Monitoring and evaluation of irrigated agriculture

A case study of Bhima Project, India

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Serious monitoring and evaluation of irrigated agriculture projects in developing countries tends to be neglected by both national and donor agencies. After outlining a conceptual framework for monitoring and evaluation of irrigation projects, this article presents a case study of an evaluation carried out using the framework developed on the Bhima Command Area Development Project in Maharastra, India. It is argued that if the irrigated agriculture projects are to achieve their initially planned potential, it is essential to carry out regular monitoring and evaluation as an integral part of the management process.

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Projects on irrigated agriculture have produced intense optimism as well as pessimism in recent years. On the positive side, there is no doubt that timely, reliable and well-managed water availability and its effective use is an essential prerequisite for modern high-yielding agricultural production. The importance of irrigated agriculture can be realized by the simple fact that although only about 20% of the world's agricultural land is now under irrigation, it contributes to nearly 40% of the total global agricultural output. Clearly, the world food problem cannot be resolved without adequate water control.[1]

On the negative side, results of numerous recent projects on irrigated agriculture leave much to be desired. Not only have many of these projects contributed to serious environmental, social and health problems,[2] but also very few – if any – projects have fulfilled their planned production potential within their designed time and cost frameworks. Furthermore, certain irrigation projects have been intense disappointments in recent years. For example, a review carried out by the Club du Sahel and the Permanent Inter-State Committee on Drought Control in the Sahel (CLISS) of the irrigated agriculture projects in the Sahel concluded that the area under modern irrigation doubled during the period 1960–79, but 'generally speaking, during the past few years, the development of new areas has barely surpassed the surface [area] of older ones which had to be abandoned'.[3]

Undoubtedly, one of the main reasons for the simultaneous expression of the extremes of optimism and pessimism concerning irrigated agriculture projects is the general lack of objective monitoring and evaluation of these projects. One would be hard pressed to use all the fingers of one hand to count the number of projects in developing countries which have been reliably and objectively evaluated five, ten and 20 years after their completion. In addition, regrettably, far too

[1]Asit K. Biswas, 'Evaluating irrigation's impact: guidelines for project monitoring', *Ceres*, Vol 18, No 4, July-August 1985, pp 23–26.

[2]Asit K. Biswas, 'Environment and sustainable water development', Keynote Address, IVth World Congress, International Water Resources Association, Buenos Aires, 1982, in *Water for Human Consumption*, Tycooly International, Dublin, pp 375–392; and Asit K. Biswas, 'Health environment and water develop-

continued on page 48

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many pseudo-evaluations are carried out at present by both national and donor agencies (bilateral as well as multilateral), who are more concerned with the protection and enhancement of individual and institutional reputations than with determining the real costs and benefits stemming from the projects.[4] Furthermore, not only are there methodological problems that need to be resolved to find cost-effective and reliable evaluation techniques for the evaluation of specific projects, but there are often built-in institutional inertia and sensitivities which need to be overcome before a serious evaluation can even be undertaken.

If these constraints could be overcome, the information available after completion of evaluation should be disseminated. On the basis of past experiences, this could be a problem because the agencies concerned often do not wish to disseminate the information unless it is properly 'sanitized'. The bilateral and multilateral donor agencies often do not disseminate their evaluations and claim that they are forced to take such a step due to national sensitivities. However, in contrast, many development experts feel that one of the main reasons could be the poor performance of the donors, who do not wish to publicize some of their mistakes which become evident during an evaluation and thus prefer to hide behind the so-called national sensitivity issue. Bottral points out that the four detailed case studies he carried out for the World Bank had to be marked 'Not for Quotation', and they 'could not be published because of the supposed sensibilities of the governments of the countries concerned. For the same reason, the text of the final comparative study was "sanitized" to the extent that all references were removed not only to the particular projects studied but even to the countries in which they were located.'[5] Such restrictions, which are generally unwarranted, seriously reduce the potential usefulness and impact of the evaluations carried out, and thus tend to defeat the very purpose of the evaluations.

Methodology for evaluation of irrigated agriculture

The principal requirements for monitoring and evaluation of irrigated agriculture projects have been discussed elsewhere.[6] On the basis of these requirements, a conceptual framework for monitoring and evaluating irrigated agriculture projects for the International Fund for Agricultural Development (IFAD) was developed.

According to this framework,[7] monitoring and evaluation (M&E) can be logically divided into four interrelated levels:

- planning, design and construction of physical facilities;
- operation and maintenance of water control facilities;
- agricultural production; and
- achievement of socioeconomic objectives.

