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ENVIRONMENTAL CONSIDERATIONS IN AGRICULTURAL PLANNING IN INDIA

—AGROCLIMATIC PLANNING AND LAND AND WATER DEVELOPMENT*

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This paper discusses attempts at land and water planning in India, which are more suited to sustainability considerations. The Indian approach has been that development projects and plans should attempt to integrate sustainability considerations in their original design, rather than treating "environmental" aspects as add ons.

2. A scheme of agro-climatic planning was developed by the present author in the Indian Planning Commission (Alagh, 1987, 1988, 1989 and Planning Commission, 1988, 1989). This paper discusses the issues relating to planning of arid regions as also some controversial multipurpose projects. The purpose of the listing of planning for different zones was to emphasise that land, water, infrastructure, processing and extension support systems for the regional agricultural systems in India are very different and require alternate approaches. The Economic Survey sums up the strategy as follows:

"Land and water development strategies and cropping patterns suitable for each region have been worked out as also non-crop based agricultural activities like forests, animal husbandry and fisheries have been taken into account. Agro-processing activities are to be emphasised.

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An attempt is being made to develop a package of more appropriate projects for each region, as also involve the financial institutions more directly in the agricultural planning process. The studies/surveys undertaken in these zones would be the basis for the formulation of 8th Plan." (GOI, MOF, 1990, p. 33).

Investment Planning, Policy Frameworks and Institutional Issues

3. The agro-climatic plans for three different agronomic conditions should not be seen as a techno-economic exercise alone. A crop based approach or an approach which treat the country as a single unit would not address the major issue for agricultural development indifferent conditions. Watershed development, or alternatively drainage, flood control and conjunctive use of surface and groundwater, or again a more appropriate management of hill and forest based agriculture, are alternative regimes. Each would have a different investment and policy support strategy. In fact one advantage of agro-climatic planning is that it builds up investment and infrastructure options for alternative agricultural and farming systems, and thus removes the shortcoming of a favoured crop/region approach, say wheat based on canal irrigation. Also the locked up resource potential of different regions which can be released with marginal investments, for example improvement of existing canal systems or traditional irrigation structures, becomes feasible. Yet the central question is not the listing of possibilities but consideration of feasibility, and thus requires organisational, institutional and economic policy issues to be discussed.

4. The mindset underlying theorising on agricultural development consists of three kinds of alternative approaches. In one approach, the issue is considered as that of spreading available technologies for agricultural development through the implementation of an "appropriate" (?) framework of institutions and adjustment to incentive prices. In this view, this process can be thought of as that of operationalisation of the framework of neo-classical economic rules. The peasant is essentially rational, and if institutions are developed which permit him to respond to economic stimuli he quickly internalises the available technology, and the gains are shared between those who have access to land and those who sell their labour. Technical innovations lead to labour absorbing change and employment opportunities rise fairly rapidly. In a more extreme version of this view, international markets and adjustment to changing international prices provide the stimuli to trigger off such development. In another view. rural development is conceived essentially as a facet of

estatist planning. Institution and economic incentives play a part of such a view and yet the problem is conceived as that of operationalising the impact of agricultural and rural development technology at the farm/village level, and that of setting up para-statal and other institutions which support the extension of technology to this level as also agricultural marketing and processing. In such a view, a benign state plays a role of energising different components of the growth process, both in terms of input complementarities arising from technology and adjustment to wider factors like economy level or international demands. In an alternative to this view, the role of the state and/or other forms of political action is important but arises from the class nature of the principal agents in rural societies. In this view, feudal modes of production have first to be destroyed before economic incentives and economic organisations can play a role in transforming rural society.

5. In actual fact, in many rural areas examples of successful agricultural development or rural development experience, particularly under somewhat difficult resource endowment conditions, tend to follow a very different experience path. If sufficient irrigation water is available and the soil regime is suitable for a crop for which technology is well known like wheat or paddy, market oriented prescription have great possibilities of success since almost all the precondition of this paradigm are fulfilled in terms of the atomistic nature of peasant proprietorship and the response of the peasantry to economic incentives. Thus in many countries, including India: thinking took place in a somewhat "linear" direction. The emphasis was on irrigation and the new bio-tech technology and in many cases only on this.

6. In many parts of the country, however, the problem is far more difficult, as seen for example in the plateau and hills region and the Himalayan region. Land and water resources are meagre. Population pressure is rising. Commercialisation in many cases tends to lead to the short term exploitation of resources, and costs of soil degradation and water erosion are not fully reflected in market prices. Traditional, socio-economic systems working at low levels of equilibrium are collapsing and newer methods of sustainable development are not jelling.

7. There are, on the other hand, a number of successful experiences where the basic problems of food and energy requirements of poor rural communities have been resolved through the application of state-of-the-art scientific knowledge and technology at the cutting edge of the interface of man with land and water. In the programmes of work designed

on agro-climatic planning, an attempt was also made as a part of the development of such plans to document success and failure stories in land and water management and more optimal land use and cropping patterns. Such success stories thus studied were under alternative agro-climatic regimes which include low rainfall areas where, for example, the level of water availability on an average is 50 cms and a coefficient of variation is 40 to 60 per cent in the dry regions of India. In other words, in some years the water availability could be less than eight inches. A second kind of agro-climatic problematique was that where the availability of water was greater, say around 1,000 mm, but the variation is again 40 to 60 per cent. But the problem is set within the context of a hill slope and a valley. Unregulated commercialisation invariably means soil erosion, and precipitation instead of becoming a blessing becomes a curse since it flows down the hill, erodes the land base of the region and leads sooner or later to a collapse of the socio-economic system in terms food and energy. A third problematique can be one where past development of an unplanned type or of a badly planned type has led to resource loss. President Gorbachev, in his speech on "Soviet Agriculture," pointed out that the loss of land through waterlogging almost equalled the additions to irrigation in the Soviet economy over a period of decades. Waterlogging and soil salinity are examples of this kind. (Regions of the Gangetic Plain include large examples of this kind.)

8. Invariably, the technology to overcome these problems is well known. It is also generally well known in university and research environments not very far away from the area where the particular problematique exists. The interesting point is that just as there are a number of failures of development efforts to resolve such problems of the interaction of the society with a scarce resource endowment, there are also many examples of success. These are no longer pilot projects in the sense of designed attempts on amelioration by the state or by international agencies, but where interestingly almost invariably attempts at local level solutions of problems have been evolved at the level of the community itself. The Planning Commission has had studies initiated on a set of these experiments by independent social science institutions. The results of these and other studies are interesting in terms of the paradigms involved (Kanchan Chopra, *et al.*, 1989). These experiments have a set of common characteristics. First, they invariably involve effort at the level of a community but the basic technology is well known. In the case of a dry area, the question is that of water harvesting techniques. Resuscitation of traditional practices of storing water now require larger economic incentives, since the cost of community labour has gone up on account

of commercialisation. Areas with better endowed rainfall required watershed development. This means soil conservation which stops soil from erosion, like contour bunding, ridge ploughing, and also water harvesting, like gully plugging on the soil slopes and the use of village and percolation tanks. Once the land development and water harvesting is done, an optimal crop combination is possible in the agro-climatic plan. The land reclamation problem invariably involves more complex technology including pumping of water and the use of soil amendments. Since it involves application of the technology at the level of an aquifer, the community aspect is important (see Daman Singh and Manjul Bajaj, 1988, for details).

9. The second aspect of these success stories is invariably the importance of leadership. There is no uniform pattern of this leadership. In cases like Sukhomajri in the Punjab and the Pani Panchayats (water collectives) at Ralegaon Sidhi, voluntary organisations mattered. In others, it was some concerned official who could initiate the process. Generally, the leadership groups involved younger people, say below 45 years of age. All those who succeeded had an experimental and scientific and technological training, at least a university degree in the sciences. Also initial successes were sustained and replicated.

