project wise and not state wise.

Methodology of the Study

8. Secondary data are often not reliable and need verification with primary data to be collected.
9. Statistical analysis is to be done.
10. Methodological design should take care of the fact that many projects are multidimensional.
11. Stakeholder analysis may pose a challenge.
12. Conjunctive use of water vis-à-vis IPU and IPC ought to be understood.
13. Minor irrigation should be properly reflected in the study sample.
14. It is to be ascertained if the water is available at 'tail end' every year.

Conceptual Clarity Needed for the Study

15. Definition of IPU is not clear.
16. For uniformity of study we should follow Planning Commissions definition of IPC & IPU; Monitoring the status of existing IPC is essential.
17. IPC & IPU are two monitoring parameters and not management parameters.
18. Deficiency between IPC & IPU lies in absence of a designated system for systematic data collection.
19. Difference exists between estimates of IPC done by Department of Irrigation and Department of Agriculture.
20. Lack of coordination across different agencies involved in data collection often leads to confusion and contradiction creeping into the estimates of IPC and IPU.
21. The gap may be increasing because of yearly deterioration in IPC created.
22. Aging of canals has played a significant role in reducing their carrying capacity.
23. Depreciation value should be considered while accounting for IPC.
24. In different areas, distribution canals (line) have not been constructed, leading to potential over-estimation of IPC.

Other Relevant issues

25. Detailed study by academic institutions with proven records is essential as administrative staff has hardly any time to do so.
26. Special maintenance of irrigation system in hilly region is required.
27. Necessity of effective and efficient management system is to be emphasized.
28. Maintenance of gravity along the watercourse is crucial.

The meeting ended with a vote of thanks to the Chair.

List of the participants

Sr. No.	Name	Designation	Organisation
1	R. M. Mathur	Ex. Engineer	Water resource Department, Jaipur, Rajasthan,
2	K. K. Gupta	Ex. Engineer	IPH, Department Shimla, H.P.
3	A. S. Dullet	Superintending Engineer	Punjab Irrigation Department
4	Dalbir Suef	Chief Engineer	Haryana Irrigation Department
5	A. K. Agarwal	Superintending Engineer Engineer	Haryana Irrigation Department
6	V. K. Abrol	C. E.,	I & FC Jammu (J & K)
7	A. K. Srivastava	Director (Stat)	MoWR, New Delhi
8	V. K. Arora	Addl. D. G.	MoWR, New Delhi
9	D. K. Kaushik	C. E.,	CWC, R. K. Puram, New Delhi
10	T. V. Rammaya	Professor	IIM, Banglore
11	Sanjeev Kapoor	Professor	IIM, Lucknow
12	Dr. N. Eagambaram	Adviser	CWC
13	S. K. Singh	C.E. (BP&MO)	CWC
14	S.P.Singh	Director, Monitoring & Evaluation	Centre Water Commission Regional Office, Gandhinagar, Gujarat
15	C. S. Mathur	C. E. PAO	CWC
16	Purnima Chauhan	Spl. Sec.	Govt. of H.P.
17	A.K.Ganju	Chief Engineer	Yamuna Basin Organisation, CWC, New Delhi-110016
18	A. S. Dhingra	Commissioner CADWM	MoWR
19	Sanjay Saxena	Ex. Engineer	Govt of Delhi
20	S.M. Hussain	Director (R & D)	MoWR
21	S.C. Datta	Ph.D. student	Oregon State University
22	S. K. Datta	Professor	IIM, Ahmedabad
23	M. Chakrabarti	Visiting Faculty	IIM, Ahmedabad
24	A. Sarkar	Research Associate	IIM, Ahmedabad
25.	B. Dudhat	Research Associate	IIM, Ahmedabad

Annexure 7.3

Draft Minutes of the Third Brain-storming Session held at SEWA Bhavan on 24th July, 2008

Following request from Prof. Samar Datta of IIMA, Mr. S. K. Das, former Chairman, CWC presided over this brain-storming session. At the outset Mr. Das explained the purpose of this exercise, as it became very important for IIMA study team to sensitize both central and state/UT governments about the problems they are confronting due to undue delay in receipt of data and generally poor quality of data available, on the one hand, and administrative problems they are facing due to time over-run for no fault of theirs, which has led to serious cost overrun as well, but which apparently MoWR isn't in a position to meet. So, the main purpose was to seek suggestions from the group.

Following advice from the Chairman, IIMA team made a PPT presentation on the preliminary analysis they have made on available secondary data. The presentation brought out several flaws in the data reported to IIMA. The study team told the gathering that they had made several efforts to collect data from certain states (e.g., Haryana) and also improve upon the quality of data through repeat visits and correspondences (though they admitted they couldn't put uniform efforts in all cases as some states drew tremendous amount of efforts from them), but mostly without success. After detailed discussion of the various aspects, given time and resource constraints, the following suggestions were made, which were nicely summed up by the Chairman in his concluding remarks:-

1. As the time and resource crunch problems faced by IIMA were genuine, the Chairman appealed to the Ministry for a favorable consideration, though he feared that further waiting may help better analysis, but not necessarily the quality of data. So, to give maximum flexibility to the IIMA study team, he suggested a deadline of July 31, 2008 for submission of all necessary data with corrections from the relevant states/UTs.

