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PRESIDENTIAL ADDRESS

India's Irrigation Sector: Myths and Realities*

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I am grateful to the Indian Society of Agricultural Economics for giving me the honour and opportunity to address the distinguished gathering this year. I have chosen to speak on irrigation. This is the second time that this subject is being focused upon at this occasion. The first time, exactly ten years ago, it was dealt with by Professor A. Vaidyanathan who is, fortunately, present amidst us today. I have taken it up again not only because the subject merits attention but also because my options are rather limited. Much of my academic life has been expended on irrigation research commencing with my first work (1969) on public tubewells of Uttar Pradesh, where the technology of deep tubewells was adapted by Sir William Stampe through assiduous experimentation to suit Indian field conditions.

The Indian irrigation sector is periodically reviewed by the World Bank, a major donor of funds - and ideas - for the development of irrigation in India and elsewhere. Its first review was conducted in the early eighties, and the second in the early nineties. The second World Bank review had given a warning, in my opinion rightly, that the Indian irrigation sector may experience a major breakdown by the time we enter the 21st century. The cause identified for such a breakdown is none other than the deterioration of public irrigation works, notably state canal systems, due to cumulative neglect of repair and maintenance over the years, which, in the ultimate analysis, is traced to gross under-pricing of public irrigation.

This ominous warning, when viewed along with the alarming reports of groundwater depletion, puts in jeopardy the entire irrigation sector. What enhances the gravity of the concern is that the eighties had witnessed a continuous decline in real public investments in irrigation which comprise the bulk of fixed capital formation in Indian agriculture on public sector account. According to an estimate, the share of irrigation-related investments averaged 91 per cent of the official estimate of fixed capital formation in agriculture on public sector account (Ramesh Chand, not dated). Given the complementary relationship between public investments in irrigation and private fixed investment in farm business (Dhawan, 1998), the absolute decline in investments in public irrigation could, *ceteris paribus,* adversely impinge on the overall productive capacity of our agriculture sector. It is widely believed that the mounting volume of government subsidies in public irrigation works has been a major factor behind this decline in public investments in irrigation sector.[1]

Owing to the primacy accorded to irrigation development in our agricultural planning, irrigated agriculture has been a dominant source of growth of our crop sector, more so of foodgrains production. This has been so for the world as a whole in this century. Looking 20-30 years ahead, the trend is likely to continue in many regions, including the East Asia and South Asia where the increase in food production is expected to come mostly from

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irrigated agriculture (Winpenny, 1997). Development of irrigation in India has been driven by one overriding compulsion, namely, expansion of foodgrains production for a large, growing population. Critics of irrigation planning have not shown enough appreciation of it, which is unfortunate, for the compulsion is still there and would persist if we continue to dither in our population control effort.

Notwithstanding its numerous drawbacks and inefficiencies in implementation, the strategy of treating irrigation as the kingpin of agricultural development has worked. There has been an almost one-to-one correspondence between foodgrains production and gross irrigated area, i.e., the elasticity is almost one. Nearly six-tenths of our crop output now originates from irrigated fields, although these account for only a little over one-third of our total crop acreage.[2] Any slackness shown to irrigation in the coming years would imperil the growth of our crop sector, not to mention its wider macro-economic ramifications.

MAJOR OR MINOR IRRIGATION

A variety of structures comprise the Indian irrigation sector. These can be dichotomised in more than one way: (1) major or minor; (2) surface water or groundwater based; (3) gravity-flow or lift irrigation works; (4) public or private; and (5) traditional or modern. The first two classifications are currently much in vogue, and greatly overlap each other. The first classification is no doubt peculiar to India: in the plan and other official documents large scale irrigation is described under the head 'major and medium' irrigation, and small scale irrigation under 'minor' head. This is certainly not a satisfactory usage, for in our irrigation history, the area benefiting from minor irrigation works (dugwells, tubewells, tanks, etc.) has always exceeded the corresponding area covered by major and medium irrigation works, mostly comprising canals originating from big dams and barrages built across rivers.