10. The third feature of these kinds of success stories is the high rates of measurable "economic" return and at the same time lack of profitability in market prices of each one of these successful experiments (Table 1). In all the success cases, participative methods mobilised the labour resources of the community. At 1986 or 1987 prices when these experiments were evaluated, the investment costs varied between Rs. 9,000 and Rs. 11,000 per hectare for land which was made available for agricultural or orchard crops after reclamation, and between Rs. 2,500 and Rs. 4,000 per hectare for social forestry purposes. As far as the economics was involved, between 38 to 53 per cent of these resources were bankable once the community was involved because many of these efforts were labour intensive, particularly the investments in land development and water management. The internal rates of economic returns to these investments were in the range of 18 to 27 per cent per annum, making them some of the most socially profitable investments in the Indian economy. Yet at going market prices, many of the families ended up making losses. A counterpart to these losses was a deficit in energy/food requirements of many of the families involved. There is, therefore, no guarantee that with the given structure of international or national markets, financially viable development will result. The paradigm ques-

tion in this kind of development is of an important nature. None of the received methods of thinking correctly interface with the available institutions in the kind of development being described. Decentralised working of markets is important and they do not necessarily provide automatically for the application of the available technology towards sustainable development in terms of the interface of man with the scarce resources

TABLE 1—SELECTED CHARACTERISTICS OF WATERSHED DEVELOPMENT PROJECTS

Sl. No.	Name	Land/Water Development Cost/ha.	Current Input Rs./ha.	Return Rs./ha.	Return Annual %	Remarks
	(1)	(2)	(3)	(4)	(5)	(6)
1.	Naigaon	11.364	2809.56	212		1984/85
2.	Sukhomajri	22.221		7,979	19	1986/87 benefits include those to villages and government agriculture, dairying, fisheries, fodder etc. Col. 5 ref. to IRR.
3.	Samithed	1,500	n.a.	n.a.		Returns are in terms of plantations, rise in water table and fodder in 312 acres of land; 78,000 saplings.
4.	Ralegaon Sidhi	9,689	n.a.	n.a.		Drinking water available within 100-150 metres of each household.
5.	Tejpura	4,246	Additional 816.8	3,764		Doubling of bajra and jowar yield 70 cross bred cattle : Plan for 200,000 trees.
6.	Mittemari	2,030	n.a.	n a.		Incremental income of Rs. 2,540 per household as compared to control village.
7.	Sikundarpur and Kotpurva	11,220	10,825	255 days of grain requirement for a family plus 400 days of fodder for a pair of animals		Ussar Reclamation Project

Source : SPWD (Nov. 1988). For Row 7, Daman Singh and Manjul Bajaj (1988).

of land and water. Also the income levels generated at existing prices may not meet subsistence requirements. A measurable kind of intervention is necessary in the economic or social context, and yet it has to be of a kind which does not lead either to the suffocation of local initiatives, or to a neglect of the great vitality of rural markets.

11. The question of socio-economic rules which permit this participatory kind of development is a very complex one. It is quite clear that estatist type of co-operation does not solve the problem, nor does a technocratic regime which relies on the so-called transfer of technology paradigms through centralist auspices. For example, land development projects financed through international financial institutions have led to low rates of returns also. Perhaps the answer lies in social control on a part of the resource endowment. When water is harvested in a watershed, a set of community rules has to be evolved. For example, the Pani Panchayats give rights even to landless labourers on a part of the harvested water. Yet the peasant does not have to give up his rights to land. Socialisation and co-operative institutions do not have to be holistic either/or propositions with individual initiatives. It is possible for individuals to co-operate for limited and well defined purposes.

Market Functioning: Limits and Opportunities

12. It is being suggested that in many rural/agricultural situations in our country the application of state-of-the-art technology to develop the slender resource base of the area requires community organisation at the level of, say, wrtersheds or aquifers. However, such requirements can be for limited purposes and the "institutions" challenge is to mesh such community requirements with the advantages of factor and commodity markets working essentially with functioning atomistic peasants. Such community *requirements* are a *precondition* for better use, for example of lands in hill slopes or sandy areas, with dune formation or at the level of an aquifer, either for reclamation of, say, saline land or the development of water harvesting or aquifer exploitation methods.

13. Will an overall policy framework set in the context of competitive domestic and international markets be consistent with and support the kind of developments discussed earlier? In other words, how will community based systems which meet the technical requirements of resource use relying on the labour endowment of the area interface with the rest of the economy. Experience tends to suggest that at ongoing market prices many of these experiments are financially unviable at least for those peasants who have a slender resource base. These losses have been estimated both as calorie/fuel gaps from a minimum biologically determined requirement for a section of the labour force (8 to 17.5 per cent), or financial losses if labour costs of development are full accounted for (13.2 to 27 per cent). The nature of such "losses" can help in appreciating the interface of markets with labour institutions. First such

losses can be minimised by development of domestic and international markets. These help by raising the value of agricultural/forest/residue produce and also reducing input costs. The price of a modern water harvesting/energy saving technology may be lower than a domestic substitute, for example, an energy efficient pump set, a modern seed or pesticide, a more efficient sickle, seed drill or power tiller, or the use of photovoltaics for providing energy in remote regions. Second it has to be appreciated that in many cases initial costs may be high, and so the case for selective non-market forms of intervention may be good since capital markets are poorly developed. Consider that in many land development/reclamation schemes, generally particular crop combination cycles are technologically recommended for soil consolidation/improvement. For example, fodder crop or a tree crop may require to be grown in reclaimed land to avoid relapse into degradation. At going market prices such a crop may be unprofitable. Again invariably under such conditions in initial years input rates are high, for example the number of waterings required, seed rates or soil amendment requirements will decline as the organic composition of the soil improves. Thus initial subsidies/public intervention mechanisms may be required.

14. The conventional theoretical answer to such "low" carrying capacity of land features is to suggest migration and transfer of populations to the non-agricultural or urban sectors. While useful as a long term guideline, the immediate relevance of such advice is not very clear. Also, improvement in land productivity is anyway a precondition of such a desirable outcome, and in any case if soil improvement is a dynamic process excessive migration may be the wrong answer. The upshot is that market oriented rules need considerable modification when applied to realistic rural development possibilities. In fact, so called "sub-optimal" policy alternatives, for example preference to input subsidies over output subsidies, may need to be experimented with given the fragmented nature of labour markets. Having said this, however, two guidelines are important and may be stated firmly. Generally, markets are efficient methods of getting across to farmers and, other things remaining the same, should be used as the preferred form of delivery of inputs or output collection and processing. Second, development of markets and communication and processing infrastructure must get high priority for rural reform. In fact, the heart of institutional reform is to evolve a policy regime which uses fiscal and investment packages which unleash the power of properly functioning markets for generating higher incomes and employment and, wherever necessary, use direct intervention methods also.

15. To sum up therefore, the direct involvement of village level beneficiary oriented organisations is required since:

(i) the experience is that totally officially sponsored schemes have limited effectiveness (around 40 per cent as per the concurrent evaluations of Indian rural development scheme);

(ii) a part of the cost of land and water development schemes becomes bankable and this really means that through the kind of mechanics described earlier the labour assets of the community, instead of being a drag on employment, lead to asset creation;

(iii) it becomes easier to channel structured subsidies to poorer beneficiaries through this method. Such subsidies are required for land development, water harvesting methods, and also for vegetative and crop cover on such lands. At going market prices of outputs and inputs, studies show that such schemes are not financially viable. Instead of accepting such "market failures," the challenge is to channel public funds to energise the community to also contribute its bit and foster such schemes on a larger scale;

(iv) such organisational changes lead to the very exciting possibilities that assetless persons can share in the rewards of possible community efforts. For example, in the Pani Panchayat landless labourers have a share of the water saved, and in a number of watershed schemes energy entitlements are given to all. No wonder, in a number of such cases, we are in the somewhat happy state that practice is running ahead of theory, and the practitioners are explicitly unhappy with the social scientist and the planner.

16. The kind of agricultural development discussed would require very detailed link up with technological and industrial progress. The process of rapid growth of non-agricultural employment opportunities in rural areas has to be hastened more. Agro-processing and input supply to the agricultural sector through development of marketing and service centres will need to complement a diversified planning strategy.

New Investment Strategies

17. When this new kind of planning is done for each region of India, new investment and policy strategies emerge for the country as a whole. Features like watershed development, soil conservation, accelerated ground water development and tank irrigation are initiated. Operational targets are described below.

18. As Integrated Watershed Development Programme (IWDP) is based upon a multi-disciplinary approach, the organisation implementing this programme will also have to be structured accordingly so that the desired results are achieved. The beneficiaries covered in a micro watershed should be involved right from the planning stage, ensuring active involvement. They should also share the cost. Employment programmes like the Jawahar Rozgar Yojana require to be integrated with watershed development programmes. It has been suggested that structures to be constructed on government land, which will be benefiting the community, may be funded by the government. Planning of fuelwood trees on wastelands in upper ridges might also fit into this category. Soil conservation, planting of fruit trees and grasslands will be on individuals' fields. A part of the total cost of land and water development could be met by the beneficiary, a part could be raised through institutional finance and the balance could come from the government(s). Considering plateau and dry zones (Zones 7, 8, 9, 10 and 13) for IWDP, the picture that emerges is shown in Table 2. If an annual target of 4 million hectares is kept, 20 million hectares could perhaps be covered by 1994/95 and the balance of 24 million hectares in the IX Plan.

