Chapter III

THE DESIGN, EXECUTION, MANAGEMENT AND UTILIZATION

3.0 The Need for Project Appraisal

"In the private sector firms are motivated to innovate and cut costs by the love of profits and the threat of bankruptcy".[1] The survival of private firms in the system is based on the efficient production. In public sector such tenacious forces do not operate to affect the investment decisions. The other than pure financial considerations are acting more strongly. Political commitment of the community plays a vital role in investment decisions in public sector. While the political commitment may generate an insight to evolve projects in the better interest of the community at large, the method generally fails to provide objective criteria to help reach decisions. The objective evaluation of the proposals is necessary not only because there will be gamut of completing projects to be implemented by limited resources but also because there will be conflicting objectives which may be mutually exclusive. For instance an irrigation project may be competing with a forestry development project, cross-breed development project or dry land technology project. There has to be some objective evaluation if the political commitment is there for all the projects and resources are enough only for any one of the project.

1 L. Douglas James/Robert R. Lee in Economics of Water Resources Planning, McGraw-Hill Series, 1971, p.163.

If the irrigation sector has been provided with some earmarked financial resource then too an objective evaluation would be necessary in order to select between the alternative technically feasible locations. The choice of one location in a particular watershed may enhance the growth potential of the area whereas the choice of location in another watershed may ensure re-distribution of allocation in favour of a backward region. It is likely that political choice may be biased in favour of a region or the other without having any objective justification. The project evaluation or appraisal therefore becomes very essential.

In the context of the present study the intention of looking into the project formulation and appraisal techniques will serve two-fold purposes. Firstly, it will help under-standing the way in which the project appraisals are done presently and secondly, it will show how the current practices lead to some of the gaps which are realized once the project is commissioned. This study will further help in challenging the economic viability of minor irrigation tanks in the district. A badly formulated and ritualistically appraised project coupled with bad management and poor maintenance may sabotage the entire project. If the past precedents are of such nature then they should serve as a warning bell for future investment decisions.

3.10 What is Project Formulation?

Project formulation is the process of presenting a project idea in a form in which it can be subjected to comparative appraisal for the purpose of determining in definitive terms, the priority which the project should receive during the course of resource allocation under conditions of severe constraints on resource availability.[2] It is essentially an analysis of the project idea to clearly bring out the implications of costs that will have to be incurred and the benefits that will accrue if the idea is concrretised and implemented. The elements of project formulation and appraisal, generally include identification, feasibility studies, cost-benefit analysis, input analysis, implementation management etc. We shall look into them in a broad sense in the following sections.

3.11 Identification Process Followed :

The District presently has 56 class I Minor Irrigation tanks which are declared as completed (Refer Appendix 1 of this chapter for List). These tanks have been built over a span of 50 years. Majority of the tanks have been built from Third Five Year Plan onwards. The official records and reports available for tanks do not display any information on the process of identification of location for a tank. Interaction with the concerned authorities in this regard,

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2 P.K. Mattoo : Project Formulation in Developing Countries. The MacMillan Company of India Ltd., 1978.

however, revealed a uniform pattern in identification. Most of these projects have been identified either by villagers or by local area representatives or both. The representation that is made is often not covering the entire population's view point. The department which acts further on the proposition is hardly practicing the method of opinion survey in the proposed site area. The base for the representation made by a group of villagers or area representative is often either a village tank which has historical existence or a scarcity work that has come into existence in recent past.

The projects involving a community as a potential beneficiary should be identified with more consultation and consensus of the total population that is intended to be benefitted. Generally, the participation of each and every member (in case of MI Tanks - each and every farmer in the Command Area) is almost essential for the success of the project. Projects of the kind under study (MI Tanks) also entail a necessary follow-up programme by the farmers in the Command Area without which the project may perform miserably. According to norms and practices the government department builds the main structure at the dam and lays out a Canal and/or main branches. From the main outlet of the Canal the water has to flow to fields via the field channels which are not laid by department. It is expected of the farmers in the Command Area to lay down the net-work of field channels. The farmers in the proposed

Command Area may be willing to have irrigation facility built but may not necessarily be willing to plan and lay down the field channels at their own individual costs. In such an event even if the entire project is meticulously planned and implemented the desired impact will not be felt in the Command Area.

3.12 Project Formulation

For formulating irrigation projects in general and MI Tank projects in particular, the state government as well as the Central Government has been issuing circulars to the department from time to time. Upto 1965, the department carried out only a detailed technical survey specifying the location, sites, command, Head works, waste weir and other relevant technical details. From 1965 onwards the department was asked to carry out a preliminary survey to begin with. The department was to gain an approval of preliminary survey report to forge ahead with a detailed technical survey. The preliminary survey report is supposed to include an idea about the site, catchment, rainfall and run off, storage capacity, waste weir, earthen dam, land acquisition, command area and financial estimates. On the basis of this information other higher authorities order a detail technical survey.

At district level the Executive Engineer (EE) is in charge of the formulation and implementation. This divisional incharge has under him number of sub-divisions whose number depends on the work load. The incharge of the sub-division is the Deputy Engineer (DE). He is the man directly in charge of the field technical staff. The preliminary survey as well as the detailed technical survey is carried out by him and his staff. The report is then submitted to the EE. If the financial estimate is less than Rs.3 lakhs, the EE has power to sanction the project. When the estimate exceeds this stipulated amount the EE reviews the report and passes it on to the higher ups. At higher level the report reaches the Circle Office, which is headed by a Superintending Engineer (SE) and covers some specified areas including more than one district. The power delegated to this office has a limit at Rs.7 lakhs. If the estimate is higher than this amount the report is passed on to the Apex authority - the Central Designs Organization (CDO). The CDO reviews and recommends the project, which is then accorded a technical sanction by the irrigation department of the State Government.

3.13 A Peep into the Procedural Details.

There are two basic reasons for delving deep into the procedural details. In the planning process two types of issues have to be resolved. One is the substantive issue that relates to the philosophy and social wisdom on which the planning is to be based. Second is the procedural issue in a given framework for implementation. The projects are made or marred depending upon how best these issues are tackled. The contention of this study is to bring out clearly that certain crucial factors that are ignored may turn the projects economically non-viable.We shall deal with the procedural issue first. The first reason for going into these details is to show that the authorities which are involved in actual formulation of the project reports are unable to do so with any significant level of competency.The second reason is to show how these procedural lags disturb the very substance of a project idea.

The first indication about the extent of incompetency among the actual formulation authorities is given by the time taken to accord technical sanction for the project.If one assumes that the actual formulation authority is fully competent then the time taken for according technical sanction should either be equal to or slightly more than the time taken for correspondence between various levels depending upon the financial estimates. If the approval of apex authority is sought with a thorough formulation the maximum time taken should not exceed four months. It has not been possible to have access to all correspondence files pertaining to each and every class I MI tank in the district and hence the following table displays information only about those tanks for which we had access to their respective correspondence files.

Table 3.1

Time taken to accord Technical Sanction for some of the Class I MI Tanks inPanchmahals

Sl. No.	Tank Code	Date of submission by DE	Date of technical sanction	Duration in months
1	2	3	4	5
1.	LUT8	16-8-1963	12-4-1967	44
2.	LUK4	14-5-1970	21-7-1971	14
3.	LK 9	4-5-1970	8-1-1971	08
4.	ST19	22-12-1965	8-6-1966	06
5.	DBK14	17-8-1966	22-3-1968	19
6.	DBK13	22-8-1966	28-8-1968	24
7.	DBT14	11-3-1970	25-9-1970	06.5
8.	JT11	3-9-1968	29-10-1971	37.5
9.	JT12	3-9-1968	8-1-1971	28
10.	HK12	9-3-1966	8-7-1974	100
11.	DT32	3-9-1965	30-4-1966	09
12.	ZT30	30-1-1969	23-4-1970	13.5
13.	ZT22	19-10-1967	26-11-1971	37
14.	ZK16	27-3-1967	10-7-1967	03.5
15.	SHT9	3-12-1965	15-6-1966	05.5
16.	ShK8	10-2-1968	19-7-1971	35
				24.5

Source: Compiled from Executive Engineer's Office, MI Division, Godhra.

From Table 3.1 it can be seen that the project has gained technical sanction in as early as 3.5 months and as late as 100 months. If we take the average time taken for these 16 listed Class I MI Tanks, it reveals that on an average two years or 24 months are taken before the technical sanction is accorded. 8 tanks out of the sample of 16 have taken less than 24 months to obtain a sanction and the rest 8 have taken more than 24 months.

There are many factors which delay and hasten the process. It is likely that the early sanctions have been accorded to certain projects because they must have been in the top priority list of the District Panchayat. It also depends whether the other officials such as District Development Officer (Chief Executive of Jilla Panchayat) have shown more than casual interest in sanctioning of the project. One of the basic reasons for delay, however, is that the reports prepared have serious lacunas. This is reflected by the rémarks that are raised at each level of project appraisal. It would have been enlightening if we could support the table with further information on the remarks raised and time taken for compliance of such remarks in the process of formulation and appraisal. But this information again is not available for most of tanks. It is difficult to trace back the files since the record keeping authorities have been changing from time to time. Nevertheless, we are in a position to illustrate our point with the help of a case. The case has been discussed in one of the studies carried out at the district level.[3] The work discussed is still on going. It is for this

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3 Sudarshan Iyengar et al., A Case Study of Chalvad Minor Irrigation Tank in Panchmahals (Mimeo) District Project Planning Cell, Panchmahals, May 1979.

reason that the files could be obtained for study purposes. The project report was appraised in this case at 4 levels. At all the levels there were remarks. Most of the remarks were also repeated at different levels. On the submission of report to the EE, his office raised about 43 remarks and sent the report back seeking complaince from the DE's office. The report was then sent to the Circle Office which again raised 29 remarks. After complying these remarks the report was sent to another Circle Office, since the jurisdictions had undergone a change. The new circle again raised 22 remarks and sent it back for compliance. Once the revised project was sent to circle the circle passed it on to CDO, - the Apex body, since the cost estimates exceeded the power of sanction vested with SE. The CDO in turn raised 44 remarks and sent it back for compliance. Once this was done the re-revised project report was accorded technical sanction. Out of these 133 remarks 68 were pertaining to technical matters questioning the basis of estimates and designs, 52 were pertaining to general lacuna in marking, mapping, inconsistency, content lag, clarifications and others and 13 were pertaining to the working out of the economics of the project. The details are provided in appendix III of this chapter.

The above illustration indicates that the formulation authorities are either incompetent or negligent or both. This is clearly evident since one of the highest authorities of the irrigation department namely the Chief Engineer and Joint Secretary to Government of Gujarat in a Resolution has drawn attention to this phenomenon. The Resolution states. "Looking to the Maps and Estimates that are prepared and presented by Panchayats it is apparent that the concerned officials are indifferent to the procedures. Instead of studying and surveying of the project according to the set norms and by the relevant high authorities, it has become a practice to merely sign and stamp the reports and maps and push it forward to higher authorities for sanction."[4] If the trend has been similar in past and if it is likely to be so in future, the scientific project formulation and appraisal is not likely to take place as a result of which wrong investment decisions may be taken by according technical sanctions to unscientifically formulated projects.

3.14 Crucial Gaps

The negligence and low level of competence not only delays the implementation but also leads to ad hoc estimates which may misrepresent the economic viability of the projects. Some of the factors in such project formulation and appraisal also may lead to unsuitable designs of the structures. In spite of the fact that Apex body like CDO takes many precautions before sanctioning a project, the general practices of the day have some serious lacuna in arriving at the

4 IrrigationDepartment,PWD , Government of Gujarat Resolution No.NSY 1066/17774 - A,Sachivalaya Gandhinagar, Dated 6th December,1976.

estimates of certain crucial values. These values are decisive in arriving at benefit-cost ratio and the designs of some of the structures.

To illustrate this point, once again we shall be taking the help of the same case study as reported earlier since (a) the details about all the 56 tanks are not available and (b) one may assume that if the procedure is true for an on-going project it has also to be true for the projects that have been completed.

In the process of project formulation and appraisal for Minor Irrigation Tanks two variables are of crucial importance. The first is the effective Command Area that would actually get irrigated by the stored water and second is the cropping pattern that is proposed. It is possible to make different sets of assumptions for arriving at the value of both these variables. The department at district also has a set practice through which the values are obtained. We shall discuss this procedure first and then try to bring out the limitations.

In the process of detailed technical survey, once the location for head works or Head Regulator is fixed the Command Area is arrived at with the help of the topography sheet. Since the system is of flow irrigation the extreme point toward which water will reach depends upon the contour heights of the Command Area. An approximate distance is fixed towards which the water will flow in canals with gravitation. Once the extreme limit is located, the Command Area which is known as Gross Command Area (GCA) is worked approximately using the topo-sheet. The next step is taken to arrive at the culturable Command Area (CCA) which is derived by deducting area not available for cultivation, area under houses, roads, wells, and others from the GCA.

For Chalvad MI Tank the GCA was fixed at 240 acres.[*] The Irrigable Command Area (which is same as CCA in this case) is 222 acres. The entire Command Area is divided in 8 blocks.[**]

The first gap in the method adopted by department is reflected when the area under each survey number (which is revenue assessment) is added for all the 8 blocks. The area worked out by this method is 222 acres and not 240 acres. 222 acres therefore, must be the actual GCA. Out of this 8 acres are not cultivable, 5 acres are acquired for Canal and 2 acres are covered by houses and wells. This then brings down the CCA or ICA to 207 acres instead of 222 acres as shown by the department. The new figure will definitely have an impact on the B:C ratio which has been calculated by the department assuming 222 acres under effective Command.[***]

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* Study quoted on p.9.

** Map of Chalvad Minor Irrigation tank is contained in statistical Appendix which may be supplied if called for.

*** These records were collected from Talati, the village level revenue official.

This gap, however, is not very serious in nature since GCA is only a guesstimate which is made to get an idea about Command Area. For the purposes of calculating B:C ratio and working out the economic viability of the project the cropping pattern is of immense importance. The department also considers cropping pattern for calculating the B:C ratio. When cropping pattern is considered to work out the B:C ratio it has to seek consistency with the useful storage of water that will be made available. This means that whatever cropping is proposed for the acreage to be covered under Command, the water that is stored should be enough for all the crops with their respective duties.*

The B:C ratio calculation will be consistent if and only if the available storage in the proposed tank will be able to meet the water demand required by the crops that are proposed. At this stage there again is serious irregularity. Let us understand the process little more elaborately.

Generally, one would expect (the irrigation department also presumes this) that the District Agriculture Officer's office is contacted for obtaining a proposed cropping pattern for the identified Command Area. This is, however, not the practice. It is the personnel of the DE's office who prepare the tentative cropping pattern for the Command Area, calculates the B:C ratio and then sends it to the DAO's office, which generally approves what has been proposed.

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* For 'duty' kindly refer to Glossary of Irrigation terms in Appendix VII of this Chapter.

The matter would have been less serious if the department stopped at this. Since the formulating authorities have to also show that there is sufficient water to meet the water requirements of the crops, it indulges into another practice. To show that there is enough storage a different cropping pattern is then assumed. This practice is probably adopted since useful storage is an unalterable figure derived from the catchment area, run off and the precipitation. It is only that the cropping pattern can be varied and not the storage. Let us illustrate this.

In case of Chalvad MI Tank the useful storage is calculated to be 9.88 MCft. (Million Cubic feet). This value can not be altered for the reasons already discussed. The department has to see that the proposed cropping pattern is consistent with this supply. The cropping pattern which is proposed for seeking this consistency is that out of 222acres 24 acres are proposed under paddy (11%) and 198 acres are proposed under other Kharif crops* (89%). The information is given in Appendix III. The duty for paddy is taken as 15 and for other Kharif crops it is taken to be 24. The total water requirement with cropping pattern works out to be 9.85 Mcft. which is slightly less than 9.88 Mcft. of available storage. Hence, it is assumed that the water is enough.

7 However, it is not the cropping pattern. For working out B:C ratio the department has suggested a different

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* Kharif Crops as per the departments dennotation refer to those crops which are grown between June to November.

cropping pattern to the DAO (kindly refer to appendix IV). The crops recommended are Paddy, Maize, Bajri (Millet), Groundnut, Cotton and Pulses. The duty for all these crops is not uniform. If we take the actual duties and work out the water requirement the picture will be clearer.

Table 3.2

Detailed Cropping Pattern and Water Requirement in Chalvad MI Tank Command

Sl. No.	Name of the crop proposed	Proposed Area in acres	Duty (acres per Mcft.)	Total water requirement in Mc ft.
1	2	3	4	5
1.	Paddy	24 (11)	15	1.60
2.	Maize	20 (09)	24	0.83
3.	Maize (Millet)	40 (18)	24	1.66
4.	Groundnut	20 (09)	24	0.83
5.	Cotton	50 (23)	15	3.33
6.	Pulses	68 (30)	15	4.53
	Total	222(100)		12.78

Table 3.2 shows that if we use the cropping pattern proposed to DAO by the department, the total water required to irrigate proposed crops will be 12.78 MC ft. The unalterable useful storage that is available is 9.88 MC ft. If the proposed cropping pattern is really taken up by the farmers in the specific acreage, the department will not be in a position to supply to all the fields.

The fundamental gap, therefore, is that the department tries to adjust and readjust the cropping pattern in relation to the available useful storage. It would be scientific, if the practice is reversed. Once the cropping pattern is fixed then the area that would really get irrigated or let us call it the Effective Command Area should be worked against the available useful storage.

3.15 <u>The Effective Command Area (ECA)</u>

If we assume that the cropping pattern that is approved by DAO is final then we can also find out how much area will be under ECA with 9.88 Mcft. of useful storage. The absolute area or acreage will not be of so much importance and hence we shall have to further assume that the proposed cropping pattern is the distribution of crops approved by the DAO. If a unit area is considered to be the Command then the water required for that unit area with given distribution of crops should be worked out and then with the help of available useful storage, the actual acreage can be derived. To illustrate -

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Table 3.3

The Crop distribution and Water required per unit area in Chalvad MI Tank

Name of the crops	Distributed share	Duty (acres per Mcft.)	Water requirement Mcft.
1	2	3	4
1. Paddy	0.11	15	0.0073
2. Maize	0.09	24	0.0037
3. Bajri (Millet)	0.18	24	0.0074
4. Ground nut	0.09	24	0.0037
5. Cotton	0.23	15	0.0153
6. Pulses	0.30	15	0.0200
Total	1.00		0.0574

The effective Command Area can now be calculated as under :

$$\text{Effective Command Area (ECA)} = \frac{\text{Available Useful Storage}}{\text{Water required by unit area (acre) with given cropping pattern distribution.}}$$

$$= \frac{9.88 \text{ MCft}}{0.0574 \text{ MCft}}$$

$$= 172 \text{ Acres.}$$

It can be observed that the available storage will be able to irrigate significantly less area than assumed if the cropping pattern distribution is the one which has been proposed. The reduced acreage will have a definite impact on the calculation of the B:C ratio.