2. The group advised IIMA study team to adhere to the time limits as set by the Ministry, given the constraints on both sides, even though it may mean leaving out some components of data collection, processing and analysis.

3. IIMA study team reported their difficulties and repeated failures in collecting further data from the state of Jammu & Kashmir beyond secondary data. The group advised them to remain contended with detailed analysis of available data from that state, if the latest planned trip on 4th of August fails.

4. It was felt that a detailed interaction with each state before finalization of report, as suggested by IIMA study team, would provide immense benefits, if the Ministry can support and arrange it.

The meeting ended with a vote of thanks to the Chair.

List of participants

Serial No.	Name	Designation	Address	E-mail	Phone no.
1.	Mr. S. K. Das	Former Chairman, CWC	16/9 W2A (R), Golf Green, Phase IV-B, Kolkata – 700095		033-2418-7814
2.	Dr. N. Eagambaram	Advisor, CWC	905 A (S), Sewa Bhawan, R. K. Puram, New Delhi – 110066	ekambaramn@nic.in	011-2619-2168
3.	Mr. Sayed Masood Husain	Director (R & D), MoWR	Wing 4, 1st floor, West Block-I, R.K.Puram, New Delhi – 110066	watrnd-mowr@nic.in	011-2610-4082
4.	Mr. Animesh Sarkar	RA	Wing-2H, IIM Campus, Vastrapur, Ahmedabad – 380015	animesh67@gmail.com	+91-9434195309
5.	Mr. Sumanta Sen	RA	Wing-2H, IIM Campus, Vastrapur, Ahmedabad – 380015	sumantasen86@gmail.com	+91-9228258117
6.	Mr. Vivek Pal	Deputy Director (R & D), MoWR	Wing 4, 1st floor, West Block-I, R.K.Puram, New Delhi – 110066	watrnd-mowr@nic.in	011-2610-4082
7.	Mr. Pramod Narayan	Deputy Director (R & D), MoWR	Wing 4, 1st floor, West Block-I, R.K.Puram, New Delhi – 110066	watrnd-mowr@nic.in	011-2610-4082
8.	Mr. D. B. Jadav	OSD (Irrigation Project	OSD (IP) W. R. Dept., Sachivalay, Gandhinagar	dineshjadav52@gmail.com	079-2325-1704
9.	Mr. Arun K. Raina	Executive Engineer, Irrigation Division, Udhampur	Irrigation Department, Canal Road, Jammu Tawi		+91-9419183901, 0191-2542164
10.	Ms. Purnima Chauhan	Special Secretary, IPH, Govt of H.P.	Room # 411, 4th Floor, Armsdale Building, H.P. Secretariat, Shimla H.P. – 171002.	purnima_chauhan@hotmail.com	+91-9418001253
11.	Mr. B. S. Bhatia	Chief Executive Engeneer (XEN)	Chief Executive Engineer (WR), Govt. of Rajasthan, Jaipur	bharatsenbhatia@yahoo.co.in	0141-2227020
12.	Mr. Sanjay Saxena	Executive Engineer &	Civil Div – XII, Irrigation and		011-2517-2699

		Nodal Officer	flood control department, Govt. of Delhi		
13.	Mr. Sanjay Soni	SDO	SDO, WDC Sub division, Mehrouli Road, Gurgaon, Haryana	rishab_soni@hotmail.com	+91-9818611311
14.	Mr. M. P. Sharma	Executive Engineer (XEN)	XEN, WDC KNL, Haryana Irrigation Dept., Mehrouli Road, Gurgaon, Haryana	mps8586@yahoo.co.in	+91-9416082318
15.	Prof. Samar k. Datta	Professor, IIM-A	404 IIM Campus, Vastrapur, Ahmedabad 380015	sdutta@iimahd.ernet.in	+91-9427358845, +91-9227158845
16.	Prof. Milindo Chakrabarti	Visiting Faculty, IIM-A	Wing-2H, IIM Campus, Vastrapur, Ahmedabad – 380015	milindo62@gmail.com	+91-9313199838
17.	Mr. Rahul Nilakantan	Research Associate	Wing-2H, IIM Campus, Vastrapur, Ahmedabad – 380015	nilakantusc@gmail.com	+91-9725052733
18.	Mr. Pankaj Rathod	RA	Wing-2H, IIM Campus, Vastrapur, Ahmedabad – 380015	dr_pankajkumar@hotmail.com	+91-9328048015
19.	Mr. Subho Biswas	RA	Wing-2H, IIM Campus, Vastrapur, Ahmedabad – 380015	mr_subho_biswas@yahoo.co.in	+91-9327460940