TABLE 2—AGRO-CLIMATIC ZONAL TARGETS FOR INTEGRATED WATERSHED DEVELOPMENT

Particulars	*Areas given are in lakh ha*					
Zone:	*VII*	*VIII*	*IX*	*X*	*XIII*	*Total*
1. Geographical area	395	370	331	395	196	1687
Net sown area	174	169	159	189	98	789
(% of geographical area)	(44)	(46)	(48)	(48)	(50)	(47)
2. Area needing soil/water conservation measures	158	128	132	158	107	683
	(40)	(34)	(40)	(40)	(54)	(40)
3. Area likely to be treated by the end of VII Plan (cumulative) (assuming 20%)	31	25	26	32	21	135
4. Area remaining to be treated	127	103	106	126	86	548
5. Assuming 20% will be attended by farmers themselves	25	21	21	25	17	109
6. Balance remaining	102	82	85	101	69	439

19. Extensive areas in some zones suffer from soil problems such as

salinity, alkalinity and acidity. These problems are natural as well as having arisen out of human intervention. Some soils have natural salinity or acidity due to their formation from basic material having proportionately high clay content and sodium salts. On the other hand, because of imprudent use of irrigation water or saline ground water, secondary salinity develops. All these situations badly constrain the achievement of higher yields possible through the application of improved technology. Physical target and associated benefits as worked out in the agro-climatic plan are shown in Table 3. The Planning Commission has approved a State Government Project for Reclamation of Usar Land in ten districts of Uttar Pradesh, eight of which fall within Zone 5. Such projects, taken up for improving land capabilities and as a system of land and water development, will be eligible for funding under the Jawahar Rozgar Yojna, provided the majority of the beneficiaries are small and marginal farmers. Saline water is encountered in large areas.

TABLE 3—AGRO-CLIMATIC ZONAL TARGETS FOR SOIL RECLAMATION

Particulars	*Areas given are in lakh ha*					
Zone :	*V*	*VII*	*XI*	*XII*	*XIII*	*Total*
1. Estimated area under problems soil	9.91	95.32	4.32	0.37	8.2	118.02
2. Time frame for implementation (years)	5	25	5	5	5	
3. Cost of work (Rs/ha) (tentative)	1,500	600	1,500	1,500	1,500	
4. Returns estimated as additional yield after soil conservation (%)	30	25	30	30	30	
5. Average yield kg/ha	1,993 (Wheat)	743 (Wheat)	1,905 (Rice)	727 (Jowar)	996 (Bajra)	
6. Value of additional production per ha. (Rs.)	1,166	363	1,985	338	463	

20. A regular programme to sink wells/shallow wells, wells/tubewells is required in various hills and plateau region zones where the stage of ground water development is on a low key and the run-off problem is

more acute. In terms of numbers, the largest potential of sinking additional tubewells lies in Zones 4 and 5. Under the Small and Marginal Farmers Programme (SMFP), a priority was given to the programme of sinking wells in these two zones in the SFPP also, but the pace needs to be kept up in Zone 5 and stepped up in Zone 4 with the objective of bringing at least three million hectares under well irrigation during the VIII Plan. A target to sink new wells at the rate of 200,000 wells each year for plateau regions in Zones 7, 8 and 9, a target of 100,000 wells for Zones 10, 11, 12 and 13, and a target of about 25,000 for Zones 1, 2 and 14 has been recommended. This programme should be under public/co-operative sector as well as private sector, and liberalised institutional finance should be linked, making this a bankable proposition. A suggestion meriting attention in strengthening the ground water development programme is that the beneficiaries be encouraged to form into groups and be financed by the banks for group irrigation. Many lift and other irrigation co-operatives have successfully demonstrated this approach. The other dimension which merits attention is the proper enforcement of regulations in regard to exploitation of ground water. This would be of urgent importance in some of the zones (e.g. Zones 6 and 13) where there are already signs of over-exploitation. The high priority given to ground water development in recent years will have to be continued. It is expected that a considerable part of the ground water potential of the country will be utilised in the next decade or so. Special studies have been mounted to develop integrated management systems of ground water aquifers. Particular attention needs to be paid to saline areas, coastal belts subject to salinity ingress, and other special problem areas in order to promote optimum conjunctive use. Satellite imagery in conjunction with further ground surveying can be used to update available information relating to ground water. The existence of ground water markets will have to be recognised and the institutional and procedural constraints that inhibit advantage being taken of this development removed. Where the non-ownership of the land by share croppers precludes their access to institutional credit, a way must be found to overcome this difficulty in cases in which the existence of a ground water market ensures the viability of an individual proposal. Similarly, for the purpose of funding by financial institutions, the viability of a ground water installation should not be assessed on the assumption that its command is restricted to the holding of the prospective owner if a market for ground water exists or is possible. Where ground water markets have not developed and any institutional system acts as a constraint, the state will have to play a more direct role in meeting the requirements of small and marginal farmers.

21. Tanks are an important source of irrigation in the Southern Plateau Region and the Coastal Region of Eastern India. A large concentration of tanks as irrigation sources is in Zones 3, 7, 10 and 11 (sub-Zones 2 and 6). This system has degenerated over the past decades both in terms of area irrigated and stability in supply due to silting up of tanks, weakening of bunds and weirs, and as a result of encroachment for cultivation. Restoration of these irrigation tanks should be taken up, as such a step has a potential of not only substantially increasing agricultural production but also of uplifting the level of living of lakhs of small and marginal farmers. Components of tank restoration are: (1) desilting and using the excavated earth for augmentation of fertility of fields: (2) strengthening of bunds and raising of embankments; (3) afforestation of foreshores; (4) improvement of water courses. The Zonal Planning Teams have suggested tank restoration as one of the strategies to augment irrigation in Zones 3, 7, 10 and 11. In order to deal with this programme a suggestion is also made to develop a suitable organisational frame for implementation of programme, maintenance and distribution of water, collecting water charges, etc. The magnitude is shown in Table 4. A similar approach to include other traditional methods of water storage in the village will need to be adopted.

TABLE 4—TANK IRRIGATION TARGETS IN AGRO-CLIMATIC ZONES

Particulars	*Areas given area in lakh ha*				
Zone:	*III*	*VII*	*X*	*XI*	*Total*
1. Estimated area irrigated by tanks	2.00	22.34	7.30	10.50	42.14
2. Estimated time for complete restoration of tanks (years)	2	20	7	10	—
3. Cost of restoration (tentative) (Rs/ha)					
a. Desilting	2,000	2000*	2000*	2,000	—
b. Complete package	20,000	—	—	20,000	—
4. Total cost (Rs. crores)	400	446.80	146	2,100	3,092.8
5. Present average yield-kg/ha (rice)	1,255	763	2,012	1,905	
6. Estimated additional output @ 40% of average (rice)-kg/ha each year	502	305	805	762	
7. Value of added-Rs/ha output @ Rs 190/ha (tentative)	954	579	1,529	1,448	

*The ZPTs have proposed desilting only.

Decentralization, Employment Schemes, and Agricultural Planning

22. A high rate of agricultural growth-average around four per cent annually as compared to the recent achieved rate of around 3 per cent and a composition of growth-regional land and water management strategies, cropping intensity and crop diversification goals, growth of non-crop based agriculture, all become essential to achieve higher employment growth. The point is that the approach will have to be regionally specific and detailed. The argument that village communities have to be involved in the agricultural investment strategies requires to be operationalised in practice. While the economy moves over to a more dispersed and diversified rural framework in which viable employment opportunities are higher than the labour force growth, and the point of the earlier exercises was to demonstrate the viability of such a scheme in terms of empirical detail, in the short run special employment and anti-poverty programmes will also be required to move towards an employment assurance at the earliest feasible stage.