The first level – planning, design and construction of physical facilities – is a discrete phase, which is probably the easiest of the four levels to handle. This is also a level of activity where some form of monitoring and evaluation has always been a standard practice. It is generally a common practice among engineers to monitor the progress of the construction of physical facilities according to previous plans, time schedules and cost estimates. There are, however, important areas (such as employment or user participation) where data are seldom

continued from page 47
ment: an understanding of interrelationships', *The Environmental Professional*, Vol 7, No 2, pp 128–134.
[3]Club du Sahel and CLISS, *The Development of Irrigated Agriculture in the Sahel*, Club du Sahel, 1980, p 33.
[4]Biswas, *op cit*, Ref 1.
[5]A. Bottrall,, 'Why evaluate irrigation system performance?', Proceedings, Workshop on Methodologies for Evaluating the Performance of Irrigation Systems, Bangladesh Agricultural Research Council, Dhaka, 1986.
[6]Asit K. Biswas, 'Methodology for monitoring and evaluation of integrated land and water development', in J. Lundqvist, U. Lohm and M. Falkenmark, eds, *Strategies for River Basin Management: Environmental Integration of Land and Water in a River Basin*, D. Reidel, Dordrecht, pp 49–61. Also Asit K. Biswas, 'Monitoring and evaluation of an irrigation system', *International Journal of Water Resources Development*, Vol 2, No 1, 1984, pp 3–25.
[7]Biswas, 1984, *op cit*, Ref 6.

collected and analysed on a systematic basis, and yet such information often has serious policy implications.

The level of operation and maintenance (O & M) of water control facilities is one of the most underestimated aspects of irrigation projects in developing countries. And yet, if the benefits from such projects are to occur on time and to the specific target groups, it is essential that O & M be carried out efficiently to ensure that irrigation water availability is reliable, that farmers at the tailend receive their regular quota of water, and that the drainage system is functioning properly so that salinity and waterlogging problems do not occur in the future. A review of past irrigation projects indicates that most agencies are generally not ready to undertake O & M work when the construction phase is completed. It seems that O & M is still accorded low priority, at least when judged by the actual performances of both governments and international institutions or donor agencies. Thus, not surprisingly, inadequate funds are available for O & M and maintenance efforts are often postponed until a major crisis appears. During this period of postponement the efficiency of the projects continues to decline, and consequently the problem faced during crisis situations is technically more complex to resolve and more costly than had the maintenance works been carried out on a regular basis.

A major problem worth noting is the fact that although O & M is poor for irrigation, it is generally even worse for drainage. Poor drainage contributes to salinity and waterlogging development, but since such problems usually take some time to develop, the magnitude and extent of the problems are seldom realized until they become serious.

The third level is agricultural production. Any irrigated agriculture project should provide efficient water control in order to increase the incomes of people in the project area. Efficient water control, referred to at the previous level, by itself is not a sufficient condition to maximize agricultural production, which simultaneously requires other essential inputs such as seeds, fertilizers, pesticides, machinery, energy, and factors like extension, credit and marketing facilities. It is equally important to ensure that irrigation water and the factors mentioned are available to the farmers in an integrated and timely basis. For evaluation at this level, all the factors mentioned – with the exception of irrigation water which has already been considered in the previous level – need to be considered.

Information needs to be collected at critical times for each cropping season, so it can then be used to provide better coordination between the different organizations responsible for the various inputs and services. At the end of the cropping season there should be an overall performance review. This review would be helpful in preparing an integrated and improved plan for the subsequent cropping season.

In many irrigated projects, evaluation of agricultural production may require the maximum effort when compared with the other three levels mentioned in this section.

Achievement of socioeconomic objectives is the fourth level of the monitoring and evaluation framework. The purpose of irrigation is to increase agricultural production, which will not only increase availability of food for people, but also directly contribute to increased income generation of both farmers and non-farmers. Increased productivity and the rise in farm income could go a long way to achieve the socioeconomic objectives of the project.

Table 1. Maximum landholding per family of five in Maharastra.

	Hectares
Irrigated land	
Perennial	7.2
Seasonal: assured	10.8
Seasonal: unassured	14.4
Paddy land (assured rainfall)	14.4
Other rainfed land	21.6

It is, therefore, essential to monitor and evaluate the impacts of the project on the proposed beneficiaries. For example, it is quite possible that an irrigation project may enhance the employment and income potential of landless labourers on farms and in neighbouring towns due to intensified agricultural activities. Equally, it could replace overall employment potential by undue emphasis on mechanization, which could make the life of landless labourers far worse than the pre-project level. It may be possible that the income of small farmers and landless labourers increases significantly due to the project, thus making more equitable income distribution in the area. Alternately, the benefits could accrue primarily to the large farmers at the cost of small ones, and thus make income distribution even more skewed than before.

It is equally important to monitor the impact of increased income on some quality of life indicators. For example, is the increased income improving the quality of life of the people in the project area, eg better literacy rate, improved health services, provision of clean water and sanitation, or is it being primarily used for conspicuous consumption, as has been observed in certain projects.