ANNEXURE 8

Annexure 8

Efforts made by IIMA Study Team till 06/12/07

Date	Team members	Person/ officials visited within state/UT	Purpose	Actions taken
14-09-2007	Prof. Samar K. Datta (SKD), Prof. Milindo Chakrabarti (MC), Mr. Bharat Dudhat (BD)	Details available in minutes (Annexure I.1).	1st Brain-Storming (BS)	Points made already accommodated in questionnaire for secondary data collection. The rest are being accommodated in the second-stage questionnaire for primary data collection.
17-09-2007	SKD, MC, BD, Mr. Animesh Sarkar (AS)	Mr. Rajesh G Bhatt, Mr. M. K. Yadav, Mr. S.J.Desai (Department of Irrigation, Govt. of Gujarat) Mr. S. D. Vora, Mr. P.K.Laheri (SSNNL)	Introductory meeting to the Gujarat Govt. officials in Irrigation Dept to get an idea from them on how to proceed on this project.	A number of points made, which are already / being accommodated in preparation of questionnaires & study design.
21-09-2007	SKD, MC, BD, AS	Officials from MoWR and State Irrigation Departments	2nd BS	Details of suggestions made, which are being followed, are summarized in the minutes of this meeting (see Annexure I.2)
28-	SKD,	Mr. J. B. Patel,	Further discussion on	Discussion drawn attention to

09-2007	AS, BD	Mr. R.G. Bhatt, Mr. Aditya Sharma, Mr. Pandya, Mr. A. B. Pandya, Mr. R.A.Sherasiya (Departments of Irrigation & Agriculture, Govt. of Gujarat & CWC, Gujarat Office).	conceptual issues.	(a) factors associated with optimum utilization of IPC like deposition of silt, change of gravity, lined & un-lined, future demand, maintenance and cleaning of canal floor etc; (b) DSC & AKRSP's works to reduce gap between IPC & IPU through formation of Water Users Associations (WUA) through implementation of Participatory Irrigation Management (PIM); (c) Biotic & a-biotic factors influencing supply of irrigation water to farm land.
01-10-2007	SKD, AS, BD	Mr. Sachin, Development Support Centre (DSC); and Mr. R. G. Bhatt (Department of Irrigation, Govt. of Gujarat).	Discussion on framing a suitable questionnaire for secondary data collection.	Points noted: (a) advantages of volumetric charges on irrigation and participatory irrigation system to reduce gap; (b) importance of cost-benefit ratio in deciding on CCA; (c) need for depending on data from Irrigation rather than Agriculture & other Depts in view of our requirement to get project-wise data; (d) wastage of water by farmers on head, distance from dam, lack of incentives for more WUA, etc. as impeding factors. DSC handed over a number of useful reference materials. Mr. R. G. Bhatt handed over a simple questionnaire for collection of secondary data, which is being used after slight modification in consultation with

				two officials of Rajasthan Govt.
03-10-2007; 4-10-2007	SKD, AS, BD	Members of Narmada Control Authority (Environmental Sub-committee) and specially Mr. Dhingra (Commissioner, CAD, MoWR).	To have a first time field level experience of a major project (Narmada) in S. Gujarat.	Taken note of the deliberations and observations made during meeting & field visit.
05-10-2007	SKD, BD	Mr. R. M. Mathur, Mr. M. Kumar (retired) & Mr. H. Yadav (Departments of Irrigation & Agriculture, Govt. of Rajasthan) & Prof. Vijay Vyas	Introductory meeting to the officials of Rajasthan Govt to discuss modalities of secondary data collection, preliminary selection of major/medium projects for primary data collection, fine-tuning questionnaire for secondary data collection & discussion on conceptual and methodo-logical issues	(a) A local contact/resource person and six projects tentatively selected: Indira Gandhi Nahar (First phase) Major project, Chumbal Major Project; Jakham Major Project; Jawai Major Project; Santhal Sagar Medium Project; and Gurgown Medium Project, covering all agro-climatic regions; (b) Data related to cropping pattern collected from Agr. Dept.; (c) points noted: selection of sample should include old, medium and new projects; often no renovation done to dam, canals & distributaries, once structures are constructed; rainfall in dam catchments area as well as in command area must be noted; (d) wrote a formal letter to Mr. Kumar to act as our local contact person, explaining his responsibilities and token honorarium with copy to Mr. Mathur.

06-10-2007	AS	Mr. Deepak Sanan,, Ms. Purnima Chauhan, Mr. C.L.Sood, Mr. K.K.Gupta, (Department of Irrigation & Public Health, Govt. of Himachal Pradesh)	Initial discussion about the project implementation and handed over questionnaire for secondary data collection.	(a) Dept. promised to send the required information by next 10 days; (b) informed that HP has only four medium projects and no commissioned large project - of which one is using gravitational force, another one is a mixture of gravitational and lift and the rest are lift irrigation projects; (c) told that 93% irrigation facilities are provided from minor irrigation schemes; (d) apparently no evaluation study available; (e) Ms. Chauhan suggested two names as possible local contact/resource person in response to Mr. Sarkar's request - Mr. Ashok Mahajan and Mr. B.D.Thakur to act as liaison between IIMA study team and the Dept and to facilitate IIMA's job against token honorarium as per MoWR approved budget.
06-10-2007	AS	Director (Department of Agriculture, Govt. of Himachal Pradesh).	To look out for clues & data	Noted that they have created only small projects and handed over to the beneficiaries (less than 50ha); No data is available on change in cropping pattern.
07-10-2007	AS	Mr. Ashok Mahajan, Himachal Pradesh	To explain to him about his responsibilities as a possible local contact/ resource person.	He agreed to serve and handed over his bio-data for necessary action. A formal letter has already been sent to Ms. Chauhan with copy to him (re-sent recently attempting to