23. The wage employment programmes like NREP and RLEGP have been generating about 700 million man days of employment every year. The evaluation of the programmes showed some positive points, such as prompt payment of wages, creation of durable assets and implementation of works through Panchayati Raj institutions rather than departmentally. However, the studies pointed out that the employment being provided under the programmes was for a short duration and did not always make an impact on the levels of living of the rural people. The selection of the beneficiaries was not proper, inasmuch as the poorest of the poor for whom the programme was meant were sometimes left out altogether. Under RLEGP it has not been possible as yet to implement the guarantee envisaged in the VII Plan.

24. The Mid-Term Appraisal of the VII Plan had anticipated these problems. Thus:

> 2.36 Another important issue which needs consideration is whether RLEGP should continue to have a separate entity form NREP. A proposal to merge the two programmes is under consideration, because the field situation reveals that there is not much justification for maintaining a separate entity for RLEGP, since the programme objective and implementation in the field are by and large similar.

and again :

> 2.14 Two basic policy thrusts in the Plan namely improved water management strategies in irrigated and assured rainfall areas and watershed development in dry land areas are expected to lead to greater labour intensity both in the development (capital) phase and in the agricultural output (outcome) phase. On both these fronts the Seventh Plan Schemes have really been initiated in the second year and now need to be pursued with vigour (MTA, pp. 33, 42).

25. The Mid-Term Appraisal also talked of the problem of wrong identification and leakages. The Planning Commission had been suggesting that organisations of beneficiaries were necessary to overcome this problem at the local level. For example :

> However, it is noticed that wherever the *Panchayati Raj* Institutions have been actively involved, the implementation of rural development programmes has been better and the selection of beneficiaries and designing of schemes have been more satisfactory. The Planning Commission has been impressing upon the States that various rural development programmes will be realistic and meaningful only if people's representives are actively involved and associated in local level planning, design formulation and implementation of those programmes and the selection of beneficiaries in the anti-poverty and employment programmes such as IRDP, NREP, RLEGP, etc., and that there is no better instrument to meet this need other than the *Panchayati Raj* institutions (Planning Commission, 1987, p. 16).

26. The two employment programmes were merged in 1989. Also an attempt was made to permit local communities to undertake the kind of land development and water management works which have been described earlier as central to the efforts of turning around the sub-regional agricultural economies. The Manual of the Jawahar Rozgar Yojana clearly brings out these intentions as follows :

> 19.4 The renovation of important community works such as irrigation tanks is also permitted. Similarly items like land shaping, drainage, field channels, etc. on private lands which are part of a project to improve the productivity of an area taken as system of land and water management (both in watersheds as well as in command areas) can be undertaken. However, only those blocks of land would be permitted to be taken up under the programme where more than 50 per cent of the land holders are small and marginal farmers and they own not less than 25 per cent of the land in the block. The total number of farmers

covered by any such works will not be less than 10. No recovery of the cost of land development will be made from the small and marginal farmers. In the case of large farmers, the recovery pattern to be prescribed by the State Government. The rate of recovery will be the same as in a similar scheme being implemented by the State Government. The amount so recovered will be an additionality to the programme.

27. Panchayat Raj reform has to attempt not only political decentralisation but representation of poor and under employed sections of the society in local institutions. The Scheduled Caste and Scheduled Tribe communities account for a substantial part of the landless labour and rural artisan workers. The purpose of the Jawahar Rozgar Yojana is to provide funds to back up the process of political decentralisation through economic enfranchisement. Such programmes should move over towards an employment assurance. Also, as argued earlier, the framework now exists for local communities to integrate the employment programmes with poverty removal programmes. The VIII Plan should also make a large effort to initiate land and water development schemes of the kind described above with the Panchayati Raj Planning framework.

The Next Phase of Irrigation Planning in India

28. There are a number of critiques of irrigation planning in India. Irrigation, it is said has unacceptable costs. Large projects like the Sardar Sarovar and IGNP are uneconomic. Unless technological issues are properly integrated with socio-economic and production system relations, different kinds of water development strategies can and do lead to environmental costs and may not be sustainable in the long run. But the challenge is to see that technological, agronomic and socio-economic aspects are properly integrated into water development planning, such that environmental costs do not arise. We have seen earlier that water management is, at the present stage, a critical part of India's agricultural development strategy. The issue is not surface vs. groundwater development or dams vs. watersheds, but planning with and without sustainability concerns. The argument that large water transfer projects have unacceptable environmental costs and low benefits arises, and we will see only if major planning failures are postulated. But with poorly planned and executed projects, low or negative returns to investment, land degradation and environmental problems arising out of use of poor quality water in relation to the soil can and do also arise with groundwater use. Similarly, small watershed projects need very careful planning

strategies, and in fact raise important concerns of popular participation in local planning. It is important therefore to face up to some of the real issues of land and water development, rather than discussing the problem only on general first principles and with impressionistic data.

29. We address questions of planning for the use of water, particularly those areas where the engineering aspect impacts on economy and society and, therefore, there is the requirement of a wider range of skills to be brought to bear on the solution of purely technical and structural problems.

30. It is true that we have in the past not been the best conveyors of water. Our skills in dam designing and construction are recognised globally, but questions of planning and a management of water conveyance system have received much less attention. Conveyance losses are high, in many cases 40 to 60 per cent higher than the designed standards. In some areas, improper water regulation and drainage has also led to water-logging. This is socially extremely wasteful in the context of the land water scarcity of the Indian economy. The issues involved in water conveyance are, therefore, of very high priority.

Agricultural Regions and Water Use

31. Let us begin at the level of the agricultural field. Irrigation engineers have to learn to design water delivery systems differentially for the different regions of a canal-command. For too long commands of large irrigation projects have been treated as homogeneous and uniform entities. Soil conditions, temperature and its distribution, rainfall and its distribution, the ground water regime, existing forest cover, and existing tanks, minor rivers and drains are all features which need to be paid very detailed attention. This will normally require that a command is regionalised into components. In Statement A, data is presented on a large project in western India where, while the initial intention was to provide for a uniform pattern of irrigation through the command, after detailed consultations with geologists, demographers and land use planners, meteorologists and agricultural scientists, the command was broken up into 13 regions (Sardar Sarovar Narmada Command).

32. Even in the Indira Gandhi Nahar area the initial feeling and intuitive sense was that of regional homogeneity of the proposed command in the Phase II area. The available data showed that the average annual rainfall varied only by 40-42 per cent as between different rain gauge

STATEMENT A

TABLE A-1 REGIONS OF THE NARMADA COMMAND

('00 ha.)

Sl. No.	*Name of the Region*	*Region No.*	*GCA*	*CCA*
(1)	(2)	(3)	(4)	(5)
1	Saukheda-Savli	1	2531	1619
2	Sinor-Vadodare	2	2731	1876
3	Bharuch-Amod	3	1532	849
4	Vagra-Jambusar	4	1113	368
5	Mehmedabad-Daskroi	5	2957	1923
6	Sanand-Kadi	6	1817	1257
7	Dholka-Dhandhuka	7	4760	2643
8	Limdi-Botad	8	2940	1826
9	Halyad Malia	9	2684	1680
10	Viramgam-Dasada	10	3446	2421
11	Sami-Harij	11	1917	1152
12	Radhanpur-Vav	12	4628	3197
13	Rapar-Mundra	13	1229	428
14	All regions	14	34285	31239

Climate and rainfall
Maximum and Minimum temperatures are known to vary in the command area between 40 degrees during May to 5 degrees during January.

TABLE A-2— ANNUAL PARTICIPATION IN THE COMMAND

Sl. No.	*Mean annual rainfall (mm)*	*Regions*
1	800—1000	1, 2
2	700—800	3, 4, 5, 6
3	600—700	7, 8, 9, 10
4	400—600	11, 12, 13

TABLE A-3—VARIABILITY OF ANNUAL RAINFALL IN THE COMMAND

Sl. No.	*Coefficient of variation*	*Degree of reliability*	*Percentage of area under Narmada Command in Gujarat*
1	above 60	exceptionally	—
2	40 to 60	very low	46.0
3	30 to 40	low	54.0
4	Soils		

TABLE A-4—AREA SUITABLE FOR GROUND WATER DEVELOPMENT (Sq. Km.)