In view of this, the literal connotation of 'minor' can be quite misleading inasmuch as it does not portray the great importance of small scale works in the Indian irrigation sector.[3] The usage is resented by the votaries of 'small is beautiful', as also by those who are morbidly opposed to major irrigation works. One of the most vocal among the latter has not only tried to amuse us by punning on 'minor' ('minor becomes major'), but has also gone to the extent of pleading for suspension of further investments in new major irrigation capacity (Vohra, 1996). This brings us to the policy issue of major versus minor irrigation, an issue which keeps surfacing again and again ever since the launching of the First Five Year Plan in which large scale irrigation development occupied a distinctive position.

Leaving aside the ideological underpinnings that can ever keep the issue alive, a principal factor responsible for making the controversy unresolved so far is the lack of hard data on comparative costs and benefits in respect of these two categories of irrigation. Standpoints on the issue have hinged on the protagonists' personal predilections mixed with inadequate statistics of costs/benefits. Under these circumstances there is ample scope for either side to make misleading claims for gaining support against the rival viewpoint. While nothing material can be done about the subjective factors, except perhaps acknowledging them, agricultural economists can still play a useful role in firming up the comparative cost- benefit picture about the two sources of irrigation, so that the debate gets anchored more in the ground reality than in a make-believe world of fictitious numbers and fictional propositions, e.g., minor irrigation is a low-cost option with production impact double the level of major

irrigation. Unless this state of affairs is changed, the controversy would continue to persist, and entail the risk of misdirection in policy making.

The agenda thus stated sounds easier than it is in practice. Yet the task needs to be taken up in order to lend clarity to policy making. I hope some younger scholars would apply themselves to this measurement task in all earnestness. It is not impossible even in the present state of data availability. I will later demonstrate this for canal irrigation with the help of the Central Statistical Organisation's (CSO's) *National Accounts Statistics* (NAS).

But presently I would like to touch upon a singularly one-sided character of the minor versus major irrigation debate prevailing in the country. While major irrigation has been scrutinised critically by big dam opponents for its numerous drawbacks, the same spirit of critical scrutiny is altogether missing in respect of their portrayal of minor irrigation as an ideal alternative. As a result of such an unbalanced critique, people are left with an erroneous impression that major irrigation is an altogether ill-conceived and unwarranted irrigation, while minor irrigation is an ideal choice, cost-effective, dependable and self-sufficient. That minor irrigation too suffers from serious shortcomings and limitations has just not been probed by its votaries. The results of the first Census of Minor Irrigation (CMI) analysed by me recently (Dhawan, 1997 c) do not buttress such an image of minor irrigation.

Irrigation engineers have for long underlined the undependability of wells and tanks during drought years. The CMI data provide eloquent testimony to this. The reference year for the CMI was 1986-87, which was a normal rainfall year for the country as a whole, except Gujarat which experienced drought that year. Owing to drought, water availability in minor irrigation works other than tubewells fell drastically in that state. As many as 55 per cent of the dugwells fell into disuse. Consequently, the area irrigated by dugwells, the mainstay of minor irrigation of the state, shrank to the level of merely one-third of normal irrigation potential. Likewise, 63 per cent of the state's small scale surface flow works could not provide irrigation to a single hectare, with overall rate of capacity utilisation for this class of works being reduced to below 10 per cent. The story was only a little less grim in the case of surface lift irrigation schemes: 20 per cent of them went out of use but their rate of capacity utilisation was no more than 25 per cent.

The only type of minor irrigation works that somewhat withstood the ravages of the drought were tubewells. The rate of capacity utilisation in their case averaged at 67 per cent for shallow tubewells and 72 per cent for deep tubewells.[4] Clearly, it is patently fallacious to ascribe the merits only of tubewell irrigation to the minor irrigation segment as a whole. There are inherent hydrogeological limits to the tubewell option for meeting our growing needs of irrigation in a sustainable fashion. Tubewell technology is technically not feasible in non-alluvial tracts which constitute nearly 70 per cent of Indian land mass. And we must not be oblivious of the long-run deleterious consequences of this technology on the groundwater balance of a region. It is a dangerous technology which can eventually lower groundwater tables, leading to even exhaustion of the groundwater resource in semi-arid, low rainfall regions. Reports of irreversible groundwater depletion in India emanate precisely from such tracts which have witnessed an explosive development of tubewell irrigation.