From a management viewpoint, it is essential that monitoring and evaluation be carried out continually. Decision makers must be aware of the developments so that appropriate policies may be formulated and implemented in time to reverse undesirable trends. To this end, both intended and unanticipated impacts should be monitored.

The time factor is very important for this type of evaluation since some of these results may not materialize until eight to 12 years. Socioeconomic monitoring need not be carried out as frequently as O & M monitoring of water control facilities or agricultural production. Key variables could be monitored annually, with others being surveyed once every three to five years.

I evaluated the Bhima Project on the basis of this conceptual framework.[8]

Evaluation of Bhima Project

The Bhima Command Area Development Project is located in the province of Maharastra, India. Rapid industrial growth of 4.8% per annum during the past two decades has made Maharastra one of the most industrialized and urbanized provinces of India. Most of the industrial growth, however, has taken place in its two principal cities – Bombay and Pune. In contrast, agricultural growth has been low, 0.7% per annum. Thus, both regional income distribution and rural–urban migration have become problems.

Currently, some 59% of the provincial area is under cultivation. The area of an average farm is 5.3 ha, but the average farm size varies significantly from one district to another. The vast majority of the farms are owner operated (92% according to the 1970 census). Maximum landholdings allowed in Maharastra for a family of five (husband, wife and minor children) depend on the degree of water availability and control, and are shown in Table 1.

Agriculture provides nearly two-thirds of the provincial employment but accounts for only one-third of the income. Since there is very little prospect for horizontal expansion of agriculture in Maharastra, emphasis has to be placed on better use of agricultural land, and substantially increasing the cropping intensity which is among the lowest in India. For

[8]Asit K. Biswas, 'Mid-term evaluation of the Bhima Command Area Development Project', Report to the International Fund for Agricultural Development, Rome, 1984, p 111.

a mostly arid region, such improvements cannot occur without irrigation.

The government of Maharastra has been conscious of the importance of irrigation for the provincial economy and welfare. Nearly $1.3 billion was invested in major and medium surface irrigation works during the three decades after independence to bring additional 870 000 ha of land under irrigation. Compared to the average cost of Indian irrigation projects, at $860/hectare, irrigation investment per hectare in Maharastra has been 73% higher. The high cost, however, can be explained to a major extent by more difficult physical and climatological conditions within which irrigation systems had to be developed.

Since water is the major constraint for further agricultural development, the provincial government has embarked upon an ambitious irrigation expansion programme under Maharastra Composite Irrigation Projects (MCIP) I and II. The Bhima Command Area Development falls under MCIP II.

The Bhima Project consists of a storage dam across the Bhima River – a major tributary of the Krishna River – near the village of Ujjani (hence often called Ujjani Dam), which is nearly 150 km from Pune towards Solapur (Figure 1). Since the construction of the dam, a new village of Bhimanagar has developed near the dam. The project has a gross command of 166 400 ha, but a net irrigable area of 126 000 ha. Since good dam sites are not available, the Bhima Reservoir has inundated an area of 29 000 ha. This means the ratio of the land inundated to the total land to be irrigated is 1:4.35 which is somewhat on the high side. The command area extends on both banks of the Bhima and Sina Rivers (see Figure 1).

For the evaluation of the Bhima Project, a study centre was established at the newly developed village of Bhimanagar from where it was possible to move all over the command area. Extensive series of discussions were held with senior, middle and junior officials from the Departments of Irrigation and Agriculture. In addition, relevant issues were reviewed with various officials of the Maharastra Land Development Corporation, banks, cooperatives active in the command area,