Sl. No.	*Region*	*Total area*	*Alluvial area*	*Hard area*	*Saline area*	*Net suitable area for ground-water development*
(0)	(1)	(2)	(3)	(4)	(5)	(6)
1	1	2,530	550	1,980	—	2,530
2	2	2,730	2,730	—	260	2,470
3	3	1,530	1,530	—	650	880
4	4	1,110	1,110	—	8,800	310
5	5	2,960	2,760	200	170	2,790
6	6	1,820	1,600	220	160	1,660
7	7	4,760	4,450	310	3,590	1,160
8	8	2,940	1,580	1,360	1,150	1,790
9	9	2,680	2,400	280	1,650	1,030
10	10	3,450	3,450	—	1,650	1,800
11	11	1,920	1,920	—	1,070	850
12	12	4,630	4,630	—	2,230	2,400
13	13	1,230	820	410	820	410
14	Total	34,290	29,530	4,760	14,200	20,080
15	%	100	86	14	41	59

TABLE A-5—INDICATORS OF AGRICULTURAL DEVELOPMENT IN EIGHTIES

Sl. No.	*Region*	*Average size of holding ha.*	*Cropping intensity*	*Irrigation intensity*	*Pump sets per 1000 ha.*	*Tractors per 1000 ha.*	*Index of value of production per ha. of net area sown*
(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	1	2.9	103	9.5	16	0.9	106
2	2	2.5	109	35.5	19	1.9	150
3	3	3.4	101	13.7	15	1.9	87
4	4	4.3	100	4.2	8	0.6	60
5	5	2.0	118	35.3	41	3.8	159
6	6	4.0	110	28.6	36	1.4	125
7	7	6.4	103	10.9	27	1.5	76
8	8	6.8	101	7.7	33	0.3	98
9	9	7.0	105	15.2	62	0.6	97
10	10	6.3	102	5.3	13	1.0	75
11	11	6.2	103	6.5	8	0.0	97
12	12	7.8	106	9.9	9	0.1	72
13	13	4.8	102	6.6	28	0.0	113
14	All regions	5·3	105	15.3	25	1.1	100

stations in the period 1930-60, but there were years when this variation could be in the range of 928.24 per cent. While a considerable part of the command had a depth to below ground water table of over 40 metres, area with levels below 20 metres was not unsubstantial. Also there were pockets of critical hard pan areas. Regionalisation, aquifer and other studies have now been completed for this purpose. The IGNP Stage II area, for example, has now been divided into three areas. Zone I area above Nachno and Phalode has more than 50 m alluvial cover and variability of rainfall is low. Zone II is the area below this zone. Rainfall has high coefficient of variability and low soil cover. Zone III is the Lift Command Areas with higher rainfall and loamy sand soils. Hard pan areas coverage varies in the three zones. Thus irrigation planning will have to be different in each sub-zone (Statement B).

33, This phase is important for irrigation planning. This phase has to be seen not just as a question of regional studies. The association of the irrigation engineer with the wide disciplines of geography and land use, meteorology and ground water will from the beginning sensitise the irrigation planner to the diverse agro-climatic and agro-ecological environment in which the water system has to operate, and this sensitivity is extremely important for planning the physical features of the irrigation structures.

Cropping Patterns and Farmers Behaviour

34. There is the much vexed question of cropping patterns and the problems that arise when the 'design' cropping pattern does not materialise on the field or the 'sanction' for the crop(s) is violated in practice. The practice up till now has been to consult agronomists and to fix these parameters in to the design of irrigation projects. Much depedds on the seriousness of the agronomist who gives the projection. In one particular case of a project which used to be singled out by Prime Minister Indira Gandhi for critical comment, the cropping pattern in the project area was taken from the Second Five-Year Plan of the particular state in which it was located. The project area is less than five per cent of this large paddy growing state. Paddy is totally unsuitable as a crop for the black soil in the command area. But somehow paddy was recommended as a crop for this project. Irrigation system design for paddy of course created considerable havoc in the subsequent phases of development there.

35. Here again, there is considerable need to understand and quantify the behaviour of the Indian farmer in the agro-climatic regime being studied. Economists have for long worked on this problem and have developed 'acreage response models.' These essentially postulate that the acreage allocation of the farmer follows profit maximising behaviour and depends on rainfall and its distribution, irrigation, the agricultural technology available and relative prices. The use of these models for irrigation planning would mean that the farmer's behaviour is studied and statistically estimated through acreage allocation models for an area

STATEMENT B

PLANNING STUDIES FOR IGNP STAGE II
TIME CHART

Sl. No.	Study Title	Agency	Input for Studies at Sr. Nos.	Time Chart in Months 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Bench-Mark Surveys	ORG	3,10,13	—	—	—	—	X	—	—	—	@							
2	Soil Surveys:																		
	a) Available Reconnaisance & Semi-detailed Surveys	IGNP/ CADA	3,7,8,9	—	—	@													
	b) Semi-detailed Surveys in remaining areas			———————— To continue as per stipulated work plan															
3	Regionalisation of the Total Command Area	ORG	8,9,10,11 18	—	—	X	—	—	@										
4	Hydrological/Meteorological Studies	IGNP/ CADA through University.	3, 10, 16	—	—	X	———————— do ————————												
5	Groundwater Studies (Generation of basic hydrogeological data	State Ground-water Dept.	3, 8, 9	—	—	X	—	—	@										
6	Crop Yield Study	IGNP/ CADA	10, 13	—	—	X	—	—	@										
7	Conveyance loss & other Engineering Studies of Conveyance System	IGNP	13, 15	—	—	—	—	X	—	—	—	@							
8	Groundwater Aquifer Modelling & Conjunctive use Studies	ORG	9, 10, 13, 15	—	—	—	—	X	—	—	—	@							

9	Drainage Studies (Possibility of ponding Depressions with canal water)	IGNP	8, 13, 16	— -- X — — — — @
10	Cropping Pattern & Crop Water Demand Studies	ORG	13, 16	— -- — X — — — @
11	Pilot Scheme on Sewan Grass for Scientific Development of Animal Husbandary	Rajasthan Agric. University Bikaner.	13, 16	— — — X — — — @
12	Afforestation & Ecological Studies	Forest Dept.	16	-- — — — — X — — @
13	Inter-regional Water Allocation Policy (Agri, & non-agri.)	ORG	15, 16	— — X — — — @
14	Operation & Maintenance (Water Management in particular)	ORG-CADA	15, 16	— — X — — — @
15	Conveyance System Design Parameters	IGNP	16	— — — X — — — @
16	Integration of Planning Studies & preparation of a detailed Project Report to be Posed to the World Bank.	WAPCCS		— X — @

Note : Month (1) in the Chart starts from November, 1987.

X Submission of Interim Report.

@ Submission of Final Report/Recommendations.

of the kind with due consideration of the agro-climatic characteristics of the region in the command.

36. For the different possibilities of water availability, it would be possible to estimate alternative crop sets that the farmer would consider once irrigation is available to him. The model would be of an econometric variety as follows.

Formal Models of water Allocation

37. We take a big irrigation command. With some simplification the same principles will apply to ground water development. The command has 'r' regions and 'c' crops. First take the obvious fact that regionalisation should be done with irrigation characteristics, namely rainfall and distribution, soil characteristics, water aquifer characteristics and the possible layout of delivery systems. Administrative and/or general economic development categories *are* not important. Assume that potential crops for the command are worked out with agronomic studies.

38. For any region '*r*', the potential crops '*c*' are defined, Now we can first work out.

(i) Arc $= f(R, I, Prc)$

where

Arc = Area in the *r*th region under crop '*c*'
R = Rainfall (mean = variability can also be tried)
I = Irrigated area
Prc = Relative price of cth crop (or relative profitability can be tried)

(i) can be estimated with distributed lags. Work out a relative price configuration for the future. Then for alternative levels of irrigated area, alternative crop sets combinations can be worked out (A_{rs}/A_r). In the next step for each crop set, work out water requirements in peak period w_r. Now with an aquifer model, limit surface water delivery such that waterlogging is ruled out. This gives alternative combinations of ground and surface water delivery (totalling to w) which can be used potentially in each region.

39. For each possible crop set in each region, using potential crop yield

(Table 5) and cost of cultivation data for each crop, value added in agriculture can be worked out. Work out separately for wages (hired or imputed) and surplus. Given the estimates of cost of delivering water, maximize value added for all regions applying a social wage criterion which is derived after examining inter-regional irrigation possibilities.