There is one more crucial impact on the overall project due to this kind of deviation. The use of cropping pattern with respective duties is also most relevant for determining the design discharge from the Head Regulator. It is this figure which decides the fate of fields in future since if the design discharge is lower relative to duties than all the fields will not get irrigated and if the design discharge is higher relative to duties the storage may be used up fast which would lead to wastage. In case of Chalvad MI Tank, once again, the department has used the cropping pattern with which the available useful storage was matched with water requirement by crops. The department's calculation of design discharge is given in appendix V. If we once again assume that the cropping pattern approved by DAO is correct, the design discharge by both the direct method and by $\frac{AI}{DC}$ method* differs significantly. The calculations have been shown in Appendix V. The design discharge computed by department works out to be 3.65 cusecs. The value of discharge considered is the one which is derived by AI/DC Method since it is higher of the two. With the changed cropping pattern the design discharge works out to be 5.42 cusecs. If the farmers in reality take up the detailed cropping pattern as suggested in specific acreage, the head regulator will not be in a position to discharge necessary amount of water since the structure that has been built on considering relatively low discharge requirement will act as a definite physical constraint. This may be detrimental to the project as a whole.

* For discussion on methods kindly refer Glossary of Irrigation terms, Appendix IX, Chapter 3.

3.16 Is this manipulation ?

This kind of exercise, which the department performs, is an indication towards manipulation of data. As already stated in the earlier chapters the higher sanctioning authorities do insist on certain values of the B:C ratio and cost per acre. It is likely that the manipulation helps the formulating agencies in increasing the acreage in order to reduce cost per acre and improve the B:C ratio. The procedure adopted to calculate B:C ratio, their possible distortions and the impact of all such manipulations will be discussed at length in the next chapter. The only point which has been brought to notice and needs an emphasis is that it will be correct to assume about similar practices in past. This would mean that the Class I tanks which are being studied for our purpose must be suffering from such inadequncies in formulation and appraisal. The Command Area which have been suggested for all those tanks will have to be accepted with definite reservations. The ECA of all the tanks which are operating in the district will necessarily be lower than the CCA figures which are supplied to us by the department. It is likely that if scientific formulation techniques without manipulations were attempted, not many projects would have passed the B:C ratio tests as well as the cost per acre test. The small exercise which has been performed also justifies our basic enquiry about the wisdom of public investment in MI tanks in Panchmahals.

3.17 Further Gaps in Formulation and Appraisal :

In the previous subsection, the attention has been drawn only to some of the crucial issues relating to the main structure, their designs and implications thereof. However, an irrigation project whether big or small is never complete if the discussion and planning of the related fields and sectors is absent in the formulation and appraisal. Generally, the department bases all its calculation of benefits and costs on 'before' and 'after' concept. The basic limitation of this approachis when 'after' irrigation calculations are made water supply is the only new variable which is added. This is however not the reality. It is better to use the concept of 'with' and 'without' irrigation. In the dynamic society the farms may also experience some changes without irrigation. These changes if already existing need not be considered as costs/benefits when irrigation is introduced. Again when the farm management has to be evaluated with irrigation, the costs and benefits are not restricted to cost of water and additional yield alone. The additional yield value that is generally estimated is not a function of water alone. The supply of water to fields by itself may help the yields to improve but not to any significant extent. It is therefore necessary to formulate and appraise an irrigation project reviewing and analysisng the role of other related departments such agriculture (for technology and extension) credit institutions (for input supply) and the soil conservation department (for land improvement).

Presently no such considerations are being made. The irrigation department limits the exercise only upto building of structures. All the MI Tanks, therefore, have this basic limitation. One is not sure whether the Command Area land is prepared, whether the field channels are laid, whether input supply is proper at reasonable cost and whether other infrastructural facilities are provided to the farmers in the Command Area. This limitation may lead to substantial reduction in the utilization of the capacity that has been created and jeopardize the viability.

3.2 The Project Implementation :

Once the project is accorded technical sanction, tender papers are prepared, agency is fixed and the work order is released. All these procedures take their own time depending upon the cost of the project, readiness of the agency to work and the tender quotations. One practice, however, is worth mentioning. Generally, the project is divided into two parts - The construction of head works and earthen dam and the laying out of Canal. These two parts, most of the times, are treated as two different projects. The first project report concentrates mainly on the head works. The Canal estimates are prepared at later stages and a separate sanction is sought for the purpose. The division at district level is generally concerned with the sanctioning and executing of the head works. In most of the tank projects, Canals are laid after a considerable delay. There have been cases where there has been a time lag of 3 to 4 years between the completion of head works and laying of Canals. This increases the cost of the project significantly, which is not accounted in the caluclation of the economics of the project while working out the total cost of the project, a lump sum amount is stipulated for the Canals which is invariably less than the actual cost since the detailed Canal estimates are prepared after a time gap of one or two years. This also has its implications on the commissioning of the project and the flow of benefit which should flow. The implementation of the approved project is thus not systematically programmed. This however, is purely a procedural issue and is capable of being tackled if some project management and monitoring techniques are used.

3.3 The Management, Operation and Maintenance

The management of Class I MI Tanks in the district is with the Minor Irrigation Divisiom of the district. The Sub-Divisions which cover certain jurisdiction of the district are the defacto management units. At the tank site there are two persons who are directly incharge of operation and maintenance. Each tank has an irrigation clerk known as 'Pani-

Karkun' in local parlance and a watchman known as 'Pagi'. Any unusual development is brought to the notice of the Deputy Engineer who heads the sub-division. The irrigation clerk invites for applications from the farmers during prescribed time, scrutinises them, sends them to DE's office, seeks approvals and opens the gate at the head. He is also the supervisor assisted by watchman who oversees the distribution of water, and regularises the outlet openings and closings.

The district presently has three types of Class I MI Tanks which are following :

(a) <u>All Season tanks</u> : These tanks are designed to irrigate the Command Area (Area differs with season) in all three seasoms of Kharif, Rabi and hot weather.

(b) <u>Two Season tanks</u>: These tanks are designed to irrigate the Command Area in Kharif and Rabi.

(c) <u>Kharif tanks</u> : These tanks are designed to irrigate in Kharif season only.

There is, however, nothing hard and fast about these tanks. Observations show that the All Season tanks have generally failed to irrigate in hot weather whereas there are instances where Kharif tanks have been able to supply water in Rabi and Hot weather also. The supply from a tank depends on the storage that is available in a particular year and the demand for water from the cultivators in the Command Area.

There are some general guidelines which govern the management and operation of these tanks. The government has set the time periods for season, application and delays. These guidelines are mentioned to gain a sound idea.

1. The seasons and their duration.

Season	Duration
1. Kharif*	16th June to 15th November
2. Rabi	16th October to 15th March.
3. Summer/Hot weather	16th February to 15th June
4. Summer Paddy	10th December to 31st May
5. Local as well as Hybreed Jowar	1st August to 31st Dec.

Note: * For Cotton the facility is provided beyond the given date and it is charged on two seasoned crop basis.

2. Application for Water

Season	Last date for applying	Last date for declaring approval
1. Kharif	31st July	31st August
2. Rabi	15th November	30th November
3. Summer	31st March	15th April

Note: For Summer Paddy and a two seasoned crop (Rabi & hot weather) last date for applying is 1st December.

Generally, all the provisions of Bombay Irrigation Act and Gujarat Canal Rules apply as necessary in the management of MI works.* These rules include the details about delay,

*The Details about the management and administration are given in the Manual on Irrigation Management of Minor Irrigation works, PWD, Sachivalaya, Gandhinagar, 1976.

water rates, breach of Canals, irrigation cess, betterment levy, construction of water courses etc.

Once the sanction of the section office of the DE is obtained on the application forms the irrigation clerk prepares the demand statements. The Demand statement according to Manual means, 'the statement showing the names of irrigators, particulars of survey numbers and area for which water is taken and the irrigation charges assessed for the season'. After the demand statement is finalised, the original is forwarded to the Recovery Officer, after due scrutiny.

The irrigation clerk orders the opening of the gate in consultation with the cultivators who have demanded for water. In case of serious differences of opinion he relies on his wisdom.

On paper there exists a complete system which calls for a thorough programming and management of these tanks. There is a provision for Canal Advisory Committee comprising of the Executive Engineer, the District Agriculture Officer, Taluka Development Officer and non-official members. The function of the committee is primarily of advisory nature and it is also supposed to touch the problems regarding water requirement, new and improved variety of crops, the methods of improving the supply of seeds, prevention of diseases etc. There is also a provision of 'Water Panchayat Committee' comprising of 3 to 7 members elected from among the irrigators, with each irrigator having power to vote for the member as well as in the matters of dispute. The Committee is supposed to elect a Sarpanch and look after preparation of demand statements, estimation of quantity of water required in ensuring rotation, prevention of wastage and misuse of water, holding Panchnamas in case of defaulting cultivators, settling mutual disputes etc. etc. In reality not much is done.

The maintenance of these projects is again with the divisional office. Each project or tank is provided on a prorata base Rs.10 per acre of the Command Area. The amount is used to maintain the irrigation clerk and the watchman. No earmarked fund is kept aside for the maintenance of the structure when the project is formulated and appraised. In case of major damage, the division allocates funds for repairs etc. by obtaining sanctions from the concerned authorities. It is generally felt that the maintenance side is the most neglected. This is mainly because resources allocated for this purpose are extremely scarce.

These procedural issues have been dealt at some length since successful management is key for the success of the project. The management, operation and maintenance have their impact on the utilization of the resource potential that has been created. The continuous underutilization will definitely reduce the benefits flowing to all the three namely individual farmers, project authorities as well the society as a whole.

The second reason for such discussion is that if there exists no scope for improvement in management in the given framework, then this will have to be taken as an effective constraint which will have to be considered at the time of formulation and appraisal of the project. One may have to find a way to impute some value in terms of reduced acreage due to given management while computing the Benefit-Cost ratio of the project.

3.4.0 Utilization - Conceptual Issues

The analysis and interpretation of utilization of a community irrigation project is not simplistic in nature. The basic reason is that utilization is directly related to the performance of the project. The performance evaluation then throws some light on the economic viability of the project. The objective of performance evaluation again need not be the same across area and population. The criteria evolved to judge the performance of an irrigation project depends mainly on weightages attached to certain variables whose values may help understanding the utilization. The weightages that are attached are derived from the objectives that are laid down for performance evaluation. These objectives need not necessarily be purely economic in nature. It may again depend upon the type of area that is being studied and population segment which is the beneficiary. However, some objectivity has to be evolved so that a uniform standard to judge the socio-economic viability is established.

3.4.1 <u>Productivity V/S Equity Performance</u>

Recently there has been much debate revolving around the performance evaluation of the irrigation projects. Two major issues are being discussed. One is the measurement of productivity performance and the other is the measurement of equity performance. The equity performance again involves firstly, equity in terms of availability of water at the head of the outlet of a minor, branch and main Canal, availability in the middle of the Command of these out lets and at the tail of these outlets, Second equity concept that is involved is whether the Canals should be so laid out as to benefit more of small and marginal farmers (may be at a higher cost but technically feasible) or should it be laid out according to relatively easy technical feasibility. The second equity concept is rarely being discussed by experts. For Productivity and equity performance definite areas have been well identified by Dr. Roberoto Lenton which are as follows :[5]

He states that "Productivity" performance can be measured by :

1. Water delivered
2. Area Irrigated
3. Yield
4. Income

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5 Dr. Roberoto Lenton - 'A Note on Alternative Forms of Performance Evaluation in Irrigation System', presented at Workshop on Water Resources DAP Research Projects, Bangalore, May 4-5,1981. Ford Foundation, New Delhi.

It can be measured either :

1. On the farm
2. On an outlet
3. At higher levels of aggregation.

"Equity" performance canbe measured through the variability of water delivered, area irrigated, yield and income at the head, middle point and the tail, of either a watercourse, minor Canal, distributory Canal, branch Canal or main Canal.

He further goes on to discuss the methods to evaluate, the performance and equity by working out some technically feasible optimum values and then relate it to the actuals.

In this section basically, we are concerning ourselves with first two factors mentioned under the productivity performance namely water delivered and Area Irrigation. The primary objective of the project is to deliver water and irrigate the area. The discussion on yield and income will be taken up in the next chapter. However, the study has not conducted any primary survey to collect statistics on yield and income on farm).

3.4.2 Implications for an MI Tank

Since our area of study is minor irrigation sources and especially the MI Tanks there are further problems. While measuring the water delivery performance, one is not in a position to measure exactly the water that has been delivered to farms or even water courses or field channels. The department has no practice of measuring the actual discharge even at the Head Regulator against the designed discharge. The only possible information with regard to water delivery can be had from the 'Gauge Register'. The Gauge Register is suppose to be maintained by the irrigation clerk on daily basis. It is in this register that he records the levels in the tank on day to day basis. Under the ideal conditions (which would mean that tank bed is impervious and there are no extra leakages and losses other than estimated in designs) the water delivered to the fields in the command in a particular season can be estimated by finding out the differences in water levels in tank at the time of opening the gate and at the time of closing it for the season. This difference minus the carriage losses should give us some idea about the water delivered to fields. If this exercise is performed for all the three seasons namely Kharif, Rabi and hot weather, one may be in a position to estimate the total water delivered in an agricultural year.

The issue here is that the figure thus obtained should be compared with what parametric value. This would call for an explanation on how the useful storage in a tank is arrived at. There are three variables which determine the quantity of water that will be flowing into the reservoir.They are the rainfall, Catchment Area and Run-off. The run-off is calculated on the basis of the catchment and rainfall. There are formulae worked out on experiment basis which help estimating the run-off. The formulae generally used for working out run off and storage for Minor Irrigation tanks are the ones given by Inglish and Dickens. Since one of the variable is rainfall, which has variations year in and year out, the estimates are done on the basis of 'dependable rainfall' figure. In the arid and semi-arid zones there are significant variations in the total precipitation. The current practice to arrive at 'dependable rainfall' is to tabulate the annual rainfall data for the last 40 years, arrange it in descending order and determine the annual rainfall figure by taking 75% dependability. 75% dependability would mean that the annual rainfall figure which is placed at 30th place (in descending order) is taken as the dependable rainfall. It is assumed therefore that in future 75 times out of 100 there will atleast be an annual precipitation amounting to the figure which is placed 30th. This is fairly a liberal assumption. The run off is then calculated by considering the catchment. There are three types of catchment - Good, Average and Bad. With the same total precipitation all the three catchments will amount to different- run-off figures. On the basis of run-off the total storage in the reservoir is estimated. When the catchment receives the necessary rainfall as stipulated, the reservoir is full and said to achieve the Full Supply Level (FSL). The useful storage or live storage of a reservoir is the total stored water in the reservoir upto FSL minus the bed level storage (Sill RL), which can not be supplied (Also known as dead storage).

Coming back to our discussion on water delivery, we are now clear technically that the total water discharged in all the seasons will have to be compared against the useful storage and then say something about the utilization of water. It would have been far more easy if the useful storage was an unalterable figure year in and year out.This may not necessarily be the case. One obvious reason is that the rainfall may be less than the dependable rainfall in which case the storage will be less and hence may lead to reduce water delivery. There is no solution for this phenomenon. If the precipitation in the catchment is higher than the dependable rainfall, the reservoir will have more water which will be spilling over the waste weir which is built for the purpose.

If we take the live storage figure every year and compare the water delivered for that year we shall be in a position to talk about gaps or otherwise. However, the issue is whether this kind of exercise is worth in the context of the overall project formulation and appraisal. Though it is accepted by the authorities when technical matters are discussed that the storage in the tank may vary with variation in rainfall, it is generally overlooked when the Command area is discussed. Over the project life (Normally life of MI Tank is taken to be of 50 years) it is assumed for all practical purposes that the useful storage and Command Area will not alter. If we continue to compare the water delivered every year against the useful storage under ideal conditions, we shall be going away from the reality and if we compare it with the useful storage actually stored we shall be disturbing the project viability.

However, the better thing to do is to look at the annual rainfall at the relevant rain gauge stations amd compare it with the dependable rainfall figure. If the rainfall recorded at the station is less than the dependable rainfall then one may accept it as constraint for that particular year and proceed to check the water delivery figures. If the actual rainfall for the year is equal to or more than the dependable rainfall then the useful storage can be less only if the catchment has developed some problems or the estimates are wrong.To maintain uniformity one will have to compare the water delivery against the actual storage as well as optimum storage figures. In the next section both are attempted.

The next problem is to look into the figures of Area irrigated. While formulating the project the culturable Command Area and irrigable Command Area are fixed by the project authorities. In the previous section on project formulation and appraisal we have discussed at length the vital gaps that are existing. Since they are gaps which can be corrected reviewing an ideal system one may assume that the irrigable Command Area is scientifically derived. While raising issues relating to area irrigated we shall also be making the same assumption.

In the Arid and Semi-Arid zones the reservoirs that are built for irrigation have different implications. These zones not only receive relatively less precipitation but also receive them unevenly. The distribution of rainfall is not always in consonance with the time when the crops are required to be watered. A reservoir at this stage is a boon to the cultivators. The Kharif crops are then in some sense insured against nature's niggardliness. In Rabi and hot weather the reservoirs really help in increasing the cropping intensity and shifting towards a favourable cropping pattern.

3.4.4 Tank Designs and Determining Utilization

This may be the reason that in these areas the tanks are designed specifically for seasons. As mentioned earlier in Section 3.3, the Panchmahals district has three types of Class I MI Tanks. There is a tank which by design can irrigate the fields in all the three cropping seasons, there are tanks that are designed to irrigate in Kharif as well as Rabi and there are tanks that are designed to irrigate only in Kharif. The season specific structures only mean that if the water is delivered in the season/seasons for which they are designed then no more water will be available after the season/s. For instance, a MI tanks designed for Kharif alone will exhaust water by irrigating fields in Kharif and will not be able to irrigate fields in Rabi. However, if there are only few farmers in Command Area who have demanded and used water in Kharif then some of the useful storage will be available for the Rabi season also which can be utilized. The utilization by way of area irrigated, therefore, is not a simple expression of number of acres. Once again we resort to the ideal conditions. If the rainfall is above dependable figure, if the catchment has had no other problems, and if the calculations are correct then we have the necessary storage or designed useful storage. Let us assume that the tank is designed to irrigate in two seasons Kharif and Rabi. Let us also assume that the irrigable Command Area in Kharif is calculated correctly after making due allowances for carriage losses. Now if the actual area irrigated in Kharif is less than the potential area, would we be justified to call this phenomenon as underutilization. This is a moot point. Firstly because one will have to make sure that rainfall was either not sufficient or not evenly spread or both, before making any statement about underutilization. If the Command Area receives good and evenly distributed rainfall then the farmers may not be inclined to demand water for irrigation. In such an event no water may be supplied in Kharif. The useful storage available for Rabi crops then will be higher than the storage which would have been available had there been complete stipulated supply of water in Kharif. The storage available in Rabi will be equal to the water that could be supplied in Kharif plus the Rabi share minus the evaporation losses that would take place during Kharif. This storage will no doubt be capable of irrigating more acreage than estimated for Rabi season, but it can not be simply an addition of Kharif and Rabi area. Such simple addition will not be possible because there will be feasibility problem. By gravitation the water may reach only certain point and not beyond since the discharge at the head would be an already fixed quantity. The alternative uses of the extra storage then could be two. One could be to irrigate more intensively and the other to carry over the storage further for hot weather for which the tank is not basically designed. This will be strictly an added advantage of the project. Intensive irrigation could be beneficial as well as efficient if and only if the pre-planning had a thin supply approach to a larger Command. If sufficient intensity is already planned for, intensifying further would only lead to the wastage of water. The additional area that would get irrigated due to increased storage/supply (or increased intensity in Rabi) in Rabi as well as Hot Weather will not strictly be comparable. The increased production in the Command due to this phenomenon will have different implications. The extent of utilization then will have to be measured depending upon the supply in each season after Kharif.