				remove possible confusion/mis-understanding from their side)
08-10-2007	SKD, BD & Prof. Sanjeev Kapoor of IIML, who was visiting SKD	Mr. Apoorva Oza (AKRSP)	Discuss the project and learn about their studies & experiences	Noted the points made: (a) Area with WUA has higher IPU; (b) farmers have no control over irrigation sources, nor is there enough involvement of farmers. ©even in case of groundwater management aspects neglected; (d) Check dams are very successful in Saurashtra region. Handed over a number of useful reference materials.
08-10-2007	AS	Director (Department of Agriculture, Govt. of Himachal Pradesh).	Collection of materials.	Collected a list of irrigation project of Agr. Dept; also collected copies DPR of some sample projects.
08-10-2007	AS	Mr. Kulvi, Bhal Valley, (right bank), Baggi, (Department of Irrigation, Govt. of Himachal Pradesh).	Field visit to Bhal Valley project	Gathered knowledge of a combination of flow and lift irrigation system.
09-10-2007	SKD, BD	Mr. R. Patel, Mr. Srikumar, Mr. Gohil, Mr. Lad and Mr. Pujari (Department of Irrigation, Govt. of Dadra & Nagar Haveli).	To build a rapport with officials and to initiate the process to get required data.	Noted: (a) Only one medium project is there under command area of Daman Ganga; (b) Approximately 525 minor irrigation projects are there; © Main reason for utilization gap in this region is rapid industrial growth as 80% agricultural area

				of Dadra allegedly converted into industrial area; (d) Apparently, requirement of irrigation has reduced because of reduction in agricultural land and improved irrigation technology (drip and sprinkler).
09-10-2007	AS	Mr. Ravinder Nath Rathore, Mr. Jasvinder Singh Thakur, Mr. Arvind Verma, Panarsha. (Department of Irrigation, Govt. of Himachal Pradesh)	To see a minor irrigation project at Panarsha.	Lifted water is flowing to the field through lined canal and later on through unlined channels.
10-10-2007	AS	Mr. Dalbir Suef, Mr. Gyan Singh. (Department of Irrigation, Govt. of Haryana)	Initial discussion about the project and handing over the questionnaire for secondary data collection.	No data provided; told that the previous nodal officer was changed and a new nodal officer appointed.
11-10-2007	AS	Mr. V.K. Mantro, Mr. Ashish Middas, Mr. S.K.Saluja, Mr. A.K. Bansal. (Department of Irrigation, Govt. of Punjab)	Initial discussion about the project and handing over the questionnaire for secondary data collection.	(a) provided irrigation map of Punjab; (b) only one medium project exist; (c) every main channel of a major project is treated as a separate major project; (d) most of the projects are more than 50 years old; (e) one region is reported facing problem of acidification and water logging.
11-10-2007	AS	Mr. Pradip Mehra (Advisor,Admini	Initial discussion about the project and handing over the	Points noted: (a) There are altogether 52 tube-wells; (b)

2007		strator), Mr. Rajib Batish (Department of Irrigation, Govt. of Chandigarh UT) and Mr. Jayram Singh, Mr. R.K.Rao, Mr. V.K.Varadwaj. ((Department of Agriculture, Govt. of Chandigarh UT)	questionnaire for secondary data collection.	most of the area is acquired by the Govt., so, a small area is left for agriculture.
12-10-2007	AS	S.K.Saluja, Mr. A.K.Bansal (Department of Irrigation, Govt. of Punjab)	Visited a flood control dam called Jayanti Dam.	Gathered field experience.
23-10-2007 to 25-10-2007	BD	Mr. R. G. Bhatt (Department of Irrigation, Govt. of Gujarat)	To collect list of major and medium projects and to discuss preparation of questionnaire for secondary data collection.	List collected and inputs sent to Prof. Chakrabarti.
29-10-2007	BD	Mr. R. Patel, Mr. Shrikumar and Mr. Vyas; Deputy Director of Agriculture (Departments of Irrigation & Agriculture, Govt. of Dadra & Nagar Haveli UT) Haveli UT)	To discuss selection of sample for primary data collection.	4 villages on right bank canal and 4 villages from left bank canal of Daman Ganga tentatively selected; with help of Mr. Vyas handling Minor Irrigation Schemes selected 3 more villages which are mainly depending on surface lift, well and surface irrigation; from Deputy Director of Agriculture collected data related to area, production and yield of last 4