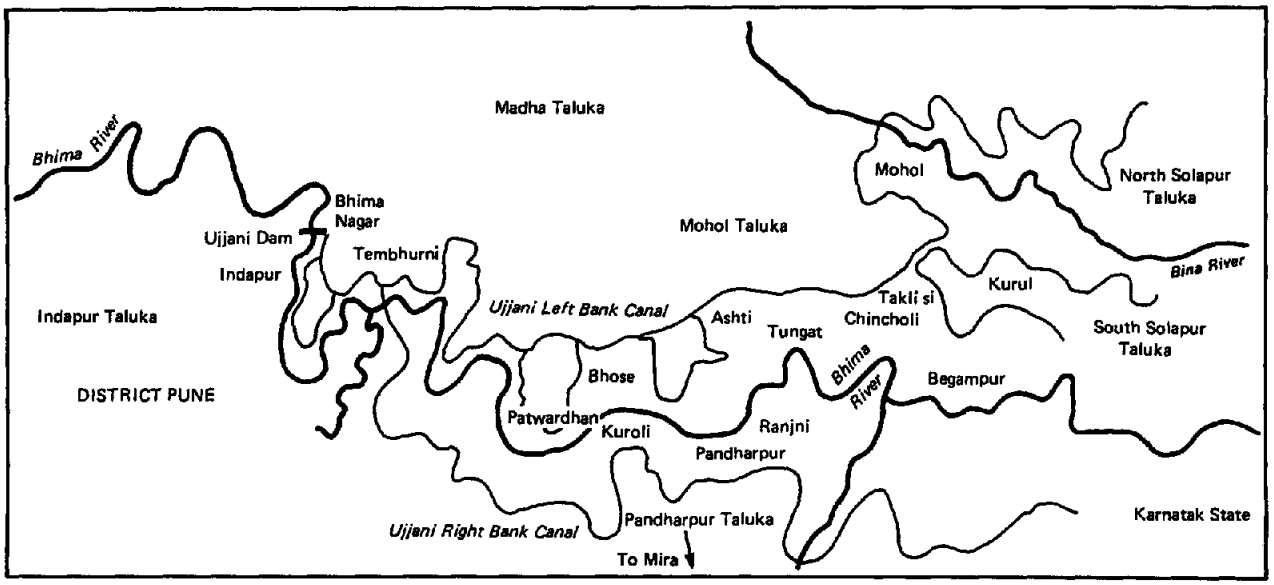

Figure 1. Area of the Bhima Project.

education and health officials, research institutes, village leaders and individuals.

Much of the emphasis of the evaluation was placed on the villagers – their perceptions of and attitudes to the project. We wanted to know the views of large, medium and small farmers as well as landless labourers on the impacts the project has had on their lives: if and to what extent it has changed their aspirations, their views of benefits and disbenefits of the project and the overall impact of the project on their lifestyle and quality of life. We also specifically wanted to know the impacts of the project on women.

The plan was to review and analyse the actual working and effectiveness of the various components of the projects, and then to determine the present status of socioeconomic development in the command area. The idea was that having defined the present status, we could then compare it to the socioeconomic baseline study carried out earlier. The level of difference would give an indication of progress during the two time periods.

Unfortunately, however, on arrival in Bhimanagar, it was quickly apparent that the socioeconomic baseline study would be of no use for the evaluation because no thought was given as to the possible use of the study later, and no data were available on the parameters which would have been helpful for evaluation. Accordingly there was no choice but to adopt the recall method within the overall rapid rural appraisal. For this, three sets of questionnaires were used.

The first set of questionnaires was used to review the general situation over the command area that is receiving irrigation water. Six villages were chosen for this review: four villages receiving irrigation water for all three seasons since 1980 – Shevare, Vadoli, Takali Gor Akole and Chandaj; one village receiving irrigation water for *rabi* only since 1979 – Patwardhan Kuroli; one village receiving irrigation water for first time for *rabi* 1983/84 – Phulchincholi. The number of villagers interviewed in each village varied from 24 to 44, depending on their population. In each village, people interviewed included farmers with large (over 5 ha), medium (25 ha) and small (less than 2 ha) holdings and landless labourers. The interviews were carried out by canal inspectors.

In addition, 26 wives of farmers interviewed in the six villages were then interviewed by women interviewers. These again included large, medium and small farmers and landless labourers. The interviewers used were two graduate women living within the command area.

The third set of interviews was primarily to determine the present land-holding pattern, input availability, income from sales of agricultural products and total income. This included an exhaustive set of interviews in six villages in Madha Taluk only. Altogether 837 small, medium and large farmers were interviewed by canal inspectors in the following villages: Alegaon Budruk, Alegaon Khurd, Chandaj, Ranjani, Rui, Shevare, Takali Gor Akole and Vadoli. In addition, there were a few selected case studies of individual farmers. Details of these case studies and sample questionnaires can be found elsewhere.[9]

The time required for this mid-term evaluation, including field work, analyses and report preparation, was nine man-weeks.

Implementation progress

[9] *Ibid.*

The overall progress in implementing the major infrastructural compo-

nents has been generally excellent. An important component, the Ujjani Dam, was completed almost three years ahead of schedule. However, progress with minor distribution networks, on-farm works and roads and bridges has not been commensurate with other developments mainly due to insufficient and erratic supplies of cement and inadequate funding from the government of Maharastra.

About 10 000 ha were under irrigation in *rabi* in 1983/84 and this was expected to increase to 26 000 ha by October 1984 (target 62 000 ha). The original target of 62 000 ha was expected to be achieved by 1985. The yields of irrigated crops increased steadily. For example, average yield of *rabi jowar* increased to 1.5 tons/ha, three times the yield prior to irrigation. Groundnuts, which could not be grown in rainfed conditions, have become a particularly popular crop, with an average yield of 2.5 ton/ha.