The Command Area that has been fixed for Kharif then comes under question.The general practice is to add the Command Area for Kharif and Rabi and call it the total Command. The Command Area that is fixed for Kharif season only tells us about the feasibility of water reaching the fields in desired quantity at the time of requirement. It is not the area which would get irrigated every year inKharif. Since the Command Area of a MI Tank is generally small not exceeding 2000 acres, one can easily rule out the possibility of different farmers experiencing separate differences in total precipitation and variation in precipitation. That is to say if one farmer experiences shortage of water or lengthening of rainfall time beyond the crucial watering srage, all the farmers in the Command of a MI tank will experience the same thing. The only possible exception will be a small band of those farmers who would have delayed sowing. Such farmers would generally be a very insignificant proportion of the whole and hence may be ignored (Incidentally, the department is also reluctant to accept demand from a very small group of farmers. Since economies of scale would disfavour such a supply). It can be said, therefore, that the entire Kharif Command area will be brought under irrigation only when there is insufficient or uneven rainfall. This depends upon the statistical probability of insufficient rainfall worked out on the basis of past - atleast 100 years experience. Say for instance for Panchmahals district the statistical probability of insufficient and uneven rainfall is said to be 0.35.[6] This means that every third year is potentially an year of insufficient and uneven rainfall. The farmers are likely to demand water in Kharif every third year which is a shortage year. In the project life of 50 years of a MI Tank it may experience demand for water in Kharif for 16 or 17 years. For rest of the period it may or may not receive any demand for water. Now the Command area (total) for the project will be different for these 16 to 17 years and it will be different for rest of the 33 to 34 years other things being equal.

3.4.5 Cropping Pattern and Changes in Utilization

All along the above discussion the cropping pattern is left out or a cropping pattern not disturbing the above analysis has been assumed. However, in reality it is most likely that cropping pattern will change with irrigation. The farmers in the Command area will be generally growing rainfed crops. The crops would normally be the food grains consumed as staple food. The first possible change due to irrigation project may be that

6 DPAP Project Report 1974-75 - 1978-79. DPAP Agency Panchmahals 1974. Currently known as Rural Development Agency Panchmahals, Godhra.

the farmers may shift from inferior cereals (crops) to superior and hybreed varieties since accessibility to water now would reduce the risk significantly. The lone feeling that water can be tapped when necessary may be enough for the farmers to improve their confidence. Even if no acreage is brought under irrigation in Kharif, such a qualitiative change in cropping patterns may be beneficial for the society, One should not become highly optimistic since the water security is only one of the many significant variables that govern the farmer's decision to change. The other change in cropping pattern could be experienced by way of shifting from food crops to edible and non-edible long duration cash crops. These crops obviously can not be grown under rainfed conditions for the reasons already well-known. In such an instance there will be demand for water in Kharif season also whether the rainfall is sufficient or not. One would, however, expect that the Kharif Command that is fixed at the time of project formulation has stipulated such a change and accordingly the duty and other relevant details are worked out. If such preplanning has not been done by the project authorities at the time of formulation then the area actually irrigated in Kharif may turn out to be lower than the potential. If the project supplies water to all the farmers in Kharif with some of them growing high water requiring crops not projected in the cropping pattern, the supply will also exhaust some quantity of water that would have otherwise been supplied in Rabi. A similar phenomenon may be observed during Rabi also. If the total area irrigated shrinks as a result of this then whether we could call it underutilization or not becomes a debatable point. Looking at the area irrigated alone, therefore, is not a sound measure of the extent of utilization. The related things along with the area are crops, their duration, water requirement, yield and income. These things are all the more relevant when the proposed cropping pattern has failed to incorporate possible changes. If the proposed cropping pattern is near the actual cropping pattern then one may draw meaningful conclusion from the extent of underutilization in terms of accreage.

3.4.6 Lack of Demand and Utilization.

Before the discussion on this point is closed one point must find expression. There is a tendency among the officials (the managers and administrators) to offer an apparently powerful explanation regarding the underutilization of the irrigation both in terms of water delivered and acreage covered. Since the supply of water is regulated after there is demand from the users side, they state that the underutilization is mainly due to lack of demand and hence it should not be strictly regarded as underutilization. If we accept that that with all the given things there is lack of demand for water from the users side we also accept that the farmers in the area are for reasons to be explored not willing to either charge the cropping pattern or are constrained by somethings and hence not demanding water for irrigation. This is particularly true for Rabi and Hot Weather crops. It is possible that the other inputs supply is not easy in the area, the necessary credit is nonexistent and/or the farmers are not still attuned or ready for a change. However, the use of less water in less acreage has to be reckoned as underutilization, since the development of Command is an integral part of the construction of an irrigation project and if the authorities have not been able to coordinate, it is a case of bad project formulation, appraisal, implementation and management.

3.4.7 Variations in Storage and Utilization

The second reason for discussing the issue which relates to the justification of calling the difference in area between the potential and actual in a given year as the underutilization is that the storage in the tank itself may vary depending upon the rainfall. The Kharif Command is generally fixed considering the storage at Full Supply Level. The given acres of area in any MI Tank project would potentially get irrigated if the storage is at FSL. Any change in storage would mean reduction in potentially irrigable area either in Kharif or in Rabi. There may be occasions when the actual rainfall is less than the dependable rainfall, the storage will not be upto FSL. If the tank is designed for Kharif only then it is likely that the available storage in that particular year will not be in a position to irrigate the potential acreage. In case of Kharif alone or it will definitely be insufficient for Rabi if water is supplied in Kharif. For such a year the shrinkage in area may not be strictly termed as underutilization. But then the potential Command used for other years also can not be taken as same for such a scarce year. The formulating authority should work out on a priori basis the potential Command for years when the actual rainfall will turn out to be less than dependable rainfall. This further raises another issue. A general and much more accepted justification offered for investing in MI Tanks is that these reservoirs act as insurance against nature's behaviour. This justification has to be accepted with a pinch of salt. The justification is valid only upto some point. In the extreme cases where actual total rainfall is less than the dependable rainfall, the tank or the mini reservoir will also not be in a position to store more water. The run off will reduce, the evaporation will be faster and deep percolation may be speedy. Except for a very few cultivators at the head, the Command area in general will suffer as badly as it would have without the tank. However, when the actual rainfall is equal to or more than the dependable rainfall but less than the amount that can help retaining of water in crop zone, the reservoir will help. The crops may be requiring a single or at the most two to three additional waterings to yield optimum (given other inputs). How often such a situation is faced is a matter to be studied while formulating the project. This will be better illustrated by a figure below :

Actual and Sufficient	FSL irrigation possible but no demand
Actual Rain fall more but not sufficient for crops to grow	
Dependable Rainfall	FSL POSSIBLE Possible irrigation and demand
Actual Rainfall$_1$	Below FSL little irrigation at head
Actual Rainfall$_2$	No storage irrigation not possible

To measure the extent of utilization in terms of accreage or area, therefore, is not easy. The criteria may have to be altered from tank to tank. There is no uniform measure which can be adopted. The aggregation of the figures derived from all the tanks is not just possible.

In the next section we shall look into the extent of utilization by more than one possible manner. The extent of utilization will be measured in the following context.

(A) Available useful storage or live storage.

(B) Potential Area determined (CCA/DCA) and Actual Area Irrigated.

(A) While analysing the live storage and its utilization, we shall first compare the rainfalls for reference years vis-a-vis the dependable rainfall figure and then review the figures on amount of water used by season. The gap between the available useful storage and the actual amount of water used will be termed as under-utilization of water.

(B) In area/acreage analysis we shall first work out the acreage that would potentially get irrigated on the basis of duty, available storage and proposed cropping and then check the actual cropping pattern and area that has been irrigated. The difference between the potential area and the actual area will be termed as underutilization.

3.5. 0 Extent of Utilization :

As the departmental statistics go the total number of completed and operating Class I MI Tanks number 56. The list has been given in appendix 1 of this chapter. These tanks have been built over a period of 30 years or more. Some of them are very old tanks still in operation. For some of these old tanks many relevant details are not available. The MI Division has taken them over, when the Division was entrusted with the overall management in 1962-63 the starting of the Panchayati Raj in the districts of the State. Some of the tanks have had their natural existence in the area, some of them originally had been scarcity works and some of them are constructed as new works for irrigation.Not all tanks are technically sound at this date.Some of them have problems which are technical in nature and hence, can not possibly be considered as operating ones. We shall first try to list down these tanks classifying them into their major characteristics.

The first classification that we have attempted relates to the time of construction. The tanks have been classified into three periods, namely, before 1961 as old tanks, between 1961 to 1970 and 1971 to 1980. Table 3.4 displays that the district has 18 tanks built before 1961, 12 tanks built in the sixth decade and 26 tanks built in the 7th decade. This really means that the 46% of tanks are built in the seventh decade showing the high investment concentration in minor irrigation. The advent of Drought Prone Areas Programme (DPAP) in 1974-75 and Tribal Sub-Plan (TSP) in 1975 has made this progress possible. What is interesting, however, is the status of these tanks today. Out of 18 old tanks 14 (77.78%) are completely operational, 3 (16.66%) tanks have leakage problem and 1 (5.56%) tank has problem of silting. This tank namely DT34 is more than 50 years old and one would be surprised if the tank bed has remained without silting to full. This tank, therefore, is out of the scope for our analysis.

Table-3.4

Classification of Class I MI Tanks in Panchmahals

Time Versus Problem

Tank built and commissioned period	Completely operational Tanks	Tanks with Leakages Headworks/ canal	Tanks specified as without lining & water courses	Tanks with porous bed	Tanks with silted bed	Tanks whose canals are recently completed	In-completed canal	Total
1	2	3	4	5	6	7	8	9
Old Tanks	GA1,GT1 GT2,GK1 GT3,GK2 LUK3,HK11 ZT22,ZT23 ZT25,ZT26 ZT29,ZT30	SHK6 DK18 DT36	-	-	D PT34	-	-	-
Sub-Total	14(97.78)	3(16.66)	-	-	1(5.56)	-	-	18(100)
1961 to 1970	Lut4, LUT7 ZK15,LUT6 LUK5,LUT8 ST20	SHT9,PT32	ST17,ST18 ST19	-	-	-	-	
Sub-Total	7(58.33)	2(16.67)	3(25.00)	-	-	-	-	12(100)
1971 to 1980	LUK4,SHK7 SHK8,ZT24 ZT27,ZK16 ZT28,LUT5 ZK17	JT12,DBT13 DBT14,DBK13 DBT15,DBK14 PT33,DT31	ST16	LK9,LK10	-	LT10,ST11 HK12	ST21, DPK19 DT35	
Sub-Total	9(34.61)	8(30.77)	1(3.84)	2(7.69)	-	3(11.54)	3(11.54)	26(100)
Total	30(53.57)	13(23.21)	4(7.14)	2(3.57)	1(1.78)	3(5.36)	3(5.36)	56(100)

Note: Figures in bracket indicate percentage

The 12 tanks which have been built in sixth decade of the century contain 7 (58.33%) completely operational tanks, 2 (16.67%) with leakages and 3 (25.00%) with unlined canals and no water courses or field channels. The 26 tanks built in the Seventies contain (9 - 34.61%) completely operational tanks. 8 (30.77%) with leakages, 1 (3.84%) with unlined canal and no field channels, 2(7.69%) porous tank bed, 3(11.54%) with canals recently completed and 3 (11.54%) with incomplete canals. The total picture that emerges is, out of 56 tanks 30 (53.57%) are completely operational 13(23.21%) have leakage problems. 4(7.14%) with unlined canal and no field channels, 2 (3.57%) with porous tank bed 1(1.78%) with silted bed, 3 (5.36%) each with recently completed Canals and incomplete Canals.

'Old is Gold' is what is often said by the traditionalist. It is true atleast in this case. It is evident from the table that the tanks that have been built before 1961 have maximum share in totally operational tanks. The relatively recently constructed works have had a large share towards the problem tanks. It is to be noted that it is the recently built tanks which have leakage problems indicating towards bad workmanship generally and porous bed problem (wrong identification of site). With the overall improvement in technology one could have expected monumental structures today rather than looking for them in history. The fact is that with the passage of time the proportion of completely operational tanks to the total tanks built has been sharply declining.

Another classification with slight change has been attempted and is presented in the form of Table 3.5. Here instead of classifying according to time period we have classified them into two major categories. One is the tanks existing naturally and then converted into MI Tanks and the other is tanks designed and constructed as MI tanks. Of the 56 tanks, 29 fall in the former category and 27 in latter. Table 3.5 seems to offer a clue to the operational fitness of the tanks in a general way. Of the 30 completely operational tanks 21 tanks existed naturally and have been converted into MI tanks, only 9 have been successfully designed and constructed a fresh. Of the 29 natural tanks sites converted, 1 is extremely old (DT34 already referred) 1 is without field channels (not a technical fault) and 6 are with leakage problems. Of 27 newly designed tanks only 9 are operational and rest have problems of one kind or the other. The table shows that, in general, the natural tank sites have better scope to be converted into completely operational tanks. The reason may be purely technical to deal with which is (a) beyond the scope of the study and (b) beyond the competence of the author. The relevant point which we wish to make, however, is that the project formulation authorities could have and may still draw useful lesson from

Table-3.5

Classification of Class I M.I.Tanks in Panchmahals

Design Versus Problems

Major classification	Completely operational tanks	Tanks with leakages Headworks/ Canal	Tank specified as without lining & water courses	Tanks with porous bed	Tanks with silted bed	Tanks whose canals are recently completed	In-completed canal	Total
1	2	3	4	5	6	7	8	9
Tanks existing naturally and converted in MI tanks	GA1,GT1,GT2 GK1,GK2,GT3 LUK3,LUT4, LUK4,LUT5 LUT6,LUT7 LUT8,LUK5 SHK9,SHK8 ZT22,HK11 ZT25,ZK15,ZT26	SHK6 SHT9 DBK13 DPT32,DT36 DK18	ST16		DT34			
Sub-Total	21(72.5)	6(20.7)	1(3.4)		1(3.4)			29(100)
Designed and constructed as MI tanks	ST20,ZT23 ZT24,ZT27 ZK16,ZT28 ZT29,ZT30 DK17	JT12,DBT13 DBT14,PBT15 DPBK14,DT31 DT33	ST17,ST18 ST19,	LK9,LK10	-	LT10,HK12 JT11	DK19,DT35 ST21	
Sub-Total	9(33.33)	7(25.92)	3(11.11)	2(7.40)		3(11.11)	3(11.11)	27(100)
Total	80(53.57)	13(23.21)	4(7.14)	2(3.57)	1(1.78)	3(5.36)	3(5.36)	56(100)

Note: Figures in brackets indicate percentages.

this experience. If newly designed tanks are prone to technical problems after construction, it may lead to wastage or underutilization of the source in a significant manner. This, in actual operation, would definitely mar the economic viability of the project.

A further classification may be attempted to see whether the new designs have been resorted to in the latter years or successful attempts have been made in past also. This classification may also throw some light on the problematic tanks which existed naturally. Table 3.6 reveals this information. Of the 30 completely operational tanks 14 are old tanks. 11 of these 14 have been converted into MI tanks whereas 3 have been designed and constructed. The consolidated position of natural old tanks which were converted into MI tanks is that that out of 15 tanks, 11 (73.33%) are completely operational, 3 (20.00%) have leakages problems and 1 of course is an outdated one. There are 3 tanks which are old but have been designed and constructed to be MI tanks and all of them are operational. There are 8 tanks existing naturally and converted into MI Works of which 6 (75%) are completely operational and 2 (25%) have leakage problems. There are 4 tanks which have been built in sixties specifically designed and constructed to be MI tanks of which 1 is completely operational the rest three have a non-technical problem namely absence of field channels. There are 6 tanks

Table-3.6

Classification of Class I MI Tanks in Panchmahals

Design/Duration Vs. Problems

Classification of tanks	Completely operational tanks	Tanks with leakages Headworks/ Canal	Tank specified as without lining & water courses	Tanks with porous bed	Tanks with silted bed	Tanks whose canals are recently completed	In-completed canal	Total
1	2	3	4	5	6	7	8	9
Tanks existing naturally and converted in MI tanks								
i) Old Tanks	11(73.33)	3(20.00)	-	-	1(6.67)	-	-	15(100)
ii) 1961 to 1970	6(75.00)	2(25.00)	-	-	-	-	-	8(100)
iii) 1971 to 1980	4(66.67)	1(16.67)	1(16.66)	-	-	-	-	6(100)
Sub-Total	21(72.41)	6(20.69)	1(3.45)	-	1(3.45)	-	-	29(100)
Designed and constructed as MI tanks								
i) Old tanks	3(100)	-	-	-	-	-	-	3(100)
ii) 1961-1970	1(25)	-	3(75)	-	-	-	-	4(100)
iii) 1971-1980	5(25)	7(35)	-	2(10)	-	3(15)	3(15)	20(100)
Sub-Total	9(33.33)	7(25.92)	3(11.11)	2(7.40)	-	3(11.11)	3(11.11)	27(100)
Grand-Total	30(53.57)	13(23.21)	4(7.14)	2(3.57)	1(1.78)	3(5.36)	3(5.36)	56(100)

Note: Figures in brackets indicate percentages.

which have been naturally existing and converted in MI work of which 4 (68%) are completely operational, 1 has leakage problem and the rest has absence of field channels. There are 20 tanks which have been specifically designed and constructed as MI Tanks built in seventies of which only 5 (25%) are completely operational. The following few points are discrernible from the above classification :

1. The naturally existing tanks that have been converted into MI works have an advantage over specifically designed MI tanks.
2. There does not seem to be a systematic approach by the department to exploit the natural sites first since as many as 14 (almost 50%) works have been taken in sixties and seventies.
3. The designs and workmanship before 1961 and in 1960s seem to be better than in the seventies since of the 18 old tanks 14 are completely operational which is about 78% and of the 12 tanks built in sixties, 7 are completely operational which is about 58%. In seventies 26 tanks were built and only 9 are operational which is about 34%.
4. The problem of leakage has almost same proportions for both the naturally existing tanks as well as specifically designed ones. The reasons for this phenomenon seem to be

(a) The age problem (out of 13 leakage problem 3 are old tanks built before 1961) and

(b) The workmanship/technical problems (2 are built between 1961 to 1970 and 8 are built after 1971).

5. Lack of proper identification (2 tanks with porous bed built in seventies) and implementation management seem to have deteriorated after 1961 and more so after 1971. This may be because the department was pressed with expenditure oriented thrust due to advent of special programme such as DPAP and TSP.

The lessons one learns from this kind of classification can effectively work as a feed back to the project formulation authorities. It has a specific relevance to our analysis in the next few sections. Reviewing the extent of utilization, the above classification helps us in reducing the number of tank works for the purpose. It is clear by now that if any worthwhile utilization study has to be done, we shall have to concentrate only on 30 completely operational tanks. These tanks vide the departmental statistics and reports have no problem whatsoever and are supposed to be functioning in a normal way. This means that with dependable rainfall, the FSLs can be obtained and thus are potentially equipped to irrigate the stipulated Command Area with proposed cropping pattern.

We shall be studying the utilization of these tanks within the same broad classification of age and design. We shall also add a new dimension which has uptill now been absent namely, the size of the Command Area. Though all the Class I MI Tanks have a minimum of 100 acres area in command, the upper limit is 2000. We may get a clue to better utilization in the size classification of tanks and their utilization performance.

A better possible approach to review the extent of utilization of tanks in the district would be to consider them according to their designs. As stated earlier the tanks in the district are of three types. The first type of design is to suit irrigation in all the three seasons namely Kharif, Rabi and Hot. This has been coded as 'A' type tanks. The second type coded as 'T' are designed for Kharif and Rabi seasons. The third type coded as 'K' are designed for Kharif only.

Table consisting of the details of 30 completely operational tamks which are under our review has been compiled in statistical appendix which may be called for if necessary. The table gives information on estimated dependable rainfall, Actual rainfall for years for which the utilization statistics are available, Live capacity of the tank, season-wise potential CA, water quantity available in reference years and season-wise actual acreage under irrigation. These were taken directly from the tables that are made available from the department. On the basis of these figures we have worked out the average duty and actual duties for the reference years.

3.5.1 Utilization in One All Season Tank

The departmental statistics that is available is for different set of years for different tanks. 11 years data for the tanks built before 1970 are available and about 5 years data are available for the tanks built between 1970 and 1980. Table 3.7 displays utilization statistics of tanks by design and total number in reference years. The district has 1 all season tank that is completely operational. The utilization statistics is available for 11 years from 1969-70 to 1979-80. In the span of 11 years two years 1974-75 and 1975-76 have been bad years from the point of view of available storage. In 1974-75 the actual rainfall has been less than the dependable rainfall assumed for the stipulated storage. In 1975-76 the rainfall is more but it is likely that the rainfall in catchment is less than the dependable figure. Since the actual rainfall has been recorded at the Taluka Rainguage Station at taluka headquarters, it is likely that it does not necessarily coincide with the rainfall in the catchment. This limitation is expected since the department would find it difficult to have a rainguage station at every possible tank site. For Nine years the water available in

Table-3.7

Pattern of Utilization of Class I MI Tanks in Panchmahals by Design

(Area in Acres and Gunthas : 40 Gunthas = 1 Acre; Water use in Mcft Million Cubic Feet; Duties as Acres per 1 Mcft.)

Tank Design/ R.Yrs.	No.of tanks	Live Capa city of tanks	Total Potential Command Kharif	Rabi	Hot	Total	Average duty A/Mcft.	Total water qu.available in ref.years Mcft.
1	2	3	4	5	6	7	8	9
All Season	1	51.04	150	190	40	380	7.44	
1969-70	1	"	"	"	"	"	"	51.26
1970-71	1	"	"	"	"	"	"	51.26
1971-72	1	"	"	"	"	"	"	51.26
1972-73	1	"	"	"	"	"	"	51.26
1973-74	1	"	"	"	"	"	"	51.09
1974-75	1	"	"	"	"	"	"	17.09
1975-76	1	"	"	"	"	"	"	43.79
1976-77	1	"	"	"	"	"	"	51.09
1977-78	1	"	"	"	"	"	"	51.09
1978-79	1	"	"	"	"	"	"	51.09
1979-80	1	"	"	"	"	"	"	51.09
Rabi Season								
1969-70	12	534.72	3611	2832	-	6443	12.05	505.94
1970-71	12	"	"	"	-	"	"	533.95
1971-72	12	"	"	"	-	"	"	467.17
1972-73	12	"	"	"	-	"	"	375.55
1973-74	9	431.84	2500	2377	-	4877	11.29	432.39
1974-75	9	235.91	1881	1712	-	3593	15.23	104.11
1975-76	17	728.59	5536	3528	-	9064	12.44	731.63
1976-77	17	"	"	"	-	"	"	751.61
1977-78	17	"	"	"	-	"	"	739.31
1978-79	17	"	"	"	-	"	"	747.31
1979-80	17	"	"	"	-	"	"	685.15
Kharif Season								
1969-70	5	373.33	3625	-	-	3635	9.74	276.54
1970-71	5	"	"	-	-	"	"	302.12
1971-72	5	"	"	-	-	"	"	161.17
1972-73	3	325.56	2980	-	-	2980	9.15	61.94
1973-74	6	285.20	3860	-	-	3860	10.02	386.49
1974-75	4	337.43	3205	-	-	3205	9.50	60.70
1975-76	8	443.65	4832	-	-	4832	10.89	423.32
1976-77	9	473.78	5453	-	-	5453	11.51	459.23
1977-78	9	"	"	-	-	"	"	450.64
1978-79	10	496.57	5954	-	-	5954	12.00	464.75
1979-80	10	"	"	-	-	"	"	382.55

Table 3.7 (contd.)

Tank Design/ R.Yrs.	Actual Irrigation Acreage Water use and duty: Kharif Acres	Kharif Water	Kharif Duty	Rabi Acres	Rabi Water	Rabi Duty	Hot Acres	Hot Water	Hot Duty	Total Acres	Total Water	Total Duty	Percentage Area Irrigated to Potential: In Kharif	In Rabi	In Hot	Percentage of Actual to Total Potential
1	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
All Seasons																
1969-70	35.30	10.68	3.36	[illegible]	[illegible]	[illegible]	[illegible]	–	–	120.05	[illegible]	[illegible]	23.83	39.7	[illegible]	[illegible]
1970-71	39.15	14.87	2.64	57.05	25.92	2.20	45.30	10.65	4.30	142.10	51.44	2.77	26.15	30.00	114.37	37.43
1971-72	–	4.04	w	61.10	26.07	2.35	19.05	12.81	1.49	80.15	30.11	1.87	–	32.23	47.81	21.15
1972-73	6.00	1.51	3.97	–	–	–	16.10	14.83	.10	22.10	16.34	1.36	40.00	–	40.40	5.86
1973-74	–	–	–	49.05	21.33	2.3	–	–	–	49.05	21.33	2.30	–	25.85	–	12.93
1974-75	20.00	17.09	1.17	–	–	–	–	–	–	20.00	17.09	1.17	13.33	–	–	5.26
1975-76	–	–	–	31.00	24.29	1.28	–	–	–	31.00	24.29	1.28	–	16.31	–	8.16
1976-77	–	3.68	w	15.00	20.29	00.75	1.10	–	–	16.10	23.97	00.68	–	7.89	3.12	4.28
1977-78	–	–	–	–	8.09	w	–	34.78	w	–	42.87	w	–	–	–	–
1978-79	–	1.92	w	22.10	33.30	00.67	–	16.17	w	22.10	51.39	00.43	–	11.71	–	5.86
1979-80	25.30	4.24	6.0	[illegible]	13.56	w	–	–	–	25.30	17.80	1.45	17.16	–	–	6.78
Kharif & Rabi Seasons																
1969-70	522.15	45.02	11.6	2829.15	315.01	9.0	–	4.21	–	3351.30	364.24	9.2	14.47	99.90	–	52.02
1970-71	419.25	59.45	7.1	2824.25	332.14	8.5	10.20	19.16	0.5	3254.30	410.75	7.9	11.62	99.74	–	50.52
1971-72	666.10	82.92	8.0	2239.10	250.04	9.0	–	18.33	w	2905.20	351.29	8.3	18.45	79.06	–	45.09
1972-73	128.00	105.01	10.7	2048.25	211.62	9.7	13.35	1.35	8.9	3190.25	318.18	10.0	31.24	72.34	–	43.52
1973-74	236.30	23.82	10.0	1901.10	260.43	7.3	86.20	11.70	7.3	2224.20	296.09	7.5	9.47	79.98	–	45.61
1974-75	118.05	23.67	5.0	577.20	77.49	7.4	12.00	–	–	707.25	101.16	7.0	6.28	33.73	–	19.69
1975-76	224.20	28.34	7.9	4034.15	506.61	8.0	25.10	–	–	4284.05	534.95	8.0	4.06	114.35	–	47.26
1976-77	246.10	20.24	12.2	3523.30	430.45	8.2	67.10	23.88	2.8	3837.10	474.57	8.1	4.45	99.87	–	42.33
1977-78	150.35	13.68	11.0	2942.20	461.18	6.41	144.25	53.94	2.7	3238.00	528.80	6.1	2.73	83.40	–	35.72
1978-79	255.10	17.84	14.3	3199.05	473.94	6.81	179.35	48.80	3.7	3634.10	540.58	6.7	4.61	90.67	–	40.09
1979-80	565.05	78.77	7.2	2874.20	381.66	7.5	121.30	20.63	5.9	3561.15	481.06	7.4	10.21	81.48	–	39.29
Kharif Season																
1969-70	2183.35	169.63	12.9	679.00	62.64	10.8	–	4.67	w	2862.35	236.94	12.1	60.07	–	–	78.75
1970-71	1479.15	82.95	17.8	667.10	93.19	7.2	41.30	43.74	0.9	2188.15	219.88	9.9	40.69	–	–	60.20
1971-72	1318.00	112.84	11.7	176.00	20.90	8.4	10.10	2.66	3.9	1504.10	136.40	11.0	36.26	–	–	41.38
1972-73	181.15	17.93	10.1	57.20	6.50	8.8	–	–	–	238.35	24.43	9.8	6.09	–	–	8.01
1973-74	883.25	45.24	19.5	904.30	162.65	5.6	72.15	38.63	1.9	1860.30	246.52	7.5	22.89	–	–	48.20
1974-75	133.30	34.52	3.9	66.30	7.63	8.7	248.05	110.00	2.3	448.25	152.15	2.9	4.17	–	–	13.99
1975-76	1509.25	79.21	19.0	1560.15	199.71	7.8	11.05	7.10	1.6	3081.05	286.02	10.8	31.24	–	–	63.77
1976-77	1991.00	107.15	18.6	1825.05	214.63	8.5	77.20	51.91	1.5	3893.25	373.69	10.4	36.51	–	–	71.40
1977-78	1525.30	81.92	18.6	1517.35	165.55	9.2	200.30	86.37	2.3	3244.15	333.74	9.7	27.97	–	–	59.50
1978-79	1612.05	89.04	18.1	2221.35	248.48	8.9	8.10	43.21	0.2	3842.10	380.73	10.1	27.07	–	–	64.53
1979-80	2387.10	214.69	11.1	831.35	146.56	5.7	19.05	6.68	2.9	3238.10	367.93	8.8	40.09	–	–	54.38

reference year has been equal to or higher than the expected live capacity of the tank in question. This means that for 9 years out of 11 the tank could irrigate 150, 190 and 40 acres respectively in Kharif, Rabi and Hot seasons. The actual water use and acreage however tells a different tale. Out of Nine normal years there has been irrigation in 4 Kharif Seasons. The extent is lowest with 4% in 1972-73 and highest with 26% in 1970-71. Of the two bad years about 13% irrigation has been recorded in Kharif in relatively worst year of 1974-75 where as there is no irrigation in Kharif in 1975-76.

Rabi utilization in 9 normal years show that there has been irrigation in 6 years. The lowest irrigation was 7.9% in 1976-77 and highest was 39.7% in 1969-70. Of the relatively bad years there has been no irrigation in Rabi in 1974-75 and about 16.3% irrigation in 1975-76. In hot season the relatively bad years went without any irrigation whereas out of 9 normal years there was irrigation in 5 years with highest of 114% in 1970-71 and lowest of 3% in 1976-77.

The easy explanation for non and underutilization in Normal Kharif years is that of the good rainfall in Command. The cultivators might not have demanded water for irrigation. In 1974-75 the total store of 17.09 Mcft was used up in irrigating a meagre 20 acres area. The water use in a given season indicate to some extent towards the possible under coverage of the area. In a bad year the water use per acre expressed in terms of duty is highest whereas in normal years it has been high compared to the average duty assumed. The duty in the normal years when irrigation has taken place varies from 2.64 Acres/per Mcft to 6.07 Acres/per Mcft. This suggests that more water quantity than assumed has been used up in every year. On the basis of these figures we may say that even the normal years could not have possibly irrigated the proposed Command Area by season. The water use statistics would have been a complete explanation for the undercoverage of area in each and every season had the total water use been equal to the available storage in the reference years. However, that is not the case. Column 20 of Table 3.7 gives the figures for total water expended which shows that except for the years 1970-71, 1974-75 and 1978-79, the entire water quantity available in reference years was not used up. With actual heavy duties, the tanks still contained some store to cater to more area than what was actually covered. One reason may be that there was no demand. This issue we shall take-up in the following sections when we shall be discussing the cropping pattern and demand for water. We conclude at this stage our observations for all season tanks by stating that actual water use has been highest in hot season followed by Rabi and Kharif and there has been underutilization in acreage terms.

3.5.2 Utilization in Two Season Tanks

We now turn our attention to the two seasoned tanks. The number of tanks for which observations are available vary from 9 to 17. There are 18 tanks designed for two seasons that are completely operational. Of these one is a flow scheme for which storage is not recorded. It is a Bandhara* construction. The number of tanks considered for years 1969-70 to 1972-73 are 12. For the remaining 5 tanks, the statistics are not available since they are relatively newly built structures. For 1973-74 and 1974-75 9 tanks have been considered since rest of the 3 tanks did not record any storage may be due to short fall in actual rainfall. For 1975-76 to 1979-80 period all the 17 tanks have been considered. The first feature of the table is that the irrigation potential stipulated in terms of acres is high in Kharif relatively to the Rabi potential. This means that in the normal years with full storage the structure would irrigate relatively more area in Kharif. The water availability in reference years show different trends. In the early years (from 1969-70 to 1972-73), the total available quantity has been less than the stipulated live capacities of the tanks. In 1973-74 the water available was slightly higher than the stipulated live capacities. In 1974-75, a bad year throughout the district recorded lowest storage in almost all the tanks. From 1975-76 onwards

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* For details on Bandhara kindly refer to the Glossary on Irrigation terms in the Appendix IV.

the available storage has been more or less equal to the stipulated storage.

The area covered in Kharif Seasons has been fluctuating between 2.73% in 1977-78 and 31.24% in 1972-73. The water use in two season tanks has been better than the water use in the lone all season tank. However, the fluctuation in duty values over number of years has been there. The lowest duty recorded has been 14.3 in 1978-79 and highest has been 5 in 1974-75. The high water use in 1974-75 is possibly because of a very bad year. The irrigation in Kharif seasons (except 1974-75) has been following a pattern. It may be noted that more area is covered under Kharif irrigation in the years when the water availability in the tanks have been less than the stipulated amounts. For instance 1972-73, the water actually stored by 12 tanks amounted to 375.55 Mcft against the capacity of 534.72 Mcft. The corresponding Kharif irrigation in the year is 3190.25 acres which is about 31% of the total Kharif potential and is highest. The Kharif irrigation in late seventies is less and water actually stored is mostly higher than the stipulated capacities. A very simple explanation is that the total precipitation in the actual catchment as well as in Command must have been less than the dependable rainfall leading to lesser storage and more water demand by the Command Area cultivators. The water demand in Kharif is mainly either because the rainfall distribution fails to favour farmers or the total rainfall falls short of the requirement or both. Considering once again the year 1972-73, it can be said that the actual rainfall in the catchment must have been less than the assumed rainfall leading to shrinkage in the storage. At the same time the cultivators in the Command Area seemed to have demanded more water due to insufficient rainfall. This correlation, however, can not be established with much authenticity because there does not seem to be a proportionate relationship between the fall in the level of actual storage and rise in the area for which water is demanded. Had it been so then the minimum storage year would have shown proportionately higher area under irrigation and full storage years would have shown lowest area under irrigation. Another reason for this is that there is a possibility of change in the actual cropping pattern adopted by the farmers compared to the proposed one by the project authorities.

Irrigation in Rabi has been good in almost all the tanks except for the year 1974-75. It has been more than 70% in almost all the tanks reaching 114% utilization in 1975-76. The duty figures suggest that water use has been much intensive in Rabi compared to Kharif irrigation. This is explanable since in Rabi there is hardly any rainfall. However, the water use has been more compared to the average duty assumed. If the Kharif acreage had been nearer to the Kharif potential there would have been less supply available for Rabi.

The Rabi irrigation has been partly possible because of less irrigation in Kharif. It is necessary to note that if there was a demand in Kharif and Rabi to the proposed extent the department would not have been able to supply to the entire area. The scope for underutilization in terms of acreage is thus built in within the given systems.

There has been some irrigation in hot season too, though, the structures are not designed to cater to such demand. This is mainly because the total supply of water was not exhausted completely in the years in which summer crops have been irrigated. The use of water in hot season is again highly intensive compared to Kharif and Rabi seasons. This phenomena may be explained with the help of two factors. One is that the duty in hot crops is generally heavy and second factor is the wastage. The total discharge that has to be allowed from the main and subsidiary outlets has to be the same irrespective of the total area for which water is demanded. If a farmer at the tail end of the Canal registeres a demand he has to be supplied with water with the same discharge rate. This increases the wastage. Supplying water to 'minimum area blocks' proves to be economical. These are the economies of scale of the system.

The total acreage utilization picture is presented in column 25 of the table 3.8. The coverage is definitely better than the all season tank. Barring 1974-75, an exceptionally bad year, the total area covered has been ranging between 35.7% to 52%. At the same time total water use in the area covered is proportionately higher than project authorities' assumption. If the total water stored was released by the management one could have talked about full utilization of the resource but the total water use figures suggest that in each year some quantity of water was left unused. The management holds the lack of demand as the reason. This reason is valid only to some extent. If all the farmers in the Command Area demanded water the department would have failed to supply. The actual duty for each year is higher than the duty assumed by the department. The coverage of area thus, seems to have a fundamental limitation.

3.5.3 Kharif Tanks and Utilization

The third design of the tanks that exist in the district is that of Kharif Tank. These tanks are constructed basically to irrigate in Kharif. There are 11 such tanks in the district of which one is a flow scheme. The storage for the flow scheme is not recorded. Of the 10 tanks, 5 are in operation since sixties. The other 5 have been constructed in early seventies. The available utilization statistics suggest that between 1969-70 to 1972-73, the irrigation was done by 5 tanks. In 1972-73 2 tanks did not receive any water in the reservoir and hence only 3 tanks were harnessed for irrigation.

In 1973-74 one more tank started irrigating and was added to the fleet of 5. 1974-75 being the worst monsoon year, only 4 tanks received some water in the reservoirs. In 1975-76 the number of tanks went upto 8 and in next year the total number of tanks were 9. In 1978-79 one more tank got commissioned and the total reservoirs were 10 (excluding the flow scheme).