				production and yield of last 4 years and 10 years of rainfall
29-10-2007	AS	Mir Najeebullah, Nazir Ahmed, Md. Rashid, Dipak Kumar, Altaf Hussain Baba (Department of Irrigation & Flood Control, Govt. of J&K) and Gulam Haider, Maqsood Ahmed Wani ((Department of Agriculture, Govt. of J&K)	Discussion on implementation of project; questionnaire on secondary data collection sent earlier.	Collected some filled-in questionnaire & visited some irrigation sites.
01-11-2007	SKD, AS	Mr. A.K. Srivastava, Mr. V.K.Arora, (Shastri Bhawan, New Delhi).	To discuss modalities of getting 3rd Census data on minor irrigation.	On the basis of 2-3 selected parameters they will supply village level data to identify our sample villages; details will be provided for sampled villages in the next stage.
02-11-2007	SKD, AS	Mr. S.K.Das, (National Expert to IIMA study team).	To fix the date for 3rd Brain-Storming session at Delhi.	Date of 3rd BS finalized.
02-11-2007 to 05-11-07	SKD (only 2nd), BS	Mr. Sanjay Saxena, Mr. Ish Kumar (Department of Irrigation and Flood Control, Govt. of Delhi).	Initial discussion about the project and handed over the questionnaire for secondary data collection.	Found no major or medium projects except one medium project in Delhi which is controlled by Department of Irrigation, Govt. of Haryana and for which data are to be collected from Haryana state. Mr. Lakhsmi Singh, Mr. B.P.Singh, Mr. I.P.Tandon and

				Mr. M.C.Tyagi took AS for field visits to several irrigation schemes around Delhi for his exposure before undertaking field studies.
03-11-2007	BD	Mr. Sachin Oza and Mr. Sharma (DSC, Gujarat)	Visited their office for their suggestions on primary data collection schedules	Suggestions communicated to Prof. Datta for discussion during 3rd BS in Delhi on 6/11/07.
05-11-2007	BD	Mr. Kumar (retired) and Mr. Mathur (Department of Irrigation, Govt. of Rajasthan)	Visited the latter's office for their suggestions in primary data collection schedules	Suggestions communicated to Prof. Datta for discussion during 3rd BS in Delhi on 6/11/07. Came to know that meanwhile Mr. Mathur has already sent secondary data of 75 out of 112 projects.
06-11-2007	SKD, MC, AS	Mr. S.K.Das and Mr. Hussain (Government of India).	To report the status of work and get inputs on the questionnaires for primary data collection.	Draft minutes of 3rd BS attached in Annexure I.3.
07-11-2007	SKD, MC, AS	Mr. A.S.Dhingra (Commissioner, CADA, MoWR).	To have a look of studies already undertaken by his office.	(a) Noted his suggestion that sample must be selected at water course level of any major or medium project; (b) Photocopied some questionnaire followed by CADA to evaluate their projects.
16-11-2007	SKD, AS, BD	Mr. Bhatt and Mr. Nadapara (Department of Irrigation, Govt. of Gujarat).	Visited his office for their suggestions in primary data collection schedules	(a) met Mr. Nadpara , the nodal officer for the first time. (b) Mr. Bhatt provided photocopies of irrigation demand form, supply form and assessment form – the way they preserve data, which will be useful in modifying our primary data collection

				schedule; (c) also pointed out that from now onwards the irrigation charges will be on volumetric basis as Rs.192 per irrigation per Ha. irrespective of crop irrigated.
27 to 28-11-07	AS, BD	Mr. Mathur, Mr. Kumar, Mr. Maheswari (Dept of Irrigation, Govt. of Rajasthan)	Seeking clarifications on ambiguities and gaps in secondary data provided, so that necessary corrections can be made	Told that meanwhile data for another 17 projects sent; sat with officials to seek necessary corrections, which are yet to be implemented in our soft copies. Mr. Kumar, local contact/resource person apprised of our expectations from him.
30-11-07 to 06-12-07	SKD, AS, BD	Mr. R. Patel, Mr. Srikumar, Mr. Bhoya (Irrigation Dept, Govt. of Dadra etc.)	Field testing of questionnaire for primary data collection & finalization of sample selection	Field testing done for households and field level irrigation offices in four villages on medium and minor irrigation projects, besides getting exposure to functioning of WUAs in nearby areas of Gujarat state; choice of sample almost finalized at village level except for some clarification yet to be obtained from MoWR (already reported verbally and in interim report); filled-in questionnaire for secondary data for only medium irrigation project collected.