Drainage works are progressing slowly and therefore need to be accelerated. A land development survey has been completed on about 39 000 ha, and field channel construction and land shaping and levelling has been completed in an area of 29 800 ha as envisaged in the appraisal report. The Training and Visit (T & V) system is being developed by the extension service but its implementation is weak. Therefore, it needs further strengthening in order to increase its effectiveness. Timely and adequate supply of complementary inputs such as credit, improved seeds and fertilizer, etc, would also help to realize potential benefits.

A water management system is in operation and working effectively. Farmers of the five villages were interviewed to evaluate the effectiveness of the programme. They indicated their high satisfaction with regard to: a) utilization of the existing rotational water distribution system introduced by the project; b) adequacy of water availability; c) timeliness of the supply of irrigation water; and d) water rates charged and the method used for fixing them. However, further improvement could be achieved mainly through proper land levelling and shaping to ensure optimal water use.

Because of space limitations and the fact that the progress in implementation of various aspects of irrigated agriculture projects are generally monitored in some fashion, these issues have only been briefly mentioned here. Detailed information can be obtained from the original report.[10]

Assessment of project impact and achievements

Even though only a limited part of the Bhima Command Area has been receiving irrigation water, the impact of the project on people, biota and the environment has been substantial. On the basis of the evaluation, various impacts will be reviewed under the following categories: income, employment generation, livestock, energy use, education, transportation, water supply, sanitation, housing, food and nutrition, health, women, public participation, and environmental impacts.

Income

There is no doubt that incomes in areas receiving year-round irrigation increased substantially. Farmers are generally somewhat reluctant to provide correct income figures (assuming they themselves are aware of these) because of fear of possible taxations, reduction in benefits and/or increase in bureaucratic redtape. However, from the surveys of villages

[10] *Ibid.*

in Madha Taluka, it is clear that the incomes three years after irrigation was introduced were substantially higher than incomes just prior to introduction. The ratio of total annual income from the sale of agricultural products three years after irrigation to the corresponding income preceding irrigation varied from a high of 4.84 to a low of 2.00. The average of all such ratios was 3.05. Similar ratios of total annual income varied from a high of 4.86 to a low of 2.2, with an average ratio of 3.28. Viewed from any direction, such improvements in incomes within a period of only four years (1980/81–1983/84) have to be considered a remarkable achievement.

Indirect analyses tend to support an increase of this magnitude. As noted below, people have considerably improved and are continuing to improve their lifestyle by improving their houses and investing in livestock, better clothing and social functions (like marriages and festivals). Generally, they appear to have refrained from conspicuous consumption, though this may change in the future with further affluence.

Employment generation

Employment generation has been one of the major benefits of the project. Project-related construction activities have already provided substantial employment opportunities to skilled and unskilled workers. An analysis of this employment generation by various activities and years is given in Table 2.

The work patterns of both small and large farmers have changed substantially. Prior to irrigation, family members usually worked as daily labourers after the *rabi* season. Small farmers worked as daily labourers even during parts of the *rabi* season since there was not enough work for them in the field. Irrigated agriculture, as practised in Bhima, is a labour-intensive activity. Thus in areas where water is available throughout the year, farmers do not now have time to work as daily labourers, with the exception of a few small farmers, who still may work for a limited number of days per month as labourers.

Table 2. Man-days of employment generated (lakh × 10^5).

Circle/Division	Up to 1979		1980		1981		1982		1983		Total	
	Skilled	Unskilled	Skilled	Unskilled	Skilled	Unskilled	Skilled	Unskilled	Skilled	Unskilled	Skilled	Unskilled
Bhima Project Circle (Dam, ULBC, Disnet Construction & Lining)	2.38	72.70[a]	0.79	21.41	1.74	89.65	6.83	52.75	1.50	10.92	13.24	247.43
Bhima Canal Circle (URBC, Branches Construction & Lining)	–	–	0.83[b]	11.80[b]	1.22	20.30	1.20	11.01	1.24	5.86	4.49	48.97
Bhima Irrigation Division (Irrigation Management)	–	–	–	–	–	–	0.01	0.13	0.02	0.42	0.03	0.55
Bhima Development Division (FC Lining)	–	–	–	0.01	0.03	0.73	0.05	1.00	0.02	0.13	0.10	1.87
DSCO (Land development) OFD[d]	–	19.00[c]	–	8.84	–	10.53	–	11.66	–	15.50	–	56.53
Bhima Command Road Division[d] (Roads in Command Area)	–	–	–	2.40	–	3.79	–	4.61	–	4.90	–	15.71
Total	2.38	91.70	1.62	44.46	2.99	125.00	8.09	81.16	2.78	37.73	17.86	371.06

Notes: Skilled and semi-skilled included under 'skilled'.
[a]Covers the period 1.1.78 to 31.12.79.
[b]Covers the period 1.7.80 to 31.12.80. Prior to BCC, the work was with BPC.
[c]Covers the period from 1977 to December 1979.
[d]Both for DSCO and BCRD, the figure of skilled are included under 'unskilled', the majority being unskilled.