The foregoing evidence should caution us against entertaining fond ideas that minor irrigation works are free from the problem of unutilised capacity, a point on which their

advocates have exulted too much, while the anti-canal protagonists among them excessively berated our canal works. That the problem of under-utilisation of capacity is not specific to major and medium irrigation is well borne out by the CMI data. For the whole country, minor irrigation capacity was utilised only to the extent of 80 per cent, and that in a normal rainfall year, if you leave aside Gujarat. The percentage varied across states: 50 to 60 per cent in Orissa and Tripura, 60 to 70 per cent in Assam, Goa, Karnataka, Manipur and Meghalaya; 70 to 80 per cent in West Bengal, Tamil Nadu, Kerala and Arunachal Pradesh. The phenomenon of 100 per cent capacity utilisation is a rarity, not a ground reality. It is a pity that some early working assumptions of the Planning Commission have been misconstrued as proven propositions by the proponents of the minor irrigation cause.[5]

DIFFERENT MEASURES OF SUPPLY COSTS

Canal irrigation has attracted renewed attention in the current climate of eliminating government subsidies as part of the economic reforms. Without correct assessment of its costs and benefits, one cannot know how much of its costs are recoverable and how much of its subsidisation is inevitable. In comparison to measurement of benefits, measurement of costs of an activity is generally viewed as a simpler task. In reality, both are quite problematic. Audited accounts of departmental enterprises, including canal irrigation, are annually published by the Comptroller and Auditor General (CAG) of India. In the case of canal irrigation, the following three types of expenditures are reported:

1. Working expenses of operating and maintaining canal works;
2. Interest payments on capital invested in canal works;
3. Capital outlay (annual as well as cumulative).

Expenditure statistics, compiled by the accounts people as per their accountancy norms, are often found wanting by economists. Since 1987-88, the expenditures (1) and (2) have been clubbed together in the CAG reports. One can no longer manipulate this data source *a la* the Vaidyanathan Committee which worked out the cost of canal irrigation for two benchmark years, viz., 1977-78 and 1986-87. The Committee had raised the interest cost by using a higher interest rate at which capital funds were borrowed in these two years, as also computed an additional item of cost, viz., depreciation at the rate of 1 per cent of capital. Since the CAG data pertain to both already completed and ongoing canal works, the Committee sought to remove the element of over-estimation of canal costs due to the inclusion of incomplete projects by computing interest and depreciation charges on reduced capital base (instead of K_t, K_{t-3} was used). In my opinion, this correction was unnecessary; after all, Gulati *et al.* (1995 a) have argued for reckoning with substantial interest costs of the construction phase of canal projects.[6] In the absence of information about such past interest costs of the projects completed by 1977-78/1986-87, the interest costs of the ongoing projects do serve as a proxy.[7]

Just as in studies pertaining to cost of cultivation where we use a couple of cost variants, we may have to do something similar while costing canal irrigation. Three cost variants readily come to mind: Cost I, Cost II and Cost III. Cost I could be viewed as the book value cost of canal irrigation that is aptly conveyed by the following expression:

$$\text{Cost I} = WE + r.K + d.K \quad \ldots\ldots (1)$$

where WE stands for annual working expenses (excluding interest charge),
K stands for cumulative capital outlay,
r stands for interest rate,
d stands for depreciation rate.

Prior to 1987-88, one had separate information on working expenses (WE) and interest payments (r.K). To estimate Cost I we simply fix 'd', say, at one per cent, apply it to reported value of 'K' and get a measure of book value Cost I. In doing so, no tinkering is done with the reported data, except adding the imputed cost of capital depreciation.

One major drawback of Cost I estimate is that it is a mix of expenditures at current and historical prices. Whereas operation and maintenance expenditures for any year are indeed at prices prevailing in that year, this is not so about cumulative value of capital (K) and interest cost.[8] Since the long-run tendency of prices including interest rates has been to rise over time, Cost I turns out to be less than Cost II computed at current values of 'K' and 'r'.[9] In the third Cost III, everything remains as in Cost II, except capital 'K', which is reworked. It is adjusted upwards for interest cost of the gestation period *a la* Gulati *et al.* but moved downwards for the reason that it should pertain only to completed irrigation projects. Evidently, the canal cost estimate III may exceed the corresponding estimate II which, in turn, would definitely exceed the corresponding estimate I by a big margin.