TABLE 5

Sl. No.	*Crop*	*5 Year Average 1969/70—1973/74*
1	Paddy HYV/6+ Irrigation	2,485
2	Paddy AV/6+ Irrigation	2,180
3	Wheat HYV/6+ Irrigation	2,489
4	Wheat Av/6+ Irrigation	2,379
5	Bajara HYV/3-5 Irrigation	1,861
6	Bajara Av/3-5 Irrigation	1,843
7	Tobacco Av/6+ Irrigation	2,337
8	Cotton HYV/6+ Irrigation	1,312
9	Cotton Av/6+ Irrigation	1,308
10	Groundnut Av/6+ Irrigation	1,456

SOURCE : Crop Cutting Experiments—Retabulations.
HYV : High Yielding Varieties
Av : All Varieties

40. The important issues, therefore, are to use farmers' behaviour patterns to work out cropping possibilities, to allocate water subject to ecological constraints (waterlogging and drainage parameters), and to explore in detail the benefits arising from spreading water through the command rather than concentrating in a few areas to avoid the tail ender problem. Technological aspects like distribution systems with sufficient capacity, control (for regulation) and efficiency (to avoid losses) are as important as the use of appropriate economic mechanisms, e.g. pricing of water and incentives for groundwater use. An estimate of possible crop sets for one region of an irrigation command in which this method has been applied is given in Table 6. The method essentially reduces the theoretical cropping sets from infinite possibilities to a set of alternatives which

need to be considered for irrigation design purposes. It also sensitizes the water resources engineer to the possibilities of alternative agricultural development in the area in which he is working.

TABLE 6—PROJECTED IRRIGATED CROP SETS (FRACTION OF CROPPED AREA) FOR REGION 1

Sl. No.	Crops	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7
(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Paddy	0.16	0.18	0.20	0.17	0.17	0.12	0.10
2	K Jowar	0.01	0.00	0.01	0.00	0.01	0.03	0.05
3	K Bajra	0.03	0.03	0.02	0.03	0.02	0.03	0.03
4	K Groundnut	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	Wheat	0.14	0.14	0.14	0.12	0.12	0.12	0.16
6	Vegetables	0.03	0.02	0.02	0.04	0.04	0.04	0.02
7	R Pulses	0.04	0.04	0.03	0.03	0.03	0.03	0.03
8	S Bajra	0.04	0.03	0.02	0.03	0.03	0.04	0.02
9	S Groundnut	0.01	0.00	0.00	0.02	0.02	0.05	0.00
10	R Jowar	0.00	0.04	0.05	0.04	0.04	0.05	0.05
11	Tobacco	0.09	0.09	0.05	0.05	0 09	0.05	0.02
12	Cotton	0.31	0.35	0.38	0.34	0.33	0.42	0.40
13	Sugarcane	0.00	0.00	0.00	0.02	0.02	0.00	0.00
14	Perennials & Fruit Crop	0.02	0.02	0.02	0.02	0.03	0.02	0.02
15	Other crops (including lucerne)	0.06	0.60	0.05	0.05	0.05	0.05	0.05

Conveyance Capacities for Conjunctive Use of Water

41. The design for conjunctive use of surface and groundwater has to be planned from the beginning. This requires emphasis on groundwater investigation. Given the kinds of crop sets discussed above, the peak

requirements of water can be worked out for each crop set. Once the possibilities of safe withdrawal of groundwater are known, the requirements of each crop set for the balance surface water can be estimated. If this kind of planning is considered from the beginning and institutionalised, either by promoting use of tubewells by the farmer or by integrating groundwater into the project, the possibilities of waterlogging would be eliminated from the beginning.

42. Two further features can be noted, namely that systematic monitoring of groundwater and the construction of water balance models at the level of an aquifer are in fact not very expensive proposition, and can be followed through fairly easily with modern computers once the basic information is available. Given preliminary estimates which can generally be built with easily available bore hole data, soil characteristics and land use information, more refined models can be developed as the investigation of soil characteristics and the ground water regime proceed at micro levels.

43. At this stage of planning, the whole question of allocation of water to different regions becomes critical and would in turn then determine the design of the conveyance system. Too little attention has been paid until now to both the costs and the benefits of irrigation development. It is not generally known, for example, that crop cutting experiments, which are the base of Indian agricultural statistics, contain data at the level of each field on which the experiment is conducted and the number of waterings in the field in the crop season. Thus, with a little effort and marginal expense on computer money, it is possible to generate estimates of the kind indicated in Table 5 generated for Gujerat. Returns to irrigation with six-plus waterings are quite high. Incidentally, infrormation of this kind would nail the critique that productivity of surface and ground water irrigation in India is low and also that 'benefits' are overestimated.

44. Now if information on alternative crop sets of the kind discussed earlier is available, and the yield from irrigation can be estimated with the degree of precision indicated in Table 5 for a recent period, and the costs of building conveyance systems to the field can be estimated accurately, a very precise estimate of the benefit of irrigation conveyance estimates can be derived (Table 7). Such calculations have in fact already been made for some advanced projects which are off the design board and we now have the techniques to replicate them on a much larger scale. With these kind of calculations, if an explicit weight has to be given to

TABLE 7—IRRIGATED AND UNIRRIGATED CROP SETS FOR DIFFERENT WATER ALLOCATIONS FOR REGION 1

Upper limit of canal utilisation ('000 ha)	*Peak canal water demand ('000 cusecs)*	*Peak G W demand ('000 cusecs)*	*Value of objective function (Rs Crores)*	*Irrigation intensity GIA / CCA*	*Annual G W utilisation ('000 hm)*	*Canal utilisation ('000 ha)*		*Irrigated set Intensity set No/Value*	*Unirrigated set intensity set No/Value*
						Kharif	*Total*		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
65	1.771	0.655	41.583	0.707	25.181	31.519	65.000	4/0.707	1/0.452
70	1.891	0.700	43.113	0.755	26.386	34.236	70.000	4/0.755	1/0.414
75	2.012	0.745	44.616	0.803	27.590	36.952	75.000	4/0.803	1/0.377
80	2.294	0.750	45.966	0.882	28.795	37.730	80.000	1/0.434 4/0.448	1/0.325
85	2.597	0.750	47.305	0.964	30.000	38.243	85.000	1/0.927 4/0.037	1/0.271
90	2.790	0.750	48.632	1.914	31.205	40.518	90.000	1/0.832 2/0.182	1/0.229
95	2.971	0.750	49.959	1.061	32.410	42.966	95.000	1/0.679 2/0.382	1/0.187
100	3.153	0.750	51.286	1.109	33.614	45.413	100.000	1/0.526 2/0.583	1/0.145

105	3.334	0.750	52.613	1.156	34.819	47.860	105.000	1/0.373 83	1/0.103
110	3.322	0.750	53.269	1.151	31.872	53.152	110.000	2/0.940 4/0.211	3/0.100
115	3.322	0.750	53.686	1.151	27.354	58.152	115.000	2/0.940 4/0.211	3,0.100
120	3.322	0.750	54.103	1.151	22.836	63.152	120.000	2/0.940 4/0.211	3/0.100
125	3.322	0.750	54.105	1.151	22.820	63.170	120.018	2/0.040	3/0.100

generate more employment in some poverty stricken region, this could be done in a quantifiable manner.

45. Irrigation projects have, therefore, now to be designed within the framework of a very detailed understanding of the agro-climatic and agro-economic regime for which they are being designed. It is possible to take into account the diverse features of the Indian agricultural economy to develop such designs as illustrated above.

Water Management Design is Genuinely Interdisciplinary

46. The important issue that needs to be emphasised is that studies of the type being discussed have to impact on irrigation design and capacities. The agricultural scientist and economist, land use and regional planner, economic statistician and geologist are not additions to the team. The work has to impact on the day to day work for the design of capacities and regulation of the systems. This has been done in our country already on some projects (Table 7). We need to replicate the selected advances faster. In fact, a working group for the Eighth Plan has reviewed the experience under the National Water Management Project and recommended that a quarter of the area under government canals should be included in a programme, the target of which should be to deliver in every crop season to each field in the command and 50 per cent can be covered in ten years (para. 115, Ch. 2)

Surface Water Projects

47. Critics of surface water projects argue that they are expensive, they do not lead to benefits in relation to costs, and they lead to waterlogging and rehabilitation costs.

48. In many cases inter-basin transfer of water attempts to transfer water from water surplus regions to strongly deficit regions. There is no evidence to suggest that schemes which involve the transfer of such water are more expensive than those which provide for groundwater lifting, say at a depth of 20 metres or more in average soil conditions on dry land conditions, leaving aside more difficult conditions like hard pan or hard rock areas where obviously capital costs of groundwater would be be higher. In such areas costs of around Rs. 40,000 per hectare are by now common. Sometimes even experienced agricultural economists work out the running costs of groundwater projects without adequately costing the opportunity energy costs of pumping.