Large farmers have now started to hire labourers for farm work; even small farmers hire labourers during harvest time. Consequently, for those local people who work as labourers, obtaining employment within commuting distances from their homes is no longer a problem. Already labourers from outside the command area are coming in for work. The labour situation during harvest time has become very tight – many farmers are now forced to go outside the command area to bring labourers for harvesting. Thus, in terms of employment generation, the project has had a significant impact both within and beyond the command area. As more and more areas come under irrigation, the labour situation is likely to become somewhat acute – at least in the initial years.

Livestock

A main benefit of the project is an increase in livestock holding. For example, in Phulchincholi village, 24 farmers of all those surveyed reported increases in livestock holdings since irrigation and only seven reported no change in their status. While farmers generally increased their livestock holdings, landless labourers have benefited as well – though not to the same extent. It appears that many landless labourers have invested in livestock from their earnings from the construction activities of the project. They are grazing their livestock along the canals and/or communal areas. A major problem, however, is the lack of suitable veterinary services in nearly all the villages.

Energy use

Many of the villages have received an electricity supply under the rural electrification programme. However, domestic coverage is extremely poor. For example, in the Takali village (population 3257), only one house has an electric connection. There are 30 street lights, which undoubtedly is an improvement. This sad state of affairs, however, is a country-wide phenomenon, where the main emphasis is on the number of villages electrified and not on coverages within villages. This policy needs to be changed.

In the villages, kerosene is primarily used for lighting, and firewood and agricultural residues for cooking. Women generally collect firewood and spend an average of two hours each day on firewood collection and related activities. Firewood, however, has become scarce and many rural families are already forced to purchase it. An interesting observation is that the percentage of people purchasing firewood in areas where irrigation water is available all year round is much less when compared to other areas receiving water for only one season or no water at all. There could be two reasons for this. First, agricultural residues in areas receiving year-round irrigation would be higher than surrounding areas, and hence this would tend to alleviate the problem of firewood scarcity. Second, people having continual irrigation have become more prosperous and have significantly increased their livestock holdings, thus increasing the dung available for cooking. However, further investigation is necessary to prove these two hypotheses.

Education

There is no doubt that the children in the project area are becoming better educated than their parents. While the new affluence has some bearing on this, it cannot be exclusively attributed to irrigation. Much of

it may have occurred without the project. Irrigation does not appear to have made any noticeable change on the number and type of schools or quality of teaching (number of teachers, their experience, educational materials, etc), and in fact a few villagers have complained about the quality of schools available.

It is not possible to make any comment on enrolment and drop-out rates since consolidated data are not available. It will be necessary to go from school to school to interview head teachers, and then aggregate the information for analysis.

Transportation

It was a strategical error for an international agency to fund only the improvement and consolidation of the existing main road. Since the main road constitutes mainly district roads and state roads, this would have been funded by the Public Works Department of the Maharastra Government as a matter of routine. Instead, the agency should have supported village roads and farm roads that could provide access to the main road. Currently no plan exists for village and farm roads. Because farm roads have not been developed prior to the arrival of irrigation and land-holdings are generally small, farmers are likely to be reluctant to give up land. This means that the construction of farm roads will now be a very difficult process. Another problem is that lack of farm roads also means lack of cattle-crossing on the channels. Accordingly cattle will damage the channels, and thus increase operation and maintenance costs and also seepage losses. This problem has already surfaced.

Another issue is the political agitation that has already started over the need for village roads. During our stay in Bhimanagar, in at least one village, people were planning to organize a *rasta rokoo* (close the road) movement in order to get authorization for the village road. Lack of village and farm roads means that access to market will be difficult and transportation will continue to be a problem.

Water supply

Sources of drinking water at present are hand pumps, tanks, wells and river. More and more handpumps are being installed. However, this appears to be part of a rural water supply programme, and probably would have occurred with or without the project. The problem with the handpumps now is maintenance – when breakdown occurs, it takes an average of four to eight months before any repair work is carried out. All the four sources of water are used at present: the primary consideration for decision to use a specific source is its distance from the house. Generally female members of the household fetch drinking water.

Sanitation and housing

There does not appear to have been any change in sanitation since the introduction of irrigation. However, there are clear indications that housing in the project area is improving. A large number of people have built, or are building, new houses, building extensions or improving their houses, eg new roofs. There does not appear to be a corresponding amount of change in terms of household furniture.

Food and nutrition

There is no doubt that the food and nutrition situation has improved

remarkably in the area receiving irrigation. Because there are two or three crops a year, both small and large farmers feel that for the first time they have food security. They feel that, whatever happens, their families will now not go hungry as they frequently did in the past.