One can also visualise some hybrid cost variants combining the features of Costs I and II. It could be one where interest cost alone is reworked at current borrowing rate, without revaluing capital 'K' at current prices. This variant has been employed in NIPFP's (National Institute of Public Finance and Policy) recent study on subsidies (Srivastava and Sen, 1997) whereby cost of public irrigation in India for 1994-95 is computed at borrowing rates of that year. Another hybrid variant is to compute Cost I as per book value but compute depreciation charge on capital 'K' on replacement cost basis. This is how I had earlier worked out the cost of canal irrigation (Dhawan, 1997 a). If beneficiary farmers have to defray that cost of canal irrigation which has actually been incurred by the government in supplying canal waters, and, at the same time, contribute to keeping the fixed canal assets intact, they must be charged depreciation cost on replacement cost basis as now used by the CSO while compiling national accounts.

UNIT COST OF CANAL IRRIGATION, 1980-93

Annual cost of canal irrigation system is to be related to some measure of volume of canal activity in order to obtain unit cost of canal irrigation. Obviously, the most apt measure is volume of canal water used for irrigation. Such volumetric information is, however, not available. In its absence, gross crop area benefited by canal waters would have fairly well served the purpose, notwithstanding the fact that temporal and spatial differences in crop pattern underlying gross cropped area might distort unit cost comparison over time and across states. But amazing as it might sound, statistics of *actual* gross irrigated area by type of irrigation are not yet available in the Land Utilisation Statistics (LUS) data base.[10] Statistics of sourcewise net irrigated area are of course available. But, net canal irrigated area, as a measure of volume of canal activity, becomes still less satisfactory as it suffers from the twin-hazard of crop pattern and intensity of irrigation effects which may seriously

interfere with temporal/spatial canal cost comparison.

In view of these difficulties researchers have been forced to take recourse to statistics of *progress* in canal irrigation mentioned by the Planning Commission in its plan documents. However, I have not used this data source because it lacks credibility outside government circles.[11] Instead, I have derived the estimates of gross canal area from net canal area figures of LUS, by utilising information on ratio of gross to net canal area available for a dozen or so states presently. Moreover, I have used NAS instead of CAG data on public irrigation. For one, the requisite cost data are available at 1980-81 prices, thereby permitting analysis of rise in average and marginal cost of canal irrigation in India as a whole in real terms. For another, depreciation charge in NAS is on replacement cost basis. How canal costs can be isolated from total costs of public irrigation given in NAS data has been explained in detail elsewhere (Dhawan, 1997 a). Corresponding to an estimated canal irrigated area of 22 million crop hectares benefited by government canals during 1992-93, the annual cost of such canal irrigation amounted to a little under Rs. 5,000 crores, indicating an average supply cost of canal irrigation of Rs. 2,277/ha. This is an overall unit cost for the nation as a whole, undoubtedly with considerable spatial and temporal variations.

Thanks to continuing price inflation, unit cost of canal irrigation shot up by a factor of 4.7 times in a time span of 13 years. Correcting for price inflation, the rise in cost amounts to about one-fourth between 1980-81 and 1992-93. What is disturbing about this rise is that in marginal terms the rate of rise was much steeper. More specifically, the marginal real cost of canal irrigation at 1980-81 prices rose from Rs. 635/ha in 1980-81 to Rs. 1,709/ha in 1992-93, the annual rate of rise amounting to nearly 8 per cent.[12]

ON-FARM BENEFITS FROM CANAL IRRIGATION

Today, the benefits from canal irrigation connote addition to farm income as a result of use of canal waters.[13] There are two hurdles in measuring these on-farm benefits. First, information about irrigated agriculture is available for its cropwise areal extent, not by its cropwise yield/production by source of irrigation. Second, precise information on associated incremental costs of irrigation is lacking. The first hurdle can be substantially overcome by the following 'second best' procedure. To begin with, one can identify for *each state* such crops, like sugarcane, as are primarily, if not wholly, raised under irrigated conditions, and likewise identify crops like pulses and oilseeds which are predominantly grown under unirrigated conditions. Next, for the remaining crops not so identified we should take recourse to General Crop Estimates Survey (GCES, also known as crop cutting experiments) yield statistics which are separated for sample irrigated and unirrigated plots for important crops for which requisite number of irrigated/unirrigated plots in the sample exists. This is how I proceeded in Dhawan (1983), a procedure which was soon afterwards adopted by other researchers in this area. One major outcome of these researches is that we today know *state-wide* picture of overall irrigated yield as a multiple (m) of unirrigated yield. It is the knowledge about this vital ratio which helps us now in utilising NAS data on gross value of aggregate crop output, so as to get reliable estimates of overall irrigated and overall unirrigated yield for each year.