Efforts made by IIMA Study Team from 7/11/07 to 14/03/2008

Date	Team members	Person/ officials visited within state/UT	Purpose
16 Nov. 07	Prof. Samar Datta (SD), Animesh Sarkar (AS) & Bharat Dudhat (BD)	Mr. R.G. Bhatt (Gandhinagar)	To know about the manner in which field level data are maintained by Irrigation Department at different levels.
27-28 Nov. 07	AS & BD	Mr. R. M. Mathur, Mr. Mahesh Kumar (Jaipur)	Correction of secondary data provided earlier and collection of fresh schedules.
28 Nov. 07	SD	Mr. S. M. Hussain, (MOWR)	Collection of CDs containing soft copy of village level minor irrigation census data.
30 Nov. to 06 Dec. 07	SD, AS & BD	Mr. Rajni Patel (Dadra & Nagar Haveli)	Testing of primary data collection schedule, selection of sample, visit to a nearby WUA to gather experience.
24 Dec. 07	Dr. S. P. Pal (SP) & AS	Mr. M. E. Haque and Mr. S. Husain (Delhi)	Reporting of progress of work and getting suggestions.
02 Jan. 08	Milindo Chakrabati (MC), AS & BD	Mr. R.G. Bhatt, Mr. S. D. Vora and Mr. P. K. Laheri (Gandhinagar)	Selection of major and medium projects in the state.
04-06 Jan. 08	MC, AS, BD	Mr. K. B. Rabadiya and R. G. Dhangar (Ukai irrigation project, Surat) Dahan Water User Association (WUA), Surat	To visit one major irrigation project for experience gathering.
21 Jan. 08	BD and Sumanto Sen (SS)	Mr. R.G. Bhatt	To collect 20 secondary data schedules.

	(SS)	(Gandhinagar)	
21 Jan. 08	MC, SP & S. K. Das (SKD)	Govts. of Haryana and Punjab and Chandigarh	To impress upon them to supply secondary data.
22Jan. 08	MC, SP & SKD	MoWR, New Delhi	Attending review meeting at MoWR
28 to 30 Jan. 80	SP, MC, BD	Mr. S. G. Patel Exe. Engg., Mr. Bharambhatt, Mr. S. P. Patel (Vadodara)	To visit one medium irrigation project, to get necessary exposure for preparation of primary data schedule.
12 Feb. 08	BD & SS	Limbadiya village near Gandhinagar	To test household and village schedule for one minor irrigation project.
21 Feb. 08	SP, SD	Mr. S. Saxena, Govt. of Delhi	To discuss modalities for primary data collection from sample villages.
22 and 27 Feb. 08	SD	Mr. S. K. Das (Kolkata)	To report and analyze progress of work to seek suggestions.
29 Feb. 08	SD, MC, SP		Meeting in Delhi for fine tuning of primary level data collection questionnaires.
29 to 2 Mar. 08	BD	Mr. S. G. Patel, Mr. Bharambhatt, Mr. S. P. Patel (Vadodara)	Field testing of household and village questionnaire in Timbi village.
04 to 05 Mar. 08	SD, SP, BD	Mr. R. M. Mathur, Mr. Mahesh Kumar and G. D. Joshi (Jaipur)	To discuss modalities for primary data collection

10 to 12 Mar. 08	SD, SP	Mr. R. S. Saini, Mr. A. S. Dullet and others at Lodhiana & Chandigarh (Punjab), Mr. Ami Chand (Chandigarh), Mr. A. K. Agarwal, Mr. Md. Haleem (Haryana)	To discuss modalities for primary data collection
13 Mar. 08	SD, SP	Mr. M. E. Haque and Mr. S. Husain (MoWR) and Mr. A. Mishra (Planning Commission)	Reporting progress of work for suggestions.

Efforts made by IIMA Study Team from 15/03/08 to 14/08/2008

Date	Team members	Person/ officials visited within state/UT	Purpose
28.3.08	Prof. Samar K. Datta (SD)	*Mr. Pandya, Chief Engineer, CWC*	To attend and deliver an invited talk to Central Water Commission, Gandhinagar on the occasion of World Water Day 2008
05.04.08 - 07.04.08	SD, Prof. Milindo Chakraborti (MC), Dr. Shakti Pal (SP), Dr. Bharat Dudhat (BD)	Min of water res. (MoWR), New-Delhi	To conduct a training workshop in Delhi of the field supervisor of an agency to conduct primary data collection during April 6-7, 2008
07.04.07	Mr. Subho Biswas (SB)	NA	To attend the training workshop in Delhi.
19.04.08 - 27.0408	SD, BD, Mr. Sumanta Sen (SS), Mr. Sanjaybhai Desai (SBD) and field investigators	Officials of Daman Ganga Project	*To collect a primary data from selected Villages in Silvassa for MoWR study*
07.05.08 – 08.05.08	SD and SB	NA	To conduct training for field investigators from Centre for Global Research (CGR)
09.05.08 – 10.05.08	SD and SB	Officials of Irrigation Dept., Rajasthan Govt. at Jaipur	To draw samples for primary data collection from the state of Rajasthan
12.05.08	SD, BD, SB, Mr. Pankaj Rathod (PR), SS	Officials of Irrigation Dept., Gujarat Govt. at IIM, Ahmedabad	To draw samples for primary data collection from the state of Gujarat
14.05.08 -	SB and field investigators	Officials of Jojwa Project	*To collect primary data from selected villages near Vadodara*