The most distinctive feature of the Kharif tanks is that the reservoirs (all of them taken together for respective years) have never received water quantity equal to their respective live capacities. The maximum achievement has been 97% in 1976-77. The reason for this again may be traced back to less actual rainfall in the catchments. Since, the structures are small, one cannot definitely say anything about the actual rainfall in the Command. If the farmers feel that rainfall received is enough for the crops then they would not be inclined to demand water for irrigation. Reviewing the yearly irrigation figures one is again not able to say with confidence that low storage in reservoirs has a corresponding higher area covered in Kharif.The philosophy behind designing Kharif tanks is to protect the Kharif crops in the areas where rainfall pattern behaves unfavourably. Comparing the area-wise utilization in Kharif tanks vis-a-vis the All Season and Two season tanks, one gets an impression that irrigation in Kharif season by Kharif tanks is relatively better. Except for the 1972-73 and 1974-75, the Kharif Season irrigation by Kharif tank is annually 27% or more reaching a maximum of 60% of the potential Command. Looking at the water use statistics one gets an impression that the water use in Kharif has been more economic than in other seasons as well as other tanks with different designs. The average duty which is calculated with the help of potential Command and live capacity of the tank is displayed in column 8 of the table. If we compare these figures with the ones given in column 12 of the table dealing with Kharif tanks, it is evident that actual duties are lower than the assumed duties for different years. The only exceptional year is 1974-75. The Kharif tanks have also provided irrigation in Rabi and Hot Season. The total area covered by the end of the year (including all seasons) has been in the range of 40 to 80%. In 1969-70 and 1970-71 and 1978-79 irrigation has been best in terms of area coverage. The worst year is 1972-73 when the total water available was very little compared to the live capacities and so also the total water utilization.

Reviewing the table 3.7 comprehensively, following general observations can be made :

1. The overall performance of all season tank is not very good. Water use has been relatively more to the area covered in all the three seasons. The performance of two season tanks have been some what better. The irrigation in Rabi has been good

both from the point of view of area as well as water use. The drawback here has been Kharif irrigation which has pulled down the total area coverage by tanks in a given year. Except for 1975-76, when the Rabi irrigation has exceeded the potential, all other years show that the coverage has been limited to the Rabi potential created. This means that the additional area, which should have got added to Rabi potential on account of non-irrigation in Kharif, has not got added. The performance of Kharif tanks by way of area coverage has been best among the three.

2. The water use in all the tanks has been generally extravagant. This is reflected from the seasonal as well as yearly duty figures. The project reports do not contain season specific estimated duties for tanks. But one may assume generally that the duty will be lowest in Kharif and highest in hot weather. This is confirmed by the actual duty figures which we have worked out. However, actual duty figures also go on to suggest that there has been extravagant use of water in more or less all the years in all the three type of tanks. Various factors may be held responsible for this phenomena. The relevant question is: why this could not be forseen at the time of project formulation?

3. The available storage in the tank in a reference year and the area covered under irrigation do not display any uniform

behaviour. This is specially so in case of Kharif tanks. There has been very good irrigation in Kharif season in a normal year and there has been bad irrigation in a bad year.

4. The fluctuations in area irrigated continue over a period of time. This is contrary to the normal belief that irrigation in Command Area picks up after the formal and informal extention work is complete. The fluctuation is not explained by the changes in the technical variables because even in the normal years the acreage and water use show fluctuations.

3.5.4 Size of the Tanks and Utilization

Design-wise analysis remains inconclusive since no design specific behaviour is revealed by the utilization statistics. Another way of classifying the available data is by size. The Class I MI Tanks in the district are of varying sizes. The size considered here is the size of Command Area. By definition the range of Command Area for a Class I MI tanks may be anywhere between 100 to 2000 acres. We have classified 28 Class I irrigation tanks into three size classes namely 101 to 500, 501 to 1000 and 1001 to 2000. There are 18 tanks in the first size class, 8 in the second size class and 2 in the third size class. Table 3.8 shows size and tank-wise irrigation potential and actual utilization.

The data base that we have gives utilization statistics for more than one year. For each a minimum of two years observations on all the relevant variables are available. The next sets contain 5 years observations, 7 years observations and 11 years observations. While reviewing the size-wise utilization of MI tanks, we have obtained average values by dividing the total figures by the number of observations. This has been done in order to (a) reduce the size of the table to manageable proportions and (b) to obtain an overall view of each tank on average performance basis. Table 3.8 thus displays information on season-wise designed potentials, their total, Expected Live capacities of the tanks, Assumed average duty for all seasons, Average storage received by tanks, Actual average all season command, Actual season-wise area irrigated water used, duty achieved and their totals.

Column 9 of the table which gives the actual Command for all seasons needs some explanations. While discussing the issues in concept of utilization, it has been mentioned that the area that can be effectively Commanded will depend upon the storage that is actually received in a tank every year. The storage received depends on the actual rainfall in the catchment. If the actual rainfall in the catchment is equal to or greater than the determined dependable rainfall the reservoir is likely to receive calculated storage. This also assumes that there are no disturbances in the catchment. Any activity in the catchment by forest department and/or Soil Conservation Department leading to diversion or checking of the water flow

Table 3.8

Utilization Abstract of 28 MI Tanks (Class I) in Panchmahals

Potential Command, Live Capacity, Actual Command, Actual Water Availability and Total Actual Area Irrigated and Water used.

(Area = Acres and Gunthas; 40 Gunthas = 1 acre; Water=Mcft; Duty= A/Mcft.)

Tank Code By Size (No.of Yrs)	Potential Command Area Khari	Rabi	Hot	Total	Expected Live Capacity	Assumed Avg.duty for all seasons	Avg.Storage received by tank Total+No. of Storage years	Actual Avg. command for all seasons
1	2	3	4	5	6	7	8	9
101to 500								
GA1 (11)	150	190	40	380	51.04	7.44	47.40	353
GT1 (11)	150	250	-	400	26.30	15.21	15.21	350
GT2 (11)	150	250	-	400	23.48	17.03	16.49	281
GT3 (11)	200	100	-	300	16.95	17.70	13.89	246
ZT25 (11)	300	200	-	500	35.10	14.25	32.10	457
ZT26 (11)	100	275	-	375	26.52	14.14	24.41	345
ZT29 (11)	150	102	-	252	17.44	14.44	17.49	253
ZT30 (11)	100	250	-	350	24.44	14.32	23.50	337
LUT5 (5)	240	80	-	320	20.92	15.30	19.12	292
LUT7 (11)	208	130	-	338	23.12	14.62	23.32	341
LUT8 (11)	333	105	-	438	27.76	15.78	22.46	354
ST20 (11)	235	115	-	350	26.74	11.22	16.21	182
ZT28 (5)	335	134	-	469	31.32	14.97	31.32	469
GK1 (11)	400	-	-	400	38.90	10.28	20.28	208
GK2 (11)	255	-	-	255	8.87	28.75	7.06	203
ZK15 (11)	300	-	-	300	33.06	9.07	28.48	258
LUK4 (5)	408	-	-	408	21.60	18.89	20.63	390
ZK16 (7)	225	-	-	225	11.87	18.95	11.00	208
Total 18	4239	2181	40	6460	465.43	13.88	390.37 (100)	5527 (100)
501-1000								
ZT23 (11)	350	450	-	800	142.29	5.62	129.36	727
LUT4 (11)	570	220	-	790	53.00	14.90	30.98	462
ZT24 (5)	725	217	-	942	87.48	10.77	87.48	942
ZT27 (7)	390	150	-	540	31.75	17.00	29.75	506
HK11 (11)	680	-	-	680	87.30	7.79	57.51	448
ShK7 (5)	564	-	-	564	36.85	15.30	36.85	564
ShK8 (5)	621	-	-	621	30.13	20.61	22.34	460
ZK17 (2)	501	-	-	501	22.79	21.98	20.87	459
Total 8	4401	1037	-	5438	491.59	11.06	415.14 (100)	4568 (100)
1000-2000								
ZT22 (11)	1000	500	-	1500	119.32	12.57	108.92	1369
LUK3 (11)	2000	-	-	2000	205.20	9.75	138.66	1352
Total 2	3000	500	-	3500	324.52	10.79	247.58 (100)	2721 (100)
Grand Total (28)	11640	3718	40	15398	1281.54	12.02	1053.09	12816

Note: Figures in the brackets indicate percentages. cont...

Table 3.8 (contd.)

Tank Code by size (No.of years)	Kharif Area	Kharif Water	Kharif Duty	Rabi Area	Rabi Water	Rabi Duty	Hot Area	Hot Water	Hot Duty	All season Area	All season Water	All season Duty
1	10	11	12	13	14	15	16	17	18	19	20	21
101 to 500												
GA1 (11)	11.20	5.28	2.18	28.10	17.87	1.58	8.10	8.11	1.02	48.00	31.26	1.54
GT1 (11)	3.05	2.31	1.35	41.30	12.50	3.34	1.05	3.81	0.30	46.00	18.61	2.47
GT2 (11)	4.10	2.55	1.67	130.30	11.64	11.23	1.00	1.93	0.52	136.00	16.13	8.43
GT3 (11)	108.15	7.34	14.76	59.15	15.56	10.68	–	0.16	w	167.30	13.07	12.83
ZT25 (11)	18.00	1.82	9.89	151.10	16.34	9.26	–	–	–	169.10	18.16	9.32
ZT26 (11)	–	–	–	205.10	11.54	10.50	–	–	–	205.10	19.54	10.50
ZT29 (11)	–	–	–	72.20	8.55	8.48	–	–	–	72.20	8.55	8.43
ZT30 (11)	–	–	–	90.20	9.03	10.02	–	–	–	90.20	9.03	10.02
LUT5 (5)	–	0.34	w	55.50	14.68	3.80	5.00	2.57	1.95	60.30	17.58	3.46
LUT7 (11)	20.10	4.33	4.47	65.15	16.47	3.97	1.00	1.32	0.76	86.25	22.32	3.89
LUT8 (11)	72.25	4.52	16.07	119.00	14.44	8.24	23.10	3.63	6.40	214.35	22.59	9.52
ST20 (11)	3.00	0.09	33.33	10.20	0.80	13.13	3.35	0.50	7.75	17.15	1.39	12.50
ZT28 (5)	–	–	–	30.30	3.40	8.81	–	–	–	30.30	3.49	8.81
GK. (11)	5.05	10.32	13.22	139.05	8.90	15.63	–	0.09	w	274.10	10.21	14.28
GK2 (11)	21.15	2.61	8.19	26.00	4.03	6.45	–	0.42	w	47.15	7.07	6.72
ZK15 (11)	–	–	–	74.35	8.49	8.82	–	–	–	74.35	8.49	8.82
LUK4 (5)	114.20	5.74	19.95	131.05	14.89	8.81	–	–	–	245.25	20.63	11.91
ZK16 (7)	–	–	–	52.15	5.50	9.52	–	–	–	52.15	5.50	9.52
Total 18	512.05 (9)	47.35	10.81	1484.20 (27)	192.72	7.70	43.20 (1)	27.54	1.93	2040.05 (37.0)	262.42 (65.91)	7.77
501–1000												
ZT23 (11)	112.0	13.17	8.50	528.30	80.54	6.57	9.35	1.21	8.16	650.25	94.92	6.85
LUT4 (11)	17.55	3.84	4.65	79.25	17.08	4.66	16.30	6.69	2.50	114.10	27.61	4.14
ZT24 (5)	12.35	3.40	[illegible]	383.35	41.43	9.27	–	–	–	396.30	44.83	8.85
ZT27 (7)	–	–	–	254.35	23.69	10.76	–	–	–	254.35	23.69	10.76
HK11 (11)	111.15	8.38	13.29	227.25	27.34	8.33	18.00	8.97	2.01	357.00	44.69	7.99
ShK7 (5)	62.30	8.32	7.54	113.10	23.29	4.86	3.10	5.24	0.62	179.10	36.85	4.86
ShK8 (5)	8.35	2.54	3.49	54.05	11.62	4.66	–	3.86	w	63.00	18.02	3.50
ZK17 (2)	–	–	–	172.00	16.58	10.32	–	–	–	172.00	16.58	10.37
Total 8	325.30	39.65	8.21	1814.05	241.57	7.51	47.35	25.97	1.85	2187.30 (47.92)	307.19 (75)	7.12
1000–2000												
ZT22 (11)	40.00	8.46	11.56	747.35	83.21	8.97	4.30	–	–	792.25	86.68	9.14
LUK3 (11)	1026.10	65.81	15.59	286.20	42.85	6.69	43.05	22.23	1.94	1355.35	130.89	10.36
Total 2	1066.10	69.27	15.40	1034.15	126.06	8.21	47.35	22.23	2.15	2148.20 (78.96)	217.57 (87.88)	9.88
Grand Total (28)	1904.05	156.27	12.18	4333.00	560.35	7.73	139.10	[illegible]	1.97	6176.70	787.18	7.85

may affect the total run off towards reservoir. For any such reason when the run-off is disturbed the storage in reservoir is likely to shrink. The reduction in storage at the start of the irrigation year will definitely have an impact on the Command area. If the actual rainfall in the catchment as well as the Command falls short of the normal rainfall, the extra water requirement of the crops in the Command area will also undergo a change. The first situation to consider would be that of the shortfall in rains below the dependable rainfall figure. If the actual rainfall in Command as well as the catchment is less than the dependable rainfall, the storage in reservoir will get affected and so also the water requirement of the crops. The initial shrink in the Command area will be a result of low storage. Depending upon the assumed duty values change in storage will lead to proportionate change in the Command area. The subsequent shrinkage in the Command area will take place in correspondence with the actual rainfall. In a normal average rainfall year the water requirement of the crops depend upon the combination of rops in the command area. If the crops grown are of only rainfed variety there may not be any demand for excess water other than the normal precipitation. It is only when farmers are sure about the additional supply from the reservoir, they may opt for water intensive crops. The irrigation in Kharif in a normal average rainfall year, thus, depends upon the crop combinations adopted by the farmers. The demand for water in Kharif will go up for both the rainfed as well as water intensive crops when the actual rainfall is below the normal average rainfall. This demand can be met by the reservoir storage in a normal way only when the actual rainfall is atleast equal to the dependable rainfall so that the desired storage is obtained. When the actual rainfall is less than the dependable rainfall not only the storage shrinks but also leads to higher demand for additional water. The total shrink in the Command area will therefore be in addition of shrink in area in proportion to water shortage in reservoir and increased duty of the crops. There is one more factor which will ultimately decide the actual size of the area that would be commanded with the available storage. This factor relates more to the policy decision. The project authorities, in the event of an abnormal year, may be faced with different type of crop combinations adopted in the potential Command area. The possible cases are : all the farmers in potential Command having rainfed crop in that year; some farmers growing water intensive crops near the head works and some growing rainfed crops at the middle and tail end of the Canal; some farmers growing rainfed varieties at the head and some growing water intensive varieties at the middle and tail end; and all farmers growing water intensive varieties. Since the Canal structures in minor works are unlined, breaching at the time of shortage should be taken as normal human behaviour. The policy decision which the authority has to make will be to choose between thin spread of water in all the possible area of the Command or more waterings to a smaller area. Whether the smaller area preferred is near the head or at the tail will depend upon the efficacy of the management. A shortfall in storage therefore can not simply be taken as the proportionate shrink in Command area.

It is however, not possible practically to arrive at the reduced Command area under above mentioned conditions and methods. The project authority is not in a position to get information on the cropping pattern before hand. Same limitation is ~~forced~~ faced by this study too. Column 9 of table 3.9 which gives the actual Command area for all season has been worked out only on the basis of proportionate shrinkage in area due to shortage in reservoir. This has been attempted in order to study the utilization more justly. It may be said that the extent of utilization thus revealed will be an underestimate to some extent.

Reviewing table 3.9 the first impression one gets is that size has some impact on the utilization. Taking the shrinked area of column 9 as the actual potential Command, the size class 101 to 500 acres show that average utilization in 18 tanks has been about 37% in terms of area covered. The water used in covering this area works out to be around 66%

which is near double.This has the following implications. It is possible that the crops taken in the Command must have been highly water intensive and/or there has been significant wastage of water. This is confirmed further if one looks at the actual duty figures in different seasons as well as for all seasons. The area irrigated in Kharif by this size class of tanks is relatively less compared with the potentials. The actual duty varies from a lowest of 33.33 in tank ST20, where the area covered is insignificant, to the highest of 1.35 in case of tank GT1. These extreme cases, however, show a very insignificant coverage of the area. The overall duty for all the tanks combined works out to be 10.81 for Kharif. This is higher value of duty compared to the assumed value of duty. Under the normal circumstances the actual duty figures by season have the following trend. In Kharif the actual duty is lower compared to assumed value, in Rabi it may be lower or higher and in summer it is higher. This is so because the water requirement in different season is different. The higher duty in Kharif against the assumed value will imply that more quantity of water is used against the assumed quantity. This type of consumption will reduce the water quantity available for next season. If the pattern continues to be the same in all the seasons, the total quantity of water used will be an inflated figure than the one estimated. The duty values by season are not worked by the authorities, so one is not able to say anything about the duty values by season. The total actual duty and the estimated average duties are comparable to some extent. The estimated average duty is calculated by us by dividing the potential Command area by the live capacity of the tank. This value is taken as the estimated value of duty. This is done in the absence of cropping pattern details in the Command area. It can be assumed that the value which is estimated as explained above shows a higher duty than any other actual duty for the water intensive crops. The size class of 101 to 500 acres shows that actual duty in Kharif is 10.81, in Rabi it is 7.70 and in Hot it is 1.93. The maximum wastage seems to be in Summer season. The reasons for this would call for technical examination of the sites and farms. This is not in the scope of the study. We just take the values as they work themselves out.

The next size class is 501 to 1000 acres and we may call it the middle sized MI tanks. The area-wise performance of the middle sized tanks is of the middle level. A total of 8 middle sized class tanks show that on an average 48% of the total actual potential Command area was covered during the period of observation. Corresponding water use was about 74%. In this case too the water use has been proportionately higher to the area covered. The proportionate water use in middle sized tanks has been less than the proportionate water use in small sized tanks. This again may be due to either change in cropping pattern in favour of water intensive crops and/or wastage of water. The actual duties by season show that it has been lowest in Kharif and highest in Summer or hot season. Again the actual duty in Kharif is higher than the overall estimated average duty. This has the same implications as arelady discussed. This has had its impact on the actual average all season duty worked out in column 21 of the table. The actual average all season duty works out to be 7.12 against the estimated duty of 11.06.

The overall performance of the third size class of tanks viz., 1001 to 2000 acres, has been the best. There are only two tanks with one Kharif tank and one two season tank. The average area covered is about 79% and water used is 88%. The actual duty is almost the same as the estimated duty. Since there are only two tanks, we shall be reviewing each of them separately. ZT22 is a two seasoned (Kharif and Rabi) tank built in early sixties or before. We have about 11 years data on this tank. It has more potential Kharif than in Rabi. The average shortfall in storage has been under 10% which means that bad years have been very few in its catchment. The Kharif irrigation has been relatively very poor compared to the potential. The duty in Kharif has remained slightly higher than the estimated one. In Rabi, on an average there has been 150% irrigation (area covered) compared to potential with a reasonable duty. (Reasonable in comparison to other tanks). In Summer the irrigation has been insignificant. In all total area covered has been about 58% on an average annually and the water use has been around 80%. The overall duty is high relatively to the estimated duty.

LUK3 is basically a Kharif tank with a potential Command of 2000 acres. The average annual storage for 11 years show that there has been significant shortfall. The annual average storage received by LUK3 has been around 67% of the estimated storage. The performance however is good. The Kharif irrigation is most significant-true to design, and there has also been significant irrigation in Rabi as well as Hot weather. What is further encouraging is the actual duty in Kharif. It is lower compared to the estimated duty for all the seasons. The actual duty for all season also worked out to be lower than the estimated one. The actual duty is 10.36 whereas estimated duty is 9.75. The area covered on an average annually has been slightly above 100%. Less water has been used to irrigate the estimated Command. One implication of this is that the farmers in the Command area have distributed the water extensively and have used it in an economic way. The department officials are of the opinion that LUK3 has a Command which has been well developed by the farmers themselves. The field channels are very well laid out. The farmers distribute the water in a best manageable way.

Size-wise classification of tanks reveal the following features.

1. Size of the command are has some impact on utilization. This is suggested when utilization is reviewed in size groups. However, there is no conclusive evidence which supports our contention. Except in size group 1000 to 2000 acres, two other size groups data suggests that there are some tanks which have performed well in area coverage and some have performed bad. If we view the tanks in decending order of size of command, we do not notice any trend.

2. Water use statistics also do not suggest any trend when related to the size. When tanks are viewed in size groups, one only finds that in bigger size groups water quantity used has been higher. One cannot comment definitely whether water was used efficiently or not. The actual duties, which are obtained with dividing the total actual area irrigated by actual quantity of water used in case of each tank, do not reflect any trend relation between size and duty.

3. Irrespective of the size, the actual available storage suffers, Of the 28 tanks, 5 tanks received average annual storage equal to the expected live capacity, 4 to 5 tanks received around 1 to 2 Mcft less of the expected live capacity. Rest of tanks received less than the capacity amounting to considerable reduction in actual storage. The groupped data suggests that small sized tanks (0 to 500 acres) had an average annual loss of 16% of the expected live Capacity,

medium sized tanks (500 to 1000) had an average annual loss of 14% and big tanks (1000 to 2000) lost 24% of expected live capacity. Whether there are any theoretical grounds for explaining this phenomena is a question to be checked by technically competent authorities.

While assessing the status of the Class I MI Tanks, we have stated that the status of tanks built before 1961 and the ones built between 1961 to 1970 is relatively better. We have, therefore, attempted to review the utilization in MI Tanks by size and their period of construction. Table 3.9 is utilization abstract of the Class I MI tanks (28) by time, size and design. The major class is the size. Within each size group, we have further classified the tanks into three time periods viz., Before 1961, 1961 to 1970 and 1971 to 1980 and their designs. The table gives information about estimated seasonwise actual potential (this has been taken as proportion of actual total potential given in column 9 of Table 3.8 according to their shares in the original potential Command), Average annual actual irrigation (area), water used, duty, average annual percentage area irrigated and water used, estimated average duty and actual duty.

In size class of 101 to 500 acres there are 18 tanks of which 10 are constructed before 1961, 4 are constructed between 1961 to 70 and 4 are constructed during 1971 and 1980. The

Table 3.9

Utilization Abstract of 28 Class I M.I. Tanks in Panchmanals.

Percentage Area Irrigated, Water used, Duties Estimated and Actual by Season, Size and Time of Construction

(Area in Acres - 40 Gunthas = 1 Acres; Quantity of Water in Mcft.; Duty expressed as acres per Mcft.)

Size of tank and time of construction	No.of tanks & their design	Estimated Kharif potential Annual	Actual Avg. Annual K irrigation	4 as %age of 3	Actual Avg.Anl. Qnty.of water used in K	Actual Avg. duty in K	Estimated Rabi Potential Annual	Actual Avg. Annual Rabi Irrigation	9 as %age of 8	Actual Avg.Annual Qnty of water used in Rabi	Actual Avg.Duty in Rabi	Estimated potential in Hot Annual	Actual Avg.Annual irrigation inHot	14 as % of 13
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
101 to 500	1A	139	11	7.91	5.28	2.08	177	28	15.82	17.87	1.57	37	8	21.62
Before 1961	7T	1018	133	13.06	14.02	9.49	1251	752	60.11	83.19	9.04	-	82	-
	2K	411	156	37.96	12.83	12.16	-	165	-	12.90	12.79	-	-	-
1961-1970	3T	602	99	16.44	9.25	10.70	275	207	75.27	32.66	6.34	-	33	-
	1K	258	-	00.00	-	-	-	75	-	8.49	8.83	-	-	-
1971-1980		[illegible]	-	00.00	0.34	w	209	87	41.63	18.17	4.79	-	5	-
	2K	598	114	19.06	5.74	19.86	-	183	-	20.39	8.97	-	-	-
All Time	12T	2172	232	10.68	23.61	21.72	1735	1046	60.29	134.02	7.80	-	40	-
	5K	1267	270	21.31	18.57	14.54	-	423	-	41.78	10.12	-	-	-
501 to 1000	1T	320	112	35.00	13.17	8.50	407	529	130.00	80.54	6.57	-	11	-
Before 1961	1K	448	111	24.78	8.38	13.24	-	228	-	27.34	8.04	-	18	-
1961 to 1970	1T	333	16	5.41	3.84	4.69	129	80	62.01	17.07	4.67	-	17	-
	-K	-	-	-	-	-	-	-	-	-	-	-	-	-
1971-1980	2T	1089	13	1.19	3.40	3.82	359	639	180.0	65.09	9.82	-	-	-
	3K	1483	72	4.86	10.36	6.63	-	353	-	54.07	6.49	-	3	-
All Times	4T	1742	143	8.21	20.41	7.00	895	1248	139.00	162.70	7.67	-	28	-
	4K	1931	183	9.48	19.24	9.51	-	581	-	81.71	7.11	-	21	-
1001 to 2000	1T	917	40	4.36	3.46	11.56	452	748	165.47	83.20	9.00	-	5	-
Before 1961	1K	1352	1026	75.89	65.81	15.59	-	287	-	42.85	6.70	-	43	-
1961-1970	-T	-	-	-	-	-	-	-	-	-	-	-	-	-
	-K	-	-	-	-	-	-	-	-	-	-	-	-	-
1971-1980	-T	-	-	-	-	-	-	-	-	-	-	-	-	-
	-K	-	-	-	-	-	-	-	-	-	-	-	-	-
All Times	1T	917	40	4.36	3.46	11.56	452	748	165.47	83.20	9.00	-	5	-
	1K	1352	1026	75.89	6581	15.59	-	287	-	42.85	6.70	-	43	-
Grand Total Before 1961	1A	139	11	7.91	5.28	2.08	177	28	15.82	17.87	1.57	37	8	21.62
	9T	2255	285	12.64	30.65	9.30	2110	2029	96.16	246.93	8.22	-	18	-
	4K	2211	1293	54.40	87.02	14.85	-	680	-	83.09	8.18	-	61	-
1961-1970	4T	935	117	12.51	13.09	8.94	404	2387	71.03	49.73	5.77	-	50	-
	1K	258	-	00.00	-	-	-	75	-	8.49	8.83	-	-	-
1971-1980	4T	1641	13	0.79	3.74	3.47	568	726	127.82	83.26	8.72	-	5	-
	5K	2081	186	9.42	16.60	19.74	-	536	-	74.76	7.17	-	3	-
TOTAL ALL TIME & SIZE	1A	139	11	7.91	5.28	2.08	177	28	15.82	17.87	1.57	37	8	21.62
	17T	4831	415	8.59	47.48	8.74	3082	3042	98.70	379.92	8.00	-	73	-
	10K	4550	1479	32.51	103.62	14.27	-	1291	-	166.34	7.76	-	69	-
	28	9520	1905	20.00	156.38	12.18	3259	4361	[illegible]	564.13	7.73	37	145	392.00

Table 3.9 (contd.)

Size of tank and time of construction	No. of tanks & their design	Actual Avg. no.of Qnty. of water used	Actual Avg.Duty in HCT	Total estimated PCA	Total Avg. Annual	19 as %age of 18	Total Av. qnty. of water available	Total actual water qunty. used	%age of water used	Estimated Avg.duty in all season	Actual Avg. duty in all seasons
1	2	16	17	18	19	20	21	22	23	24	25
101 to 500	1A	8.11	0.98	353	47	13.31	47.40	31.26	65.95	7.45	1.50
Before 1961	7T	5.90	0.34	2269	887	39.09	150.88	103.11	68.34	15.03	8.60
	2K	0.51	-	411	321	78.10	27.34	26.24	95.98	15.03	12.23
1961-1970	3T	6.05	5.45	[illegible]77	339	38.65	61.99	47.26	77.49	14.17	7.07
	1K	-	-	258	75	29.06	28.18	8.49	79.31	9.06	8.83
1971-1980	2T	2.57	1.94	761	92	12.08	50.44	21.08	41.79	15.08	4.36
	2K	-	-	598	297	49.67	31.63	26.13	82.61	18.91	11.37
All Time	12T	14.52	2.75	3907	1318	33.73	263.31	172.15	65.40	14.84	7.66
	5K	0.51	w	1267	699	54.69	87.45	60.86	69.59	14.49	11.38
501 to 1000	1T	1.21	9.09	727	652	89.68	129.35	94.92	73.38	5.62	6.87
Before 1961	1K	8.97	2.01	446	357	79.69	57.52	44.69	77.69	7.79	8.00
	1T	6.69	2.54	462	115	24.89	30.98	27.60	89.09	14.91	4.17
	-K	-		-	-	-	-	-	-	-	-
1971-1980	2T			1448	652	45.82	117.25	68.49	58.42	12.35	9.52
	3K	9.08	0.33	1483	428	28.86	80.06	74.31	92.81	18.52	5.76
All Times	4T	7.90	3.54	2637	1417	53.81	274.18	194.39	70.90	9.62	7.30
	4K	18.05	1.16	1931	785	40.65	138.38	119.00	86.00	13.95	6.60
1001 to 2000	1T	-	-	1369	793	57.92	108.92	86.66	79.56	12.57	9.15
Before 1961	1K	22.23	1.19	1352	1356	100.29	138.66	130.89	94.40	9.75	10.36
1961-1970	-T	-	-	-	-	-	-	-	-	-	-
	-K	-	-	-	-	-	-	-	-	-	-
1971-1980	-T	-	-	-	-	-	-	-	-	-	-
	-K	-	-	-	-	-	-	-	-	-	-
All times	1T	-	-	1369	793	57.92	108.93	86.66	79.56	12.57	9.15
	1K	22.23	1.19	1352	1356	100.29	138.66	130.89	94.40	9.75	10.36
Grand Total Before 1961	1A	8.11	0.98	353	47	13.31	47.40	31.26	65.95	7.45	1.50
	9T	7.11	2.53	4365	2332	53.42	389.15	284.69	73.16	11.22	8.19
	4K	31.71	1.92	2211	2034	91.90	223.52	201.82	90.29	9.89	10.08
1961-1970	4T	12.74	3.92	1339	454	33.90	92.94	75.56	81.36	14.41	6.00
	1K	-	-	258	75	29.06	28.48	8.49	29.81	9.06	8.83
1971-1980	4T	2.67	1.94	2209	744	33.68	167.67	89.57	53.42	13.17	8.31
	5K	9.08	0.33	2081	725	34.84	111.69	100.44	89.92	18.63	7.22
TOTAL ALL TIME & SIZE	1A	8.11	0.98	353	47	13.31	47.40	31.26	65.95	7.45	1.50
	17T	22.42	3.25	7913	3530	44.61	649.79	449.82	69.24	12.18	7.35
	10K	40.79	1.69	4550	2834	62.28	363.69	310.75	85.46	12.51	9.11
	28	71.32	2.03	12816	6411	50.002	1060.88	791.83	74.64	12.08	8.09

performance of the All season tank is far from satisfactory. As observed in Table 3.8, the tank has failed to receive 100% storage on an average in last 11 years. The revised potentials have been worked out for each season. Reviewing the actual irrigation against the revised potential, one can observe that irrigation has been less in each season with relatively more water quantity used. The actual duty figures given in columns 7, 12, 17 and 25 show that they have been very heavy. The only implication in this case is that there has been significant wastage of water. Presently, the tank has been reserved for the municipality from 1980-81 for water supply.

There are 7 two-season tanks which have been built before 1961. The average irrigation in Kharif has been around 13%, which is on lower side. The Rabi irrigationis relatively very good since about 60% of the revised potential Command was covered. In Summer there has been no significant irrigation at all. The overall area coverage shows that around 40% of the revised Command was covered. The water use has been again showing high duty but it is better than the All Season tank. The Kharif tank show a poor performance irrigating about 12% in Kharif. This means that the Kharif tanks may have been located on such sites where on an average the rainfall has been enough to grow normal crops thus not generating any demand for excess water in Kharif. The farmers have ventured into Rabi cultivation with having the secured supply of water in the tanks.

In summer, no hot weather crops have been sown since cultivation without irrigationis is not possible.

The overall performance in all seasons is impressive in case of Kharif tanks. About 78% of the revised potential Command was covered by Kharif tanks. The water use has also been much more economical in Kharif tanks. The actual average duty figures is 12.23 which is better than two season and all season tanks.

The tanks constructed in 60s in general show a lower performance compared to the tanks built before 1961. The overall performance of all the tanks constructed before 1961 show an area coverage of 41% and actual duty figure as 7.81 whereas the values for tanks constructed in 60s are 36% and 7.39 respectively. The performance of two-season tanks built in 60s appears to be better than the lone Kharif tank. The performance of two two-season tanks, constructed in 70s display poor performance. The Rabi performance is about 42% and area covered in hot weather is insignificant. There has been no irrigation in Kharif. The overall area coverage to the revised potential works out to be 12% and duty works out to be 4.36 which speaks for higher water use. The two Kharif tanks have performed relatively well. Though the irrigation in Kharif is limited to 20% of the revised Kharif potential, the all season coverage works out to be 50%. The water use relatively better with a duty figure of 11.37.

The next size class is of 501 to 1000 acres. There are 8 tanks in this size class of which 1 two-season and 1 Kharif tank are in operation and were constructed before 1961, 1 two season tank built in 60s and 2 two season tanks and 3 Kharif tanks built in 70s. The performance of both the two season and Kharif tank built before 1961, have impressive performance. The utilization in terms of area coverage is 90% and 80% respectively. The performance in Kharif is not good but the Rabi performance is better. In case of two-season tank the area covered in Rabi is 130% to the revised Rabi potential. The water use however suggests high duty. The relative economic use of water has been in the Kharif tank. The respective duty figures are 6.87 and 8. The performance of the only two-season tank built in 60s is not very good. The area covered was only 25% and water use was high with a duty figure of 4.11.

The performance of the two-season tanks built in 70s is relatively better than the 3 Kharif tanks. The Rabi irrigation in two-season tanks show that area covered was 180% of the revised Rabi potential. The overall performance suggests that the area covered were 45% for two season tanks and 29% for Kharif tanks. The water use also has been more economic in two-season tanks with a duty figure of 9.52 as compared to Kharif tanks with a duty figure of 5.76.

Both the large size tanks were constructed before 1961 and are doing relatively better as compared to other tanks.

One two-season tank with a potential Command of 1500 acres and revised potential of 1369 acres show that area covered in Rabi is impressive with 165% coverage. (with an overall coverage of 58%). The water use is also economic with 9.15 duty. The lone Kharif tank with 2000 acres of potential Command and 1352 acres of revised potential has performed the best. It has on an average irrigated all the area with economic water use.

A comprehensive review of Table 3.9 suggests the following things :

1. The tanks constructed before 1961 are on an average performing better than the ones constructed latter (Refer Grand total, table 3.9).
2. From among the tanks constructed before 1961, Kharif tanks have performed best both in terms of coverage and water use.
3. The tanks constructed in 60s have inferior performance and within the group the Kharif tanks have performed slightly worse in terms of coverage and water use.
4. The performance of Kharif tanks of all size built in 70s show that the coverage of area has been better whereas water use has been little extravagant compared to the two season tanks.
5. Considering all time period and all sizes, design-wise performance of the tanks show that Kharif tanks have performed well both in terms of area coverage and efficient water use.

3.5.5 CROPPING PATTERN in Tank Command

Uptill now we attempted a review of utilization of the irrigation potential in terms of area coverage and water use. There is one more important aspect which deserves attention and that is the cropping pattern. By reviewing the cropping pattern actually adopted we may be in a position to identify the reasons for intensive water use. We will also be in a position to see the change in cropping pattern if any with irrigation facility.

Such a review is best attempted when we have data on the cropping pattern in the Command area without irrigation and cropping pattern with irrigation. It has already been discussed that such details are not maintained by the department and hence we have data only on tank-wise crops grown in last 5 years (1974-75 to 1978-79).*

Table 3.10 is an abstract prepared from Table on cropping pattern compiled in statistical appendix. The table contains year-wise and seasonwise irrigation by crops for the specific tank designs. We have taken tank design as a criteria because the irrigation capacity of a tank mainly depends upon the design.

* Table containing informaton on actual crops grown and area covered for 5 years (from 1974-75 to 1978-79) has been compiled in statistical appendix which may be called for if deemed essential. The information has been compiled from the 'demand statements'. 'Demand Statements' are prepared by the department on the basis of the applications made by the farmers demanding water.

Table 3.10

By Design Cropping Pattern Actually Taken-up by Irrigators in Class I MI Tanks of Panchmahals.

Area in Acres and Gunthas 40 G = 1 acre

Tank design	No. of tanks	Name of crops	1974-75	1975-76	1976-77	1977-78	1978-79
GAI	1	KHARIF					
		Paddy	9.25 (46.00)				
		Maize	10.15 (49.00)				
		Groundnut	1.00 (5.00)				
			21.00 (100)				
		RABI					
		Wheat	00.00	26.20 (85.0)	11.00 (73.0)	-	8.30 (40.0)
		Vegitable		4.00 (13.0)	4.00 (27.0)		8.20 (38.0)
		Maize		-	-		4.35 (22.0)
		Bajri		0.25 (2.0)	-	-	-
				31.05 (100)	15.00 (100)		22.05 (100)
		HOT					
		Paddy			1.10 (100.0)		
T	18	KHARIF					
		Paddy	154.30 (33.0)	93.35 (61.0)	32.30 (39.0)	6.15 (10.8)	187.35 (82.0)
		Maize	139.35 (30.0)	-	-	12.05 (20.5)	15.25 (6.8)
		Cotton	62.20 (13.0)	44.10 (29.0)	1.10 (1.50)	13.35 (23.5)	5.00 (2.2)
		Groundnut	21.00 (5.0)	- (	-	-	-
		Tobacco	-	-	-	25.15 (43.0)	10.10 (4.5)
		Castor	-	-	-	0.10 (0.4)	-
		Spaices	0.15 (.08)	-	-	-	-
		Pulses	0.20 (.10)	-	-	-	-
		Cultivation	-	9.30 (6.0)	50.05 (59.0)	-	-

cont...