By assuming 'm' = 2.30, we have obtained estimate of overall irrigated yield. Our next task is to infer canal irrigated yield from this yield, by applying a fraction (f) to it where 'f' is another ratio, that of overall canal irrigated yield to overall irrigated yield. This fraction,

though varying from state to state, is about nine-tenths at the national level (Dhawan, 1997 b). By using this fraction, we obtain proximate estimates of canal irrigated yield for the period 1980-81 to 1992-93. Deducting the corresponding estimated values of unirrigated yield, we obtain estimates of gross benefits from canal irrigation which are shown in Table 1, along with corresponding estimates of costs of canal irrigation. Gross benefits from a canal irrigated hectare rose from Rs. 2,087 in 1980-81 to Rs. 7,132 in 1992-93, amounting to a rise of the order of 242 per cent over a 13-year span. In real terms, however, this rise is very modest (22 per cent). The output contribution of canal irrigation is netted out by deducting incremental costs of canal irrigated farming.[14] Net output benefits stood at Rs. 1,289/ha in 1992-93 (Rs. 659 at 1980-81 prices).

TABLE 1. BENEFITS AND COSTS OF CANAL IRRIGATION, 1980-81 TO 1992-93

Year	Gross benefits (Rs./ha)		Canal costs (Rs./ha)		Net benefits* (Rs./ha)		Margin of net benefits over canal costs (per cent)	
	At current prices	At 1980-81 prices	At current prices	At 1980-81 prices	At current prices	At 1980-81 prices	At current prices	At 1980-81 prices
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1980-81	2,087	2,087	488	488	556	556	114	114
1981-82	2,516	2,146	547	497	711	576	130	116
1982-83	2,559	2,136	631	527	649	541	103	103
1983-84	2,963	2,270	660	499	822	636	124	127
1984-85	3,099	2,269	787	527	763	608	97	115
1985-86	3,257	2,242	934	543	695	578	74	106
1986-87	3,432	2,200	1,080	547	636	553	59	101
1987-88	3,885	2,220	1,275	612	668	498	52	81
1988-89	4,995	2,481	1,417	656	1,081	585	76	89
1989-90	4,826	2,481	1,622	665	791	576	49	87
1990-91	5,636	2,540	1,702	607	1,116	663	66	109
1991-92	6,637	2,501	1,970	603	1,349	648	68	107
1992-93	7,132	2,544	2,277	613	1,289	659	57	108

* These are net of both canal costs and incremental costs of cultivation, e.g., Rs. 1,289 = Rs. 7,132 - Rs. 2,277 - Rs. 3,566.

BENEFITS VERSUS COSTS

Net benefits exceeded cost of canal irrigation by a fair margin throughout the period under study. However, the margin of excess tended to decline in current prices terms: the margin was 114 per cent in 1980-81 and 57 per cent in 1992-93. This decline may be attributed to farm product prices having lagged behind cost of canal irrigation. As against an overall farm product price rise of 156 per cent in the above period, unit supply cost of canal irrigation rose by 367 per cent in the same period.[15]

That net benefits from canal irrigation have been commensurate with costs of such irrigation is a noteworthy empirical result. But it raises some pertinent questions. When farmers' income gains from the use of canal waters are more than the supply cost of such waters, why subsidise canal irrigation? Why should they not pay the full cost of canal irrigation? Why talk of recovering from them merely operation and maintenance expenditure plus one per cent interest on capital cost? Or again, does not a strong case for stepping up investment outlay on canal irrigation exist when benefits exceed costs? Will this case exist once we fully reckon with large incidental costs of development of canal irrigation: loss of forest cover and biodiversity due to reservoir submergence; land degradation due to

development of waterlogging and salinity/alkalinity within canal commands; resettlement and rehabilitation costs of dam oustees, etc.? There is no doubt that supply cost of canal irrigation would increase significantly once these incidental costs are taken duly into account. But then one should reckon with canal benefits over and above on-farm income gains. This brings us to the larger issue of economic viability of investments in canal irrigation projects, which we take up in a subsequent section of this address.