- 18.05.08	investigators from CGR, Delhi		*selected villages near Vadodara*
14.05.08 – 15.08.08	SD, BD, PR, SBD, and field investigators from CGR	Officials of Jojwa Project	*To collect primary data from selected villages near Vadodara*
16.05.08 – 19.05.08	BD and field investigators from CGR	Officials of Umaria Project	*To collect primary data from selected villages near Dahod*
16.05.08 - 19.05.05	SD, PR, and field investigators from CGR	Officials of Ukai Project	*To collect primary data from selected villages near Surat*
20.05.08	SB	Officials of Jojwa Project	*To collect some necessary documents and CDs from Vadodara*
21.05.08	BD, SS	Mr. R.G. Bhatt and Mr. Gulati (Gandhinagar)	*To collect remaining secondary schedules for Gujarat State from Mr. Bhatt and to meet Mr. Gulati who is handling Minor Irrigation Schemes in Gujarat State for MoWR project*
23.05.08 – 26.05.08	SB and field investigators from CGR	Officials of Dhantiwada Project	*To collect primary data from villages of Deesa and Palanpur area in Gujarat*
27.05.08 – 01.06.08	BD, PR	Officials of Und and Rudramata Projects	*To collect primary data from villages of Jamnagar and Kutch (Bhuj) area in Gujarat.*
05.06.08 – 07.06.08	MC, BD, SB	CGR officials and interviewers	*To conduct a training workshop for CGR interviewers and Supervisors about the primary schedules*
08.06.08	BD, SB and field investigators	NA	*To collect primary data from Nagloi village near Delhi*

	investigators from CGR		
09.06.08 – 15.06.08	SB and field investigators from CGR	Irrigation Dept. Officials of Bhabour Sahib Irrigation Project and Una MIS Projects	*To collect primary data from villages of Una, HP*
11.06.08 – 18.06.08	BD and field investigators from CGR	Officials of Giri and Bal-Vally Projects	*To collect primary data from villages at these two projects at Sundarnagar, Majara in HP*
16.06.08 – 18.06.08	SB and field investigators from CGR	Officials of Naggal Lift Irrigation Project	*To collect primary data from villages near Ambala, Haryana*
19.06.08 – 21.06.08	SB and field investigators from CGR	Officials of Tail Bhakra Main Line Priject	*To collect primary data from villages near Sirsa, Haryana*
24.06.08	MC and SB	NA	*To analyze some computerized primary data at NISTADS, Delhi.*
25.06.08 – 28.06.08	SB and field investigators from CGR	Officials of Gurgaon Canal Project	*To collect primary data from the villages near Faridabad and Palwal*
14.06.08 - 15.06.08	PR and field investigators from CGR	Irrigation Dept. Officials of Chandigarh	*To collect primary data from the villages near Chandigarh.*
16.06.08 – 17.08.08	PR and field investigators from CGR	Irrigation Dept. Officials of Panchkula	*To collect primary data from the villages near Panchkula, Haryana*
18.06.08 – 20.06.08	PR and field investigators from CGR	Officials of Loharu lift Project	*To collect primary data from the villages near Bhiwani, Haryana*
21.06.08 – 23.06.08	PR and field investigators from CGR	Officials of JLN Project	*To collect primary data from the villages near Rewari, Haryana*

24.06.08 – 26.06.08	PR and field investigators from CGR	Officials of Western Jamuna Canal Project	*To collect primary data from the villages near Jind, Haryana*
21.06.08	Mr. Animesh Sarkar (AS) and field investigators from CGR	Irrigation Dept. Officials of Delhi	*To collect primary data from Nagloi (West) village near Delhi*
24.06.08	AS	Mr Saini, Punjab Irrigation Dept.	*To finalize the primary data collection in Punjab*
25.06.08 – 27.06.08	AS and field investigators from CGR	Officials of UBDC Project	*To collect primary data from the villages near Amritsar, Punjab*
28.06.08 – 30.06.08	AS and field investigators from CGR	Irrigation Dept. Officials of Punjab (Kapurthala)	*To collect primary data from villages near* Kapurthala, Punjab
28.06.08 – 30.06.08	PR and field investigators from CGR	Officials of Sirhind Feeder Project	*To collect primary data from villages under this project near Ferozepur, Punjab*
01.07.08 – 03.07.08	AS and field investigators from CGR	Officials of Bist Doab Canal Div project	*To collect primary data from the villages near Jalandhar, Punjab*
01.07.08 – 03.07.08	PR and field investigators from CGR	Officials of Eastern Canal System Project	*To collect primary data from villages under this project near Ferozepur, Punjab*
04.07.08 – 06.07.08	AS and field investigators from CGR	Officials of Sirhind Canal Circle, Ludhiana	*To collect primary data from the villages near Ludhiana, Punjab*
04.07.08 – 06.07.08	PR and field investigators from CGR	Officials of Bhakra Main Line	*To collect primary data from the villages near Patiala, Punjab*
26.06.08 –	BD and SBD and field	Officials of West Banas Project	*Collection of primary data from Villages near Sirohi, Rajasthan*