49. The standard groundwater aquifer model works out first the groundwater balance in the past and calibrates it with observational data. Such models are used to simulate the land and water regimes in the command. Given soil conditions like rugosity, hydrogeological conditions and evapotranspiration rates, natural vegetation over the crop regime and the quantity of surface water flow, the number of years and the pace at which the groundwater table rises can be worked out. Thus, a model of the Mahi Narmada Doab, an aquifer in which at present the water table is between 60 feet to about 300 feet, the model works out number of years in which under alternative irrigation delivery regimes the groundwater table will rise to say a level of around 10 feet below the surface. It may be noted that at initial phases of an irrigation project surplus water is available, and its seepage through the soil to the aquifer is a sure-shot manner of augmenting the natural resource of groundwater. In the new irrigation projects being planned such models are used to plan canal systems. Groundwater levels in a basin are monitored. Since the surface water is regulated the farmer is encouraged to invest in tubewells to realise his profitable cropping pattern. If he does not do so, state tubewells are installed when the water reaches close to the surface. The canal system is designed to convey this water abstracted from tubewells. The system is failsafe. I had argued that in projects in which this is being done not a single hectare of land would be waterlogged and have been criticized for making this claim. My only reply is to append in Statement C the groundwater levels in October 1988 in 78 points in the Mahi Narmada Doab. Thus, groundwater is being monitored with 78 piezometers six to seven years before the surface water is to become available. Thei rrigation system has been designed in a manner such that the farmer would be encouraged to withdraw groundwater, since only limited quantities of surface water would be available. If this strategy does not work and the monitored groundwater levels show alarming levels, state tubewells would be installed and water would be pumped back into the canal system which has been designed to accommodate it. Not a single hectare of land would, therefore, be allowed to be waterlogged and critics have to prove the contrary. The Planning Commission has approved the project with the precondition that studies for drainage and groundwater balances already completed for the Mahi Narmada Doab must now be completed for regions like the Bahl, Saurashtra, Kutch and Sami Harij, so that the irrigation strategy takes the soil and water balance into account. In Indira Gandhi Nahar Project in the Phase II area, groundwater levels are 20 metres to over 100 metres below the surface. Groundwater aquifer models have been built up for the area and are being used for devising irrigation planning strategies for the Sagarmal Gopa Branch (CCA

STATEMENT C

STATEMENT SHOWING SUBSOIL WATER DATA OF PIEZOMETERS NARMADA MAHI DOAB OF NARMADA COMMAND AREA, GUJARAT

Sl. No.	*Village*	*Taluka*	*District*	*Water depth below ground level*									*Remarks*
				1984		*1985*		*1986*		*1987*		*1988*	
				May	*October*	*May*	*October*	*May*	*October*	*May*	*October*	*May*	
(*1*)	(*2*)	(*3*)	(*4*)	(*5*)	(*6*)	(*7*)	(*8*)	(*9*)	(*10*)	(*11*)	(*12*)	(*13*)	(*14*)
1	Tandalja	Sankheda	Baroda	4.30	3.18	5.22	5.00	7.31	5.09	9.51	—	9.76	
2	Desan	„	„	13.03	12.13	12.86	13.39	14.28	13.43	14.28	—	15.38	
3	Jojwa	„	„	6.58	5.09	6.96	5.03	7.20	5.68	—	—	7.27	
4	Lavad	„	„	4.70	2.72	4.62	4.46	6.03	4.64	7.40	—	7.40	
5	Malu	„	„	4.35	3.31	5.48	5.67	8.25	8.31	—	—	—	
6	Ambapura	„	„	12.90	11.12	12.65	13.59	14.10	—	16.40	—	18.90	
7	Antoli	„	„	6.75	4.82	6.33	5.75	6.62	6.67	—	—	7.61	
8	Padvan	„	„	12.89	12.07	12.49	12.60	13.16	12.88	10.71	—	3.63	Filled
9	Bodeli	„	„	3.04	1.85	2.92	2.73	4.07	2.72	—	—	—	
10	Limada	Vaghodia	„	7.80	4.81	8.96	7.13	9.96	8.23	—	—	—	
11	Ramleshwarpura	„	„	6.60	4.80	6.71	6.11	7.51	7.83	—	—	—	
12	Poicha	Savali	„	33.92	32.50	34.12	34.30	35.20	34.91	—	—	—	
13	Anjesar	„	„	25.30	24.81	25.73	25.16	27.59	26.02	30.65	—	31.65	
14	Kotambee	Vaghodia	„	6.73	2.70	8.24	5.15	9.41	7.11	—	—	—	
15	Panchdevla	„	„	5.42	4.02	6.03	4.64	7.06	7.17	10.20	—	—	
16	Sarnej	„	„	6.63	2.72	6.20	5.78	6.72	6.11	—	—	—	
17	Zardaka	ol	Panchmahal	11.67	9.93	10.98	10.62	12.24	11.11	—	—	—	
18	Garadhiya	Savali	Baroda	4.27	2.77	5.00	3.30	5.22	4.89	—	—	—	

19	Samalaya	„	„	6.72	5.41	8.00	5.67	7.70	6.81	—	—	—
20	Charanpura	„	„	4.23	3.12	5.29	4.74	6.25	5.58	—	—	—
21	Amrapura	Savali	Baroda	21.70	———— Abandoned ————					—	—	—
22	Savali	„	„	9.44	9.25	10.58	10.71	11.68	12.51	14.72	—	—
23	Saradia (Handed)	Sankheda	„	—	—	18.62	18.86	19.83	18.93	—	—	31.05
24	Tilakwada	Tilakwada	„	—	—	26.31	25.17	26.24	25.34	—	—	—
25	Raika	Baroda	„	33.88	33.10	34.20	34.19	36.27	35.28	—	—	—
26	Harni	„	„	3.22	2.79	3.40	3.10	3.43	3.38	5.16	—	—
27	Kelanpur	„	„	8.42	5.79	9.90	7.03	10.36	8.61	—	—	—
28	Mavli	Dabhoi	„	10.88	9.24	11.27	11.40	12.53	11.96	—	—	—
29	Anguthan	„	„	10.19	9.62	11.52	10.54	13.37	11.31	—	—	18.40
30	Hansapura	„	„	4.39	3.11	4.16	3.42	4.33	3.93	—	5.20	6.23
31	Dabhoi	„	„	———— Abandoned ————						—	—	—
32	Shirala	„	„	30.94	30.90	31.39	31.51	32.00	32.82	—	—	35.85
33	Chandod	„	„	5.35	33.53	35.76	34.13	35.50	34.23	35.80	35.17	35.17
34	Malpur	Sinor	„	34.31	33.77	34.16	34.39	35.14	23.78	36.50	—	—
35	Barkal	„	„	22.43	19.08	22.07	19.17	22.17	19.51	—	—	—
36	Surasmal	„	„	31.82	29.89	31.74	30.53	32.03	32.93	32.70	—	—
37	Timbarva	„	„	35.82	35.20	36.00	36.09	39.95	35.84	—	—	39.00
38	Karvan	Dabhoi	„	21.49	21.68	22.15	22.50	23.70	22.66	—	—	24.00
39	Samsabad	Baroda	„	21.11	21.07	21.63	22.06	23.60	22.45	26.86	—	—
40	Patarvani	„	„	———— Abandoned ————						—	—	—
41	Itola	„	„	15.40	15.31	15.69	15.81	16.23	15.79	—	—	—
42	Alamgir	„	„	12.33	12.13	12.70	12.85	13.80	14.63	—	—	—

(Statement C *contd. on page* 34)