PROBLEM OF RECOVERABLE COSTS

A widely held view is that under-pricing of public irrigation in India is due to political reasons. This is a subject that can be better dwelt upon by political scientists who find lack of political will to be a major hindrance to good governance in soft states. It is time that we also look at the problem of cost recovery in public irrigation in economic terms. This can best be done by focusing on the determinants of farmers' ability to pay for canal waters. Benefits exceeding costs is a necessary but not a sufficient condition for full cost recovery from canal beneficiaries. While fixing the pitch of canal fee/tariff, two additional factors have to be borne in mind. These are: (i) inter-farmer variations in the accrual of canal benefits, and (ii) margin of benefits to be allowed as retention to farmers. According to many micro level surveys, under irrigated conditions small (and marginal) farmers, who preponderate in Indian agriculture, tend to realise, acre for acre, lower income benefits than do large farmers. Thus it is the magnitude of income gains from canal irrigation of these small farmers that is more relevant than average income gains for all farmers taken together in determining the pitch of canal tariff (we are tacitly ruling out linking canal tariff to farm size). Again, it is the retention margin of benefits of this class of farmers that has a stronger bearing on fixing the level of canal tariff. In view of these considerations, the pitch of canal tariff gets governed by the benefits level well below the one indicated by average value of benefits per canal irrigated hectare. Very likely, canal tariff cannot be more than four-ninths of the mean value of unit benefits accruing to farmers as a result of use of canal waters.[16] In other words, for full cost recovery benefits from canal irrigation must exceed canal costs by a margin of 225 per cent, a condition not fulfilled during the period 1980-92 (see Table 1, last but one column).

The cost estimates in Table 1 are essentially derived from book values (except for depreciation cost which is on replacement cost basis). Even these costs, which are lower than true economic costs (e.g., Cost II and Cost III), were not fully recoverable during 1980-92, requiring some subsidisation: about 5 per cent during the first half of 1980s, 28 per cent during the later half of 1980s, and 30 per cent in 1992-93. Unfortunately, the actual degree of subsidisation in canal irrigation was far higher. In 1992-93 it need have been no more than 30 per cent following the above logic: actually it was 85 per cent. But a result of greater significance is that a case for partial subsidy would have existed even though average benefits from canal irrigation exceeded canal costs by about 57 per cent, as happened in 1992-93. There is ample scope for substantial cost recovery from canal beneficiaries so long as we view canal costs in book value terms and depreciation charge on replacement cost basis. Admittedly, this conclusion is based on a highly aggregative picture of costs and benefits. It needs to be validated by analysing costs and benefits of canals at the level of each state. States can be divided into four categories:

1. High cost and high canal benefit states (e.g., Maharashtra),
2. High cost and low canal benefit states (e.g., Madhya Pradesh),
3. Low cost and high canal benefit states (e.g., Punjab and Haryana),
4. Low cost and low canal benefit states (e.g., Bihar).

Evidently, the greatest scope for cost recovery would be in category 3 states, and the least in category 2 states. Whatever be the scope for cost recovery in a state, a substantial upward revision in canal tariff in all the states would need to be effected. And so long as this tariff is not linked to volume of canal water use, one can confidently predict that reduction in subsidy in canal irrigation is not likely to adversely affect output from canal irrigated tracts.[17]

ECONOMIC VIABILITY OF CANAL INVESTMENTS

Economic viability is to be distinguished from financial viability of a project. Canal irrigation works during the British rule were undertaken in the Indian sub-continent only if these were perceived to be financially viable for the government irrigation department. Revenue receipts in the form of canal irrigation fees were expected to cover both capital and operational costs of canal works. In practice, this financial criterion was well realised. The malaise of financial unviability emerged in the post-Independence era. Despite deterioration in financial performance of the canal systems of most states, public investments in major and medium irrigation works continued to grow merrily