27.06.08	investigators from CGR	Project	*Villages near Sirohi, Rajasthan*
28.06.08 - 30.06.08	SBD and field investigators from CGR	Officials of Sardar Samand Project	*Collection of primary data from Villages near Pali, Rajasthan*
30.06.08 – 01.07.08	BD and field investigators from CGR	Officials of Baretha Bandh Project	*Collection of primary data from Villages near Bayana, Bharatpur, Rajasthan*
01.07.08 – 03.07.08	SBD and field investigators from CGR	Officials of Irrigation Dept. Sikhar, Rajasthan	*Collection of primary data from Villages near Sikhar, Rajasthan*
02.07.08 – 04.07.08	BD and field investigators from CGR	Officials of Irrigation Dept. Parwati Canal System	*Collection of primary data from Villages near Baran, Rajasthan*
05.07.08 – 06.07.08	BD and field investigators from CGR	Officials of Irrigation Dept. Chhapi Project	*Collection of primary data from Villages near Akelera, Rajasthan*
16.07.08 – 18.07.08	PR and field investigators from CGR	Officials of Irrigation Dept. Sidhmukh Nahar Project	*Collection of primary data from Villages near Hanumangarh, Rajasthan*
08.07.08	AS and field investigators from CGR	Officials of Delhi Irrigation Dept.	*To collect primary data from Asola village near Delhi*
09.07.08	SB	*NA*	*Collection of some important data from NWA, Pune for MoWR Consultancy project*
14.07.08	SD, MC, SP, AS, Mr. Rahul Nilakantan (RN)	NA	*Preparation before the Brain-storming Session*
14.07.08	SB and PR and field investigators	NA	*Collection of primary data from Villages near Gandhinagar*

	from CGR		
22.07.08 – 25.07.08	SD, MC, RN, AS, SB, PR, SS, Mr. Prashanta Swarnakar (PS)	Mr. S.K.Das, Mr. Hussain (Government of India) and different officials of different states and UTs	*To hold a brain-storming session at MoWR with full study team on 24/7* *To hold post-brainstorming discussion among team members (including Prof. Chakrabarti & Mr. Das at Delhi) about the future course of actions before submission of report to the Ministry on 25/7*
31.07.08 - 04.08.08	SD, MC, SP, RN	NA	*To work together during 2/8 to 4/8 with my MoWR consultancy project team members towards preparation of draft report for the Ministry (due on 15/8)*
08.08.08	SD, SB, SS	Officials of different projects from selected projects in Gujarat	*Collection of system questionnaires.*

Efforts made by IIMA Study Team from 15/08/08 to 01/12/2008

Date	Team members	Person/ officials visited within state/UT	Purpose
16.09.08	Prof. Samar K. Datta (SD)	Nodal Officer, Gujarat Govt. Irrigation Dept.	*To collect modified secondary data from Gandhinagar, Gujarat*
12.11.08 – 13.11.08	SD, Mr. S. K. Das (SKD), Mr. Subho Biswas (SB), Mr. Sumanta Sen (SS)	NA	*National expert, Mr. S. K. Das visited IIM-A & offered his suggestions on the draft Final Report.*

ANNEXURE 9

Terms of Reference for the study to examine various issues related to gap between irrigation potential created and utilised, to be carried out by the Consultants.

Scope of the study

1. To examine the various issues associated with irrigation potential creation, irrigation potential utilization, gross irrigation and net irrigation including the definition, the reporting practices and consistencies in data etc.

2. To suggest procedure for collection of related data to be applied uniformly throughout the country.

3. To clearly identify the irrigation potential which has been created but:

   i) has never been utilised,
   ii) has not been utilised regularly and
   iii) has gone into disuse due to various reasons.

4. To identify the reasons for gap in the irrigation potential created, irrigation potential utilised and gross irrigated area.

5. To suggest measures for minimising the gap between irrigation potential created and irrigation potential utilised.

Duration of Study

The duration of the study will be eight months. However, the consultants have to submit an interim report in six months.

Coverage

The IIM-wise distribution of States/UTs to be covered in the study is enclosed.

Other Conditions

- The consultants will engage an Advisor, who is fully conversant with the issues, from a panel of experts identifies by the Ministry.
- The consultants will fully associate the State Government with the study.

Payment

The payment schedule will be as below:

- 30% advance payment on award of study and signing of MoU
- 50% of submission of Interim Report
- 20% on submission of Final Report and its acceptance.

Statement indication region-wise distribution of States / UTs to be covered under the proposed study by the consultants.

Region	Consultant	State / UTs
I	IIM Ahmedabad	1. Jammu & Kashmir 2. Punjab 3. Haryana 4. Himachal Pradesh 5. Rajasthan 6. Gujarat 7. Delhi 8. Chandigarh 9. Dadra and Nagar Haveli