Table 3.10 (contd.)

Tank design	No.of tanks	Name of crops	1974-75	1975-76	1976-77	1977-78	1978-79
T (cont.)	18	Cotton/Maize	81.05 (17.0)	6.30 (4.00)	-	-	-
		Bajri	4.00 (0.86)	- (	-	-	9.30 (4.3)
		Juwar	-	-	-	1.00 (1.7)	-
		Hi-Mi	1.25 (0.35)	-	-	-	-
			464.30 (100)	154.25 (100)	84.05 (100)	59.00 (100)	228.20 (100)
		RABI					
		Wheat	301.05 (26.2)	1625.25 (46.85)	1815.15 (56.10)	2002.15 (55.53)	1901.10 (57.02)
		Gram	629.25 (54.8)	542.20 (15.61)	489.20 (15.13)	561.35 (15.58)	710.10 (21.30)
		Cotton	-	66.10 (1.91)	83.10 (2.57)	55.20 (1.54)	24.25 (0.74)
		Maize	147.35 (12.0)	67.35 (1.96)	99.35 (3.09)	422.20 (11.72)	406.10 (12.18)
		Wheat/Gram	55.20 (4.8)	1108.20 (31.95)	695.30 (21.50)	489.15 (13.57)	175.10 (5.26)
		Barley	0.20 (0.04)	29.20 (.85)	29.35 (.92)	13.05 (.36)	25.05 (.75)
		Wheat/Maize	2.05 (.2)	8.20 (.24)	3.00 (.09)	20.10 (.56)	8.15 (.25)
		Wheat/Barley	-	1.25 (.05)	4.00 (.12)	1.20 (.04)	-
		Gram/maize	9.25 (.84)	-	1.30 (.5)	-	-
		Barley/Gram	1.00 (.08)	9.05 (.26)	2.15 (.07)	-	-
		Barley/Maize	0.00	-	00.00	-	0.10 (.01)
		Jute	-	-	-	-	8.20 (.25)
		Tuwer	1.10 (.11)	2.05 (.06)	-	-	-
		Vegitable	-	6.00 (.17)	3.30 (.12)	14.20 (.4)	34.25 (1.04)
		Tobacco	-	0.30 (.02)	1.05 (.03)	16.00 (.44)	5.35 (.18)
		Cultivation	-	1.00 (.02)	4.00 (.12)	-	-
		Hi-Mi	-	-	00.30 (.02)	2.35 (.08)	25.20 (.67)
		Pulses	-	-	-	-	6.00 (.18)
		Bajri	-	00.25 (.02)	-	-	1.20 (.04)

cont...

Table 3.10 (contd.)

Tank design	No.of tanks	Name of crops	1974-75	1975-76	1976-77	1977-78	1978-79
		Juwar	-	-	-	1.00 (.03)	-
		Wheat/Cotton	-	-	-	4.20 (.12)	-
		Wheat/vegetable	-	0.20 (.01)	1.20 (.05)	- (.02)	0.30
		Castor	-	-	-	0.15 (.01)	-
			1148.25 (100)	3469.20 (100)	3235.35 (100)	3605.30 (100)	3334.05 (100)
		HOT					
		Pulses	-	-	-	5.30 (2.0)	51.05 (25.40)
		Paddy	1.00 (.54)	-	-	0.10 (.09)	1.00 (.05)
		Maize	18.10 (9.9)	10.35 (29.0)	51.20 (89.0)	154.35 (54.0)	35.05 (17.45)
		Bajri	73.00 (39.6)	26.30 (71.0)	4.10 (7.0)	104.10 (36.0)	67.15 (33.48)
		Bajri/Maize	56.25 (30.71)	-	2.05 (4.0)	4.10 (1.48)	7.0 (3.48)
		Juwar/Maize	-	-	-	00.35 (.30)	-
		Juwar	00.10 (00.13)	-	-	6.20 (2.26)	2.00 (1.0)
		Cultivation	22.10 (12.07)	-	-	3.00 (1.04)	-
		Pulses	-	-	-	3.30 (1.30)	32.35 (16.90)
		Shismam	-	-	-	2.25 (.91)	-
		Hi-Mi	-	-	-	1.15 (.48)	0.35 (.43)
		Vegetable	-	-	-	-	1.00 (.05)
		Groundnut	-	-	-	-	2.35 (0.43)
		Maize/cotton	13.00 (7.05)	-	-	-	
			184.15 (100)	37.25 (100)	57.35 (100)	287.20 (100)	201.10 (100)

cont...

Table 3.10 (contd.)

Tank design	No. of tanks	Name of crops	1974-75	1975-76	1976-77	1977-78	1978-79
		KHARIF					
K	11	Paddy	140.05 (52.65)	1093.00 (73.53)	1608.05 (90.14)	1453.05 (94.81)	1501.20 (90.66)
		Maize	23.15 (8.78)	-	6.10 (.35)	12.10 (.80)	6.20 (.39)
		Cotton	37.00 (13.90)	142.35 (9.61)	62.20 (3.50)	19.15 (1.26)	109.10 (6.60)
		Groundnut	3.00 (1.13)	15.35 (1.07)	-	5.00 (.33)	3.30 (0.23)
		Vegetable	-	-	1.35 (.10)	2.00 (.13)	-
		Hi-Mi	2.00 (.75)	-	1.00 (.06)	0.20 (.03)	-
		Juwar	-	-	0.20 (.03)	-	-
		Banana	-	-	3.00 (.17)	1.10 (.08)	-
		Sugarcane	-	-	-	1.00 (.06)	-
		Bajari	-	-	-	1.10 (.08)	-
		Cultivation	-	-	6.00 (.34)	-	4.00 (.74)
		Maize/cotton	60.25 (22.78)	178.30 (12.02)	-	-	-
		Tobacco *	56.00 → (3.77)	94.35 → (5.32)	36.35 → (2.41)	30.15 → (1.83)	
		Spices	-	-	-	-	00.15 (.02)
		Pulses	-	-	-	-	0.20 (.03)
			(100)	(100)	(100)	(100)	
K	11		266.05 (35)	1486.20 (91)	1784.05 (91)	1532.25 (82)	1656.10 (100) (88)
T	18		464.30 (62)	154.25 (8)	84.05 (9)	59.00 (18)	228.20 (12)
A	1		21.00 (3)	-	-	-	-
			751.35	1641.05	1868.10	1591.25	1884.30
			(100)	(100)	(100)	(100)	(100)

* To read with one space shift 1974-75 is – (nil)

contd...

Hi-Mi = Hill Millet

Table 3.10 (contd.)

Tank design	No.of tanks	Name of crops	1974-75	1975-76	1976-77	1977-78	1978-79
K (cont.)	11	RABI					
		Cotton	-	422.05 (27.89)	257.25 (13.97)	221.05 (13.71)	153.35 (13.00)
		Wheat	5.05 (9.88)	853.30 (56.41)	1258.20 (68.25)	902.25 (56.00)	668.30 (56.54)
		Juwar	-	-	4.00 (.22)	3.20 (.22)	2.25 (.22)
		Maize	0.05 (.25)	4.00 (.26)	17.15 (.94)	157.30 (9.78)	107.30 (9.11)
		Hi-Mi	- (.[illegible]2)	1.30 (.12)	1.10 (.07)	1.25 (.10)	3.25 (.31)
		Vegetable	-	2.10 (.15)	3.15 (.18)	9.20 (.59)	13.0 (1.10)
		Banana	-	-	2.00 (.11)	6.10 (.39)	5.00 (.42)
		Castor	-	-	-	1.00 (.06)	-
		Gram	28.20 (56.16)	69.35 (4.62)	54.15 (2.95)	155.20 (9.64)	157.35 (13.35)
		Barley	-	-	5.05 (.28)	20.15 (1.26)	5.20 (0.96)
		Wheat/Gram	17.00 (33.50)	43.00 (2.84)	35.25 (1.93)	12.05 (.75)	-
		Wheat/maize	-	-	7.30 (.42)	-	-
		Cultivation	-	1.00 (.07)	4.00 (.22)	-	-
		Wheat/cotton	-	-	-	4.20 (.28)	-
		Tobacco	114.00 (7.53) →	193.00 (10.46) →	116.15 (7.22) →	47.15 (4.0) →	
		Spices	-	0.30 (.5)	-	-	15.30 (1.33)
		Sugarcane	-	-	-	-	1.30 (.15)
			(100)	(100)	(100)	(100)	(100)
K	11		50.30	1513.20	1844.00	1612.10	1182.35
T	18		1148.25	3469.20	3235.35	3605.30	3334.05
A	1		-	31.05	15.00	-	22.05
			1199.15	5014.05	5094.35	5218.00	4539.05

cont...

Hi-Mi = Hill millet

Table 3.10 (contd.)

Tank design	No. of tanks	Name of crops	1974-75	1975-76	1976-77	1977-78	1978-79
K	11	HOT					
		Bajari	223.25 (69.00)	-	6.20 (9.00)	84.35 (34.73)	1.20 (24.00)
		Juwar	42.30 (13.19)	-	-	4.15 (1.79)	-
		Maize	45.30 (14.11)	-	67.30 (91.0)	147.20 (60.36)	-
		Hi-Mi	7.15 (2.27)	-	-	3.00 (1.23)	3.20 (56.0)
		Fordes	3.00 (.93)	-	-	-	-
		Vegetables	1.25 (.50)	-	-	0.25 (.26)	1.10 (20.0)
		Banana	-	-	-	4.00 (1.64)	-
			(100)		(100)	(100)	(100)
K	11		324.05	-	74.10	244.15	6.10
T	18		184.15	37.25	57.35	287.20	201.10
A	1		-	-	1.10	-	-
			508.20	37.25	133.15	531.35	207.20

Figures in Brackets indicate percentages

The only all season design tank shows that there has been no Kharif irrigation in 4 year out of 5 considered. A small area of 21 acres was irrigated in 1974-75 in GA1 Tank. Of this area 46% went for paddy, 49% for Maize and 5% for Groundnut. For Rabi farmers demanded water in three out of 5 seasons with a relative bias towards Wheat. The second place went to vegetables. Bajri and Maize were also grown in one season each. In summer only an acre of paddy was grown in 1976-77 with irrigation from the tank. The overall demand for water from farmers, who own an area of about 380 acres in Command area, has been very poor. One can not be very much certain about the reasons for less demand at this stage.

The next set of tanks are two-season tanks. 18 tanks information has been compiled for this. In case of two season tanks, there has been irrigation in all the years with variations in area covered. The range of crops that have been actually cultivated is very big in all the three seasons. In Kharif about 12 crops have been irrigated at one time or the other in 5 years. Some of the farmers in 2 out of 5 years have demanded water for flooding the fields before irrigation. The majority of demand has been for Paddy and Maize in almost all the years. Cotton was grown in 1974-75 but along with Maize. The mixed cropping adopted is probably to reduce the uncertainly of total yield from a plot cultivated. The worth noting feature is that in the five yearly observations compiled, maximum area irrigated in Kharif has been in 1974-75 which was a very bad year. This indicates that to some extent, the tanks have been useful at the time of crisis. In the normal years, water has been demanded for lesser area and mainly for Paddy and Maize. These are the crops which are grown in Kharif even without irrigation. There is nothing which hints at a change in cropping pattern over five years in favour of more water intensive non-food cash crops.

In Rabi, water has been demanded for a larger area and a wider variety of crops. There are 23 crops (individual and in combination) for which water has been demanded. The share of food crops has been very high. Wheat is the major crop for which there has been an increasing demand. Gram and Maize are the next important crops. The relative importance of wheat over year grew in 1975-76, 1976-77 and 1977-78 and 1978-79. The relative importance of Gram has gone down considerably. In 1974-75 area covered by Grams of the total tank irrigated area was around 54% which went down to 15% in subsequent three years only to gain a trifle in 1978-79. The Maize which had a share of 13% in 1974-75 lost good area in next two year and further gained original position in 1977-78 and 1978-79. The next important crop has been a mix crop of Wheat and Gram whose share has been fluctuating from a small share to 4.8% in 1974-75 to all time high of 21.5% in 1977-78. The trade off has been mainly between Gram, Maize and Wheat/Gram. Rest of the crops have been grown by very few farmers who must have made a choice because they could afford. The cash crops show neither an improvement in share nor any downward trend. The farmers have demanded water mainly for Wheat, which is otherwise also normally grown without irrigation. Grams which is grown in the tribal parts without irrigation has gone down in favour of Maize and Wheat/Grams may be because the certainty of water supply was questionable or irrigated Wheat yielded more than irrigated Gram.

Normally, one expects that the farmers in the initial stages will continue to grow the crops which are grown without irrigation and subsequently change over to more water intensive, high yielding food and cash crops because of the assured water supply. However, our sample reveals a different story. Gram, which is more a cash crop, has been substituted by Wheat and Maize. This may be treated as a peculiar response of the subsistence farmers, who would like to turn to self-sustaining food crops, once the water supply is guaranteed.*

In summer the irrigation has been relatively less. In the early years Bajri and Maize are the main crops for which water has been demanded and subsequently area under pulses have grown. This suggests a change in cropping pattern in the

* Gram is grown mostly in tribal talukas of the district. It is sown soon after the early maturing variety of maize or paddy is harvested. Gram grows on the soil where the late monsoon helps conserving some moisture. Therefore, when water supply is assured Gram is dropped.

presumed direction. The total area brought under irrigation shows significant fluctuations over the years. In 1974-75, which was relatively a bad year, shows sizeable irrigation in summer. In 1975-76 and 1976-77 the water demanded in summer shows a decline. In next two seasons the demand has again picked up. It is in the last two summer seasons that we see some change in the cropping pattern.

The Kharif tanks show impressive demand for water in Kharif and Rabi seasons. As discussed earlier, this is because of two large size tanks which have a combined Command of about 3000 acres (LUK3 and HK11). We have also mentioned that Comand farmers of the bigger size tanks are relatively more advanced than the Command farmers of the smaller tanks. This enables us to check whether the farmers have any tendency to go for relatively more cash crops.

In 1974-75 irrigation in Kharif and Rabi season has been less. The demand in summer of 1974-75 is relatively high. This phenomena is also observed in two season tanks and no explanation is available for this behaviour. In subsequent years demand in Kharif and Rabi is significant. In Kharif, major demand is for Paddy. The minimum demand has been there in 1974-75 which is 52% and it has reached to 95% in 1977-78. The next best demand has been for Cotton. The demand for Cotton is highest in 1974-75 which is around 14%. The absolute area under Cotton has gone up in 1975-76, 1976-77 and 1978-79 but their share in total area has gone down.

In Rabi season, major demand has been for Wheat, Maize, Gram and Cotton. In summer water has been mainly demanded for Bajri, Jowar and Maize - all food crops.

Reviewing the abstract table comprehensively following observations can be made.

1. The design-wise abstract does not throw any light on change in cropping pattern. It is likely that if the cropping pattern of each tank is observed individually, one may come across certain changes in the cropping pattern in the Command area of some tanks. If the cropping pattern in the Command areas of all the tanks had experienced a change, it would have got reflected in the abstract, so one may come to conclusion that water has been demanded for the crops which were earlier grown even without irrigation in Kharif and Rabi. In chapter two, section 2.1, we have already seen that the main crops of the district with and without irrigation have been, Paddy and Maize in Kharif and Wheat and Gram in Rabi. These are the crops for which the demand for water has been registered in the Command areas of the tanks.

2. In every season Food crops have been popular and demand for water for food crops that form the staple food of the farmers have been registered.

3. The demand for water for non-food cash crops have been registered but their share to total demand has been fluctuating significantly.

4. Rabi irrigation has become relatively popular with farmers since there is consistent demand for water in almost all the tanks in Rabi.

5. The demand for water in Kharif in a bad year is not in correspondence with the situation. For example in 1974-75 which was a bad monsoon year, the demand for water is relatively less. This may be because the farmers realization about the low storage in the tanks. This leads us to a very significant observation. The Kharif tank can only be useful (acting as crop saving device) when the actual rainfall is not lower than the dependable rainfall, but has a variation. In case of total failure of rainfall, the Kharif tanks also do not serve the purpose.

6. The demand for water in summer season is a satisfactory trend. The demand has remained fluctuating but still it is net improvement in the cropping intensity. Without the tank Summer Cropping is entirely ruled out for all the farmers except a few who have their own wells with sufficient long lasting water yields. At this stage we are not in a position to identify the farmers in Command areas of the tanks who have well irrigation facility.

3.5.6 Relevant Issues

The analysis of the extent of utilization from the Class I MI Tanks in Panchmahals throws light on range of relevant issues. It can now be emphatically said that creating a sound structure does not necessarily guarantee constant supply of water. The source of supply itself is likely to be affected by the exogenous factors. The water that is likely to be stored in a tank depends upon the actual rainfall in the catchment, status of catchment and actual run-off. All these variables are exogenously determined over which the project authority has no control. Such uncontrolable events have potential to disturb the total supply that is estimated. With the result one cannot treat the total supply as a parametric value. The total supply itself is a variable and hence extent of utilization primarily depends upon the value assumed by supply every year. This factor has a direct impact on the demand for water by the farmers irrespective of their individual status. The uncertainty of supply of water arising out of the variations in storage may directly affect the demand for water. The reduction in demand for water due to this factor may be treated quite independently of the reduction in demand due to bad or biased management in the water distribution to fields.

The next relevant and important factor is the water management. We have observed in the utilization abstracts that water use in case of almost every tank irrespective of design, size and period of construction has been relatively higher. The cropping pattern adopted by farmers suggest that there has been no significant shift in favour of water intensive crops.* Since we know that the cropping pattern has remained more or less the same with and without irrigation, we can say that there has been some wastage of water in almost all the tanks. This wastage is either because of (a) the bad Canal conditions which increases actual conveyance losses, (b) a poor supervision and over seeing, (c) farmers tendency to flood more water than necessary and (d) breaches in the Canals. All these factors relate to bad water management practices. This is however a factor affecting the supply of water to fields which is controlable. The effective water management would also necessarily mean additional costs. One has to then go into details to find out whether the water saved by better management with extra cost generates enough returns.

The extent of utilization simultaneously depends on the demand for water. Once again we must be reminded that creating the structure alone would not generate a constant demand

* Paddy has registered significant share in Kharif. This is a water intensive crop. However, paddy requires additional waterings and not all waterings which are necessary to grow. Paddy has many varieties and the command farmers may have shifted for transplanting variety which requires more water. However, out of the customary requirement of 10 to 12 waterings demand for waterings from irrigation sources may be 3 to 4 in a normal rainfall year. In a bad year however, demand may be for 8 to 10 waterings or more, secondly, and more importantly, there is hardly any demand of water for perennial crops like sugarcane. Perennial crops generally have higher water requirement.

equivalent of potential supply. As stated earlier the first factor that affects the demand for water by farmers is the certainty of the supply. If the farmers get a feeling that tank does not receive desired storage most of the times, an element of uncertainty would grip them and demand will be reduced. They may over a period of years realize that the storage is affected in a set pattern and hence may adjust their demand pattern accordingly by demanding more in normal years and less in very bad years. The second factor affecting the demand would also be bad management. If the caretaker, supervisor or overseer of the tank favours certain farmers, others would reduce their demand due to uncertainty. The uncertainty created by bad management will also add to the reduction in demand for water.