(Statement C *contd. from page* 321)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
43	Ankodia	,,	,,	26.36	24.47	25.99	26.98	26.77	26.37	28.90	—	30.80	
44	Jaspur	Padra	,,	28.00	27.50	28.41	28.80	30.87	29.12	—	—	—	
45	Dabka	,,	,,	16.32	16.12	16.38	16.60	16.90	16.90	—	—	22.50	
46	Karnakuva	,,	,,	25.32	25.78	26.01	25.93	26.09	27.14	—	—	—	
47	Kotana	,,	,,	Abandoned						—	—	—	
48	Bamangam	Karjan	,,	27.87	27.68	28.13	28.42	29.72	28.78	30.46	—	—	
49	Lilapur (Moti Karal)	Karjan	Baroda	14.05	13.20	15.77	13.55	16.06	13.71	16.50	—	—	
50	Urad	Karjan	Baroda	26.48	26.42	26.23	26.19	27.02	26.82	—	—	29.68	
51	Karjan	,,	,,	27.32	27.43	27.96	27.77	29.04	29.93	—	—	—	
52	Sarod	Jambusar	Bharuch	12.40	12.03	12.49	12.66	12.93	12.76	—	—	—	
53	Kavi	,,	,,	6.48	6.37	7.24	7.22	8.31	8.27	—	—	—	
54	Piludra	,,	,,	19.49	18.26	18.46	17.23	18.79	18.55	—	—	—	
55	Jambusar	,,	,,	7.10	6.00	7.39	6.60	7.99	7.84	—	—	—	
56	Matar	Amod	,,	19.21	19.71	19.50	19.42	20.73	20.07	21.70	—	23.50	
57	Jafarpur	Jambusar	,,	11.20	10.88	11.32	11.24	11.64	11.48	12.40	—	12.70	
58	Karola	Bharuch	,,	13.50	15.55	15.03	16.00	16.05	16.36	—	19.00	23.35	
59	Vagra	Vagra	,,	8.65	7.48	8.79	8.16	9.37	9.17	10.50	10.56	12.35	
60	Bhorasan	,,	,,	7.95	6.95	7.96	7.58	9.18	7.83	—	—	10.30	
61	Ochhan	Amod	,,	5.40	4.50	5.83	5.40	6.40	5.57	—	—	8.70	
62	Bhadbhut	Bharuch	,,	8.50	7.22	8.10	7.43	8.20	7.72	—	—	—	

63	Besan	,,	,,	10.50	9.60	10.41	9.91	10.67	10.12	—	—	—
64	Traisa	,,	,,	14.00	12.95	14.48	13.57	15.07	13.84	—	16.65	—
65	Nahipur	,,	,,	9.60	8.32	10.40	8.55	9.98	8.74	—	11.40	15.20
66	Nand	,,	,,	23.80	21.22	23.18	21.29	23.34	21.63	—	22.40	24.35
67	Shuklatrith	,,	,,	9.20	6.52	9.29	8.14	9.75	8.21	—	9.50	10.90
68	Bharuch	,,	,,	7.05	6.55	7.15	7.20	8.08	8.23	—	—	—
69	Kishnad	,,	,,	23.03	23.00	22.46	22.75	23.57	23.10	—	—	—
70	Sambha	Jambusar	,,	6.48	2.68	4.44	3.48	4.46	3.96	—	—	—
71	Devia	,,	,,			Abandoned				—	—	—
72	Mangrol	Amod	,,	3.40	2.82	3.73	3.81	4.18	4.22	—	—	6.05
73	Nahier	,,	,,	9.82	9.03	9.58	9.69	10.14	9.87	10.70	—	11.80
74	Gandhar	Vagra	,,	5.50	5.30	5.93	5.49	6.51	5.81	—	6.82	5.07
75	Kadodara	,,	,,	3.55	2.71	3.91	3.67	3.83	3.40	—	—	5.07
76	Luwara	,,	,,	8.40	5.75	6.13	5.65	5.88	5.89	6.95	6.63	7.83
77	Atali	,,	,,	5.65	4.90	6.00	5.65	6.00	5.88	—	—	—
78	Chandpura	Jambusar	,,	3.95	3.90	4.78	4.60	5.01	5.68	—	—	—

of 2.56 hectares) and to a lesser extent the Sahib Birbal Branch (101,000 hectares) two of the largest parts of the system. It may be noted that since the conveyed water would be sweet, quality of the groundwater could also improve through blending. The simple point is that conveyance of surface water would in fact augment the availability of water for good and hence the need to plan from the beginning for conjunctive use. To purpose of groundwater aquifer models of course is to build up computer compatible regimes which preclude waterlogging. Measurement and control systems are installed from the beginning and provision made at the design stage in such a manner that, if the farmer does not use the groundwater even when the energy cost of pumping it falls as the water table rises, the project authority would pump out the water and convey it in the distribution system, which is designed from the beginning to provide for this eventuality.

50. As regards the benefits of irrigation, quantifiable estimates have been discussed earlier (para. 12 and Table 5). It is argued that the benefits of the Sardar Sarovar Project are overestimated because the expected yield is high, i.e. around 4 tonnes of wheat and paddy and more than 2.5 tonnes of Jowar and Bajra, or around 1.5 tonnes of pulses, groundnut and cotton, and over 2 tonnes of tobacco. As against this, current yields are lower. The Sardar Sarovar Project would give controlled and assured irrigation. Thus its outcomes should not be compared with the average obtaining at present or even the average obtaining under irrigated conditions presently, since in large parts of the State irrigated areas did not get assured water supply. Detailed tabulation of crop cutting experiments have shown that in most cases average yield with four-plus waterings was more than double the average of all irrigated crops, showing that four assured irrigations were not made available on an average in irrigated areas in the State. Thus it was clear that when assured irrigation can be given to the farmer, the yield levels achieved will be those approximating to those planned for the Sardar Sarovar system towards the end of the century. In fact, such yield targets would be exceeded on account of technological progress. The benefit cost ratio would be highly favourable, making the Sardar Sarovar Project a worthwhile investment. When these have been conveyed to critics, they argue that they relate to a small experimental area. Again this is incorrect since Table 5 is from crop-cutting experiments: the source of production statistics in India. In fact, in the next five years a major priority is to be given to improvement of canal systems to deliver water to the field with the kind of planning studies described above (targets for different zones are given in Table 8). The argument of course is not that expenditure on irrigation

Development is by itself a magic wand. The issue really is that poverty and low productivity levels in dry land areas themselves have tremendous social costs. The acute scarcity of water in these areas adds on to the social and economic problems of the inhabitants. Well planned-out transfer of surface water can be a great boon in providing drinking water, removing water-borne disease, raising the agricultural productivity of the region, and can in fact lead to highly beneficial ecological outcomes. More than half of the morbidity in India is estimated from water borne diseases. In the Saurashtra Districts of Gujerat to be benefited from Sardar Sarovar, up to 20 per cent of the morbidity is from scabies, a disease arising from stagnant water. The trade-off is not between a favourable eco-system and development. As Mrs. Indira Gandhi argued in her Stockholm lectures, poverty and ecological degradation normally reinforce each other. The design of development has to augment the sustaining capability of the environment and to provide for a more active interaction between man, technology and the available land and eco-resources.

TABLE 8—IMPROVEMENT IN CANAL IRRIGATION (Lakh ha.)

Zones	*3*	*4*	*5*	*7*	*8*	*10*	*11*	*12*	*13*	*14*	*Total*
Canals	13.4	20.0	22.9	15.6	13.3	13.3	25.3	2.1	4.5	0.4	130.8
Areas needing operational improv. assume 50%	6.7	10.0	11.5	7.8	6.6	6.6	12.6	1.0	2.2	0.2	65.2
Improv. in system/ rehabilitation	4.0	6.0	7.5	2.8	2.0	3.0	7.0	0.4	1.7	—	33.8

51. The argument that surface water development is at the expense of groundwater development is not particularly clear. In areas where both are possible, the two are complementary. In others, where they do not compete, they are in their own right each important priorities. To argue that the two are competitive is to suggest for example that for a student textbooks compete with stationery. The requirements of both have to be met possibly at the expense of other inessential expenditures. However,

it has to be emphasised that water should be transferred or coveyed only after socially profitable use possibilities for it have been exhausted. Thus only 'surplus' water is to be conveyed. (This issue has been discussed in the text.)

Conclusion

52. Indian agricultural planning and policy has to meet a number of challenges in the years ahead. After a distinct decelleration of output growth aud investment efforts in the mid-eighties, the end of the Seventh Plan again saw greater priority being given to the sector both in terms of resource allocation and policy focus. These priorities have to be maintained since the sector has a razor's edge quality in relation to India's development objectives. A number of feasible investment strategies have been developed for alternative agro-economic peoples. These have now to be implemented. The investment packages for different regions are different and the development strategy has to provide for this differential focus. The land and water development strategies will require a multi-pronged approach using alternative management strategies most suited to each region. Traditional water harvesting structures, canal improvement systems and improved planning procedures have been established, but need to be implemented. Successful experiences in land management in watersheds and difficult ecological regimes need to be duplicated faster in terms of community organisations, interfaces with local governmental institutions and subsidies and market support. Economic policies have to address the question of reform of delivery systems.

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