Without exception, people in the project area feel the quality of food has improved. The variety and amount of vegetables being consumed have increased; similarly an increase in livestock holdings has meant more protein consumption (milk, eggs and meat). This consumption may be due to the absence of a ready market for the products, so it is likely that when such a market develops, most of such products may be sold for cash. This has been the general tendency in other parts of India.

Health

Comprehensive information on health was not available. However, we did manage to get the information on the incidence of malaria in Pandherpur Taluka, as shown in Table 3. While on the surface it indicates that malaria cases increased significantly in 1983, this can not be said to be due to the Bhima Project. In 1983, precipitation was high, and for the first time three irrigation systems – Ashti Tank, Bhima LBC and Nira RBC – were running for the full year. Without data over a longer period, no conclusion can be drawn on the contribution of Bhima.

An interesting observation of the above data is the fact that women appear to be more susceptible to malaria than men. According to the doctors consulted, this appears to be a correct hypothesis for two reasons. 1) Women receive less nutritious food than men. Men eat first and are given 'better' food, eg fish, meat and more vegetables. Women eat last, and thus eat whatever is left. 2) Women spend more time in homes and thus are more susceptible to mosquito bites.

No specific trend was visible for diseases like cholera or annual parasitic incidence. There is also no discernible change in the availability of medical facilities in the project area. However, there is a significant change taking place in the attitude of people to medicine: because of affluence brought about by irrigation, people appear to be moving from traditional medicines to visits to doctors and hospitals.

Health education appears to be one of the biggest problems in the project area. People are now living side by side with their significantly increased livestock holdings. Health hazards have increased markedly due to the presence of flies and other disease vectors. However, since the farmers are illiterate, they are not aware of the health dangers posed by such insects, nor do they have any information on how to protect water stored in the home for drinking, or on family planning. This is an area that needs urgent attention.

Women

The irrigation project has already had many impacts on women, some

Table 3. The incidence of malaria in Pandherpur Taluka.

	Detected cases		
	Male	**Female**	**Total**
1981	371	539	930
1982	399	383	782
1983	1544	1739	3283

beneficial and others adverse. The principal impacts concern work loads, attitudes to education, finance, wages, dowries, firewood collection and land levelling.

In terms of the work load, the number of hours worked per day has increased significantly since irrigation was introduced. This appears to be due to two primary reasons. 1) Because of the significant increase in livestock and the fact that women are primarily responsible for them, extra work needs to be carried out every day. 2) Introduction of irrigation means that two or three crops are being grown every year, instead of only one. Weeding for irrigated farming is mostly done by women, whereas very little or no weeding was done for dry farming. Additional tasks include application of fertilizer (little used before, if any), application of water to the fields, looking after labourers and an increased managerial role. Consequently, the average number of working hours appears to have increased by around two and a half hours per day, and by about four hours during harvest times.

There is now a general feeling among women (wives of both small and large farmers) that daughters should be educated. It appears that younger women have stronger feelings about the education of their daughters than their older counterparts. Interestingly, older women, whose older daughters were not educated, now feel the younger girls should go to school. How and why this change of attitude has occurred is difficult to say without further work.

So far as wives of landless labourers are concerned, a similar change in attitude can also be observed, but this does not appear to be as strong as the views of the farmers' wives. One point made by several landless labourers was that before irrigation, they had to move from one place to another searching for jobs. Thus, they could educate only one son, who was left initially with relatives and in a few cases in hostels. Daughters invariably moved with parents from place to place, and thus were never sent to school.

With the introduction of irrigation, employment opportunities near the villages have increased significantly. Now they stay in one village and find work within the village itself or neighbouring areas. Because of this new stability, they are sending their daughters to schools. One common feeling amongst both types of women-farmers and landless labourers is to educate their daughters as far as possible, but only within the school available at their village. There is a general reluctance to send daughters to schools outside villages. Such reluctance is much less for their sons.

Traditionally all financial decisions and expenditures are made by men. If women work as labourers, they hand over all their earnings to men. With improvement in family financial situation, some women are now looking for a role in making decisions on family finances.

If wages are paid in cash, they are generally about 30 – 50% less than those earned by men. All the women questioned accepted that this was fair because 'men do more work'. Many labourers are paid in kind, eg percentage of jowar or groundnut collected. Since the percentage of products earned is identical for men and women, there does not appear to be any discrimination in this practice.

The irrigation project appears to have affected dowries: with increasing prosperity, dowry requirements for marriage of daughters have increased about two to five-fold. In terms of firewood collection, there does not appear to be any change in the number of hours spent in

collecting firewood (see also under energy). Finally, women seem to feel very strongly about the subject of land levelling. This is a primary area where they would like to see good results, because they feel levelled land will reduce the extent of their workload as well as increase yields.

Public participation

The participation of the people in the area in the Bhima Project will ultimately decide the extent of success or failure of the project on a long-term basis. The first step in this direction has been the formation of outlet or *chak* committees. Since the operation and maintenance of the irrigation systems below outlets are the responsibility of farmers in the chaks, active participation of the farmers is absolutely essential for the sustainability of the project.