The other factors which affect the demand are significant but are independent of source of supply. The main factor is the economic factor. If the farmer in the Command area is not capable enough or able enough to raise other supplementary inputs necessary for irrigated cultivation he is not likely to register demand for water. This is most likely in the initial years of the project when the farmers in the Command are likely to be lacking in other resources. The farmers may not even have enough resources to construct a field channel from the outlet to his field. The resource raising capacity of Command farmers would, therefore, directly affect the demand for water.

The next factor which will affect the demand for water is the existence of wells in the Command area. This factor may affect the demand positively as well as negatively. If the uncertainty of supply is very high, the well owners may be inclined to use well water for irrigation than registering a demand with the tank authority. If a partial supply is a certainty then he may registere a demand with the calculation that he would supplement the partial supply with his well. In case of energised wells especially energised by electrification, the farmer may like to irrigate from wells because the electricity department charges a minimum on connection irrespective of the power utilization. This fixed cost may lead the farmer to decide on depending his own source of irrigation.

It is now clear that the utilization depends on supply as well as demand, both of which are variable every year. This has its implicationon the viability of the project. The returns are not as smoothly behaving as assumed by the project formulating authorities. The economic viability study carried out before investment musttake into account the above factors. We shall explore this aspect in greater details in the next chapter.

APPENDIX I

List of Class I Minor Irrigation Tanks in Panchmahals

Sr. No.	Name of the Tank	Tank Code
1.	Kanelav	GA1
2.	Orwada	GT1
3.	Dangaria	GT2
4.	Ratneshwar	GK1
5.	Kathodia	GT3
6.	Vinzol	GK2
7.	Vardhari	LuK3
8.	Jalai Dhuleta	Lu T4
9.	Kakri Mahudi	Lu K4
10.	Kaleshwari	Lu T5
11.	Kanak Denawad	Lu T6
12.	Bamanwada	Lu T7
13.	Jesola Kamalpur	Lu T8
14.	Luni Bandhara	Lu K5
15.	Dhamnod	Sh K6
16.	Guneli	Sh T9
17.	Demli	Sh K7
18.	Dalwada	Sh K8
19.	Dabhda	LK9
20.	Nakti	LK10
21.	Kalia Kota	LT10
22.	Vada Talav	HK11
23.	Ghansarvav	HK12
24.	Jambughoda	JT11
25.	Lafni	JT12

Appendix I (contd.)

Sr. No.	Name of the Tank	Tank Code
26.	Zinzri	DB T13
27.	Tidki	DB T14
28.	Sevenia	DB K13
29.	Nani Zari	DB T15
30.	Rathwana Muvada	DB K14
31.	Moti Kharsoli	ST16
32.	Fategadhi	ST17
33.	Jalai	ST18
34.	Margala	ST19
35.	Talwada	ST20
36.	Rambhena Muvada	ST21
37.	Titodi	ZT22
38.	Suki	ZT23
39.	Kalia Hill	ZT24
40.	Ghodia Vaghela	ZK15
41.	Karath Vangivad	ZT25
42.	Moti Handi	ZT26
43.	Ghasia	ZT27
44.	Malwasi	ZK16
45.	Therka	ZT28
46.	Dantia	ZT29
47.	Parthampur	ZT30
48.	Kunda Dhamena	ZK17
49.	Minakyar	DK18
50.	Zari Buzarg	DT31
51.	Abhlod	DT32
52.	Gadoi	DT33
53.	Zari Gangarda	DT34
54.	Raski	DTK19
55.	Rabdal	DT35
56.	Dadhelao	DT36.

Appendix 1 (contd.)

Sr. No.	Name of Taluka	Code used
1.	Godhra	G
2.	Lunawada	Lu
3.	Shehera	Sh
4.	Limkheda	L
5.	Halol	H
6.	Jambughoda	J
7.	Devgadh Baria	DB
8.	Santrampur	S
9.	Zalod	Z
10.	Dahod	D
11.	Kalol*	K

Note: *Kalol does not have any class I MI Tank.

Sr. No.	Design	Design Code
1.	All Season Tank (Kharif, Rabi, Summer)	A
2.	Two Season Tank (Kharif, Rabi)	T
3.	Kharif Tanks	K

Appendix II

The project report of Chalvad tank travelled from D E of Halol sub-division to E E of Godhra division to S E, Baroda Panchayat Circle to S.E. Ahmedabad Panchayat Circle to Central Designs Organization (CDO) at Apex level i.e. state level. At each level from E.E. and above remarks were raised. The total number of remarks raised were to the tune of 132. We have classified these remarked under three categories :

i) Purely technical remarks

ii) General remarks

iii) Remarks related to economic and costing analysis.

There were 67 technical remarks, 52 general remarks and 13 remarks related to economic and costing analysis. We have tabulated the remarks data to ~~analysis~~ review the repeatition. Source and correctional attempts of the remarks. have also been stated

Appendix II (contd.)

Table 3.1

Repeatation of Remarks

Particulars	Repeated at - 4 level	3 level	2 level	Original	Total
H.R.	-	-	-	6	6
T.C.	-	-	2	4	6
W.W.	4	-	2	13	18
Earthen Dam & Storage	-	-	1	20	21
Canal	-	-	-	12	13
Command Area	-	-	-	3	3
Total	4	-	6	57	68
GENERAL REMARKS					
Marking	-	-	1	16	17
Mapping	-	-	-	4	4
Inconsistency	-	-	-	6	6
Content leg.	-	-	2	12	14
Certificate	-	-	2	3	5
Clerification	-	-	-	3	3
Others	-	-	-	3	3
Total	-	-	5	47	52
Economic Analysis	-	1	3	9	13
Grand Total	4	1	14	113	133

Appendix II (contd.)

Table - 3.2

Particulars	Repeated at 4 levels	Repeated at 3 levels	Repeated at 2 levels	Original
(a) Repeatation of Purely Technical Remarks Source-wise				
H.R.				++, * @@@
T.C.			* o	+ ** @
W.W.	+ * o @		* o	++++ oooo @@@@@
Earthen Dam & Storage			*	+++++++ **** oo @@@@@@@
Command Area				+
Canal			*	** ~~oo~~ + + ******, oo, @
(b) Repeatition of General remarks: source-wise				
Marketing			*	++++ ***** ooo @@@@
Mapping	+			@@@@
Inconsistory				++ @@@@
Containt log			++	+++++ o @@@@@@
Others				+ o @
Certificate			+ * o	** o
Clarification				oo @

Remarks:
+=E.E.Office
*=S.E.Office,Baroda
°=S.E.Office,Ahmedabad
@=C.D.O.,Gandhinagar

+ =	~~43~~	34
* =	~~29~~	28
° =	~~22~~	20
@ =	~~44~~	38
	~~138~~	120

Appendix II (contd.)

Table 3.2 (contd.)

(c) Repeatation of Remarks related to Economic Analysis and costing source-wise.

Particulars	Repeated at-			Original
	4 levels A	3 levels B	2 levels C	D
		+		+++
			*	
			o o	
			@	@@@@@

Remarks:

+ = E.E.Office   + = 4

* = S.E.Office, Baroda   * = 1

° = S.E.Office, Ahmedabad   ° = 2

@ = C.D.O., Gandhinagar   @ = 6

13

Appendix II (contd.)

Project Appraisal

Section:A

TECHNICAL REMARKS AND COMPLIANCE

Table showing the nature of remarks and the action taken by the relevant authority.

Table 3.3

Nature of remark	Accepted & corrected	Explained	Total remark
1. Purely Technical remarks by			
a) E.E.	8	11	19
b) S.E., Vadodara Circle	6	14	20
c) S.E., Ahmedabad Circle	5	6	11
d) C.D.O., Gandhinagar	13	5	18
Total P.T.R.	32	35	68
2. General Remarks			
a) E.E.	12	3	15
b) S.E., Baroda	8	0	8
c) S.E., Ahmedabad	4	5	9
d) C.D.O., Gandhinagar	14	6	20
Total General Remarks	38	14	52
3. Economic Analysis Remarks			
a) E.E.	1	3	4
b) S.E., Baroda	1	0	1
c) S.E., Ahmedabad	1	1	2
d) C.D.O., Gandhinagar	5	1	6
Total E.A.R.	8	5	13
Grand Total	78	54	133

APPENDIX III

Name of work: Constructing a new M.I. Tank at Village Chalvad, Tal. Jambughoda, Dist.Panchmahals.

Tentative Crop Pattern: (Appendix No.35)

The following Crop pattern is proposed.

Sr. No.	Crop. (Kharif)	Area in Acres	Duty (Acre per M.Cft)	Amount per M.Cft.
1.	Paddy	24	15	1.600
2.	Other Kharif	198	24	8.250
		222		9.850
			against	9.882

Sd/
Deputy Engineer,
M.I.I.Sub-Division,
Halol

Sd/-
Executive Engineer,
Distt.Panchayat Panchmahals
M.I.Division,
Godhra

Sd/-

Prepared by Supervisor

APPENDIX IV

Name of work: Statement showing benefit-cost Ratio (Appendix No.37)
Constructing a new M.I. Tank at Village Chalvad
Tal: Jambughoda, Dist. Panchmahals.

Sr. No.	Crop	Area in Acre	Field in qt.per acre	Total yield	Price in Rs./Qt.	Total Value in Rs.	Proposed area for crop	Yield in qut. per acre	Total yield	Price in Rs./qt.	Total value in Rs.
		Before Irrigation					After Irrigation				
1.	Paddy	24	4	96	150/-	1440/-	24	8	194	150/-	28000
2.	Maize	20	3	60	150/-	9000/-	20	8	160	150/-	24000
3.	Bajari	40	3	120	150/-	18000/-	40	8	320	150/-	48000
4.	Groundnut	20	3	60	220/-	13200/-	20	6	120	240/-	26400
5.	Cotton	50	1.5	75	300/-	22500/-	50	4	200	300/-	60000
6.	Pulses	68	2.0	136	200/-	27200/-	68	4	272	200/-	54400
		222				104300/-	222				241600

Note: Take the current market yard price for the value of one quintal.

Sd/-
District Agriculture Officer,
Panchmahals, Godhra.

APPENDIX V

Name of work: Constructing a new M.I.Tank at village Chalvad, Tal.Jambughoda, Dist. Panchmahals.

Calculation for tentative design of canal detail crop pattern has not been done and hence tentative crop pattern as follows has been considered for working out the canal discharge and fixing the dia of R.R.Pipe out let.

(1) Tentative Crop Pattern (Appendix No.34)

Sr. No.	Crop	Area in acres	Duty in areas/ acres M.Cft.	Discharge in cusecs.
	Kharif:			
1.	Paddy	24	48	0.500 cusecs.
2.	Other Kharif	198	80	2.400 cusecs.
		222 acres		2.900 cusecs

(2) By AI/DC method

Name of crop	Area in acres	AI/ DC	C-period Rotation days	Water required in cusecs
Kharif :				
Paddy	24	3.5	12	0.57
Other Kharif	198	3.5	24	2.35
	222 Acres			2.92

The design discharge for H.R.

$$= 2.92 \times \frac{25}{100} (2.92) \text{ as canal losses}$$

$$= 2.92 + 0.73$$

$$= 3.65 \text{ cusecs.}$$

Sd/-
Deputy Engineer,
M.I. I.Sub-division,
Halol

Sd/-
Executive Engineer,
Dist.Panchayat Panchmahals,
M.I.Dn,Godhra

Sd/-
Prepared by Supervisor

APPENDIX VI

Revised detailed Appendix 34. Cropping Pattern

Sr. No.	Crop	Area in acre	Duty in acres/ cusecs.	Discharge in cusecs
1.	Paddy	24	48	0.500
2.	Maize	20	80	0.250
3.	Bajri	40	80	0.500
4.	Ground-nut	20	80	0.250
5.	Cotton	50	48	1.04
6.	Pulses	68	48	1.42
				3.96 cusecs

II. By AI/DC method

Sr. No.	Name of crops	Area in acres	AI/DC	C-period rotation days	Water required in $\frac{3}{4x5}$ cusecs
1.	Paddy	24	3.5	12	0.57
2.	Maize	20	3.5	24	0.24
3.	Bajri	40	3.5	24	0.48
4.	Groundnut	20	3.5	24	0.24
5.	Cotton	50	3.5	12	1.19
6.	Pulses	68	3.5	12	1.62
					4.34 cusecs

The design discharge for H.R. $= 4.34 + \frac{25}{100}(4.34)$ as losses

$= 4.34 + 1.08 = 5.42$ cusecs

APPENDIX VII

GLOSSARY OF IRRIGATION TERMS

1. AI/DC :

It is the ratio between the area irrigated and the discharge in day cusees for a particular period. In other words it is the area (in acres) of mixed crops irrigated by one cusec discharge flowing througuout the day. The value is taken as 3.5 to 4 at canal head.

2. AREA IRRIGATED :

The area to which water has been actually applied for irrigation.

3. AREA CULTIVABLE COMMAND :

It is the portion of gross command area which is culturable.

4. AREA CULTURABLE IRRIGABLE :

The gross irrigable area less the area not available for irrigation e.g. village areas, roads, and isolated patches of unculturable lands.

5. AREA GROSS COMMAND

The portion of the gross irrigable area which can be commanded by flow irrigation. In special cases this also includes the area irrigated by pumping or lifting the water by other devices.

6. AREA GROSS :

It is total area within the extreme limits for irrigation by a project system of irrigation or any channel. This includes higher areas to which water cannot flow by gravity.

7. AREA IRRIGABLE :

Area within the command which can be irrigated (both by flow and by lift).

8. BANDHARA :

A weir built across a stream ('a' nalla) for heading up of water and to divert it into a channel for irrigation.

9. BRANCH CANAL :

A Government channel taking its supply from the main canal or a branch and having a capacity of more than 1000 cusecs at head. Continuation of the same channel is also called a branch even though the capacity gets reduced to below 100 cusecs.

10. CANAL :

A channel constructed or maintained for the conveyance of water to feed the branch canals or directly the distributaries, or for the purpose of navigation. Legally the term "Canal" includes :

(a) All canals, channels and reservoirs constructed, maintained or controlled by Govt. for the supply of storage of water.

(b) All works, embankments, structures, supply and ascape channels corrected with such canals, channels or reservoirs.

(c) All water courses.

(d) Any part of a river stream, lake or natural collection of water or natural drainage channel.

11. CATCHMENT OR CATCHMENT AREA :

The area from which a lake, stream or water way and reservoir receives surface flow which originates as precipitation.

12. CROP PATTERN :

The percentage of various mixed crops or seasonal crops proposed to be irrigated by the existing or proposed irrigation system to suit soils in the culturable command area.

13. CUSEC :

A unit commonly used in irrigation practice to denote the discharge or rate of flow of water in cubic feet per second.

14. DISCHARGE :

The quantity of water passing a particular site in unit time at any instant.

15. DISTRIBUTORY :

It is a Govt. Channel taking its supply from a main canal or a branch and having head discharge between 100 and 25 cusecs.

16. DIVERSION WORKS:

A collective term for all works (diversion dams or weir head regulators, upstream and downstream river training works and their appurtenant structures) required at intakes of main or principal canals to divert and control river flows and to regulate water supplies into the main canal or canals.

17. DUTY :

The relation between the area irrigated or to be irrigated and the quantity of water required to irrigate it for the purpose of maturing its crops. Duty is stated with reference to a base period and the place of its measurement. It is expressed in a number of ways:

i) Water-depth units.

ii) Depth area units per unit area

iii) Area per unit rate of flow or per unit volume of water.

iv) Volume of water or rate of flow per unit area.

18. FIELD CHANNEL :

A channel to lead water to fields from the Govt. outlets on a canal, branch, distributory or minor and subminor at the cost of cultivators, such channels in each irrigation block under outlet are owned and maintained by the cultivators of that block.

19. FULL SUPPLY LEVEL :

The water level in an irrigation channel running with full supply discharge.

20. LEACHING :

The washing out of salts from the upper zone of the soil by flooding. The salts dissolve in the water which is drained off through the sub-soil.

21. LIFT IRRIGATION :

Water raised by pumps or other devices and applied to an area in the supply system, the level of which is too high for flow irrigation.

22. LINING OF CANAL :

In order to save substantial quantity of water which is lost in transit, through seepage, percolation, etc. before water reaches fields, and to overcome further serious problems of water-logging, loosing fertility of soil, etc., lining of canals is adopted for various advantages and benefits. Lining is done to fill in the bed and side-slopes of canals with various suitable material like bricks, stones, concrete, short-crete, asphalt etc.

23. OUT LET :

An outlet is a pucca opening in a Govt. channel for controlling the supply of water to field channels and is constructed at Govt. cost. These are numbered serially from head to tail of a distributory or minor or sub-minor (Ordinarily, outlets are not built on the main line or branches. When built such outlets are termed 'Direct Outlets').

24. PERCOLATION TANK :

A tank formed by an earthen dam to head up storm water, with the object of raising the sub-soil water level in the surrounding wells and producing a small flow in the nalla down below :

25. REGULATOR :

A structure through which the discharge can be regulated or varied as required also applied to a structure provided with mechanism for varying the water surface level above it.

(a) HEAD REGULATOR :

It is a structure to regulate and release water into an irrigation channel from a weir, reservoir or a parent channel. The control can be exercised through gates, needless or valves.

(b) CROSS REGULATOR :

It is a structure constructed across a channel to control the depth of water upstream and regulate the discharge passing to the off taking channel.The control can be exercised through gates, needless or valves.

26. RUN OFF :

The portion of precipitation that appears as flow in streams. The volume of water discharged by a stream draining the area or into reservoir receiving the drainage.

27. FIRST CLASS IRRIGATION WORKS :

These are the Irrigation works benefitting 250 acres or more. The administrative control of such works is with P.W.D. The Executive Engineer or the S.D.O. in charge of such works is the Canal Officer, The maintenance and repairs for these works are looked after by P.W.D. The water Rates for such works are recovered separately according to the area irrigated.

28. SECOND CLASS IRRIGATION WORKS :

These types of Irrigation works are those which irrigate area of less than 250 acres. The administrative control of such works is with the Revenue authorities like Mamlatdar or Mhalkari. The day to day repairs such as filling the ruts and hollows, clearing jungle and clearing silt from irrigation canals and Waste Weir, Channels are done by the beneficiaries themselves. For such works water rates are not levied separately but are recovered by way of "Himayat" which constitutes fixed charges per acre recovered along with the Land Revenue taking into consideration the advantage occuring from such Irrigation works.

Source: Compiled from Glossary of Irrigation Terms: Public Works Department, Sachivalaya, Gandhinagar, Gujarat, 1976.