During the 1983/84 *rabi* season, outlet committees were operational on 13 000 ha, as against 8 000 ha during the 1982/83 *rabi* season. Specifically, the outlet committees have to perform the following:

- proper maintenance of the distribution system below the outlet;
- collection of water applications for crops to be planted;
- regular payment of water charges;
- preparation of delivery schedules in consultation with the canal inspectors, and to ensure irrigation is completed as per schedule;
- assist canal inspectors in the detection of unauthorized irrigation.

At present the outlet committees are not sufficiently established to carry out all the necessary functions. Since it is a new concept, requiring a major change in farmers' perceptions and attitudes, it would not be easy to make all the outlet committees a success. Initial expectations are somewhat modest. The committees established are expected to carry out only the first task, ie maintenance of the distribution system below the outlet.

At present the canal inspectors are invariably collecting all the water applications, but farmers in certain committees are already cooperating with the canal inspectors regarding delivery schedules, which are then finalized under the direction of the sub-divisional engineer. Since water is plentiful at present, unauthorized irrigation is not a problem. However, in future, when irrigation extends to the entire command area, unauthorized irrigation is likely to be a problem.

Environmental impact

The subject of environmental impacts of the Bhima Project has been neglected right from the beginning. For example, in the 83 page Staff Appraisal Report (SAR) on the project by the World Bank, environmental impact has merited only five lines. Lack of data and limited time available for the mid-term evaluation meant we were unable to spend any reasonable period of time to review environmental impacts. However, on the basis of whatever we observed, the following comments can be made.

1) The development of a reservoir with a large surface area, and consequent increases in vegetation due to irrigation, appear to have increased the number of birds in the area. Whether any species substitution is taking place is not possible to say without further studies.

2) The presence of a reservoir of surface area of 29 000 ha in an arid region would evidently have an impact on microclimate through

increased evaporation and evapotranspiration. Meteorological observations are necessary to identify changes in temperature and humidity.

3) Within the short period the irrigation system has been established, aquatic weeds have already become a problem. Unless immediate steps are taken to control weeds, environmental problems are likely to increase in the future. Among these could be health (weeds would reduce velocity and hence provide good habitats for vectors of water-borne diseases), decreasing water quality (decayed weeds would reduce dissolved oxygen content of water) and increasing water requirements (since water velocity in canals could be reduced, more water needs to be released from the reservoir).

4) The drainage system is almost non-existent at present. Without piezometric observation, it is not possible to say definitively what is happening to the water table, and thus development of waterlogging and salinity. However, circumstantial evidence indicates that the water table has started to rise, and both waterlogging and salinity have become problems in a few low-lying areas. Our interviews with farmers in these areas indicated that crop yields have started to decline.

5) The Bhima Reservoir inundated 29 000 ha, which included 51 villages – 25 in Pune District, 23 in Solapur District and three in Ahamad Nagar District. Some 57 000 people had to be relocated due to the submergence. The relocation programme for such a large number of people leaves much to be desired – we met a few people who were very bitter about their experiences. Regrettably neither SAR nor the Loan Agreement even mention these people. While the government of Maharastra does have a relocation programme, again it appears that both planning and execution of plans leave much to be desired. It is a sad commentary that 19 years after the dam construction started, and four years after completion, 13 more villages where people are to be rehabilitated are still not ready.

Concluding remarks

An important point that emerges from the evaluation of the Bhima Project is that the degree of success of such projects depends on the top management. Much of the success of the project can be directly attributed to the Administrator of the Bhima CADA. While the planning and the design aspects of the Bhima Project are 'average' and certainly not extraordinary, Bhima can be classified as a 'success story' primarily due to the leadership and dedication of the administrator.

There is no doubt that in spite of the problems and constraints discussed in this paper, the Bhima Command Area Development Project should be classified as a major success. From my experiences of comparable projects in other developing countries, it should be rated within the top 5% of such projects in terms of work carried out by the managers within the budget available to them and the extent of the project achievements thus far.

The evaluation indicated that farmers' and landless labourers' overall level of satisfaction with the project is high. People are using irrigation water, and in those areas where irrigation water is available at present only for one season, farmers are demanding year-round irrigation.

On the basis of the analysis, it can be said that the completion of distribution network and on-farm works need to be accelerated. The Training and Visit system is not functioning properly and needs to be

reviewed and improved. Credit availability continues to be a problem. Development of farm roads, village roads and drainage systems should receive priority. A systematic and functional monitoring and evaluation system has not been established thus far; it should receive immediate attention. Equally important, the project staff should continue this type of periodic evaluation to ensure that the objectives of the projects are realized, and the constraints and problems identified are successfully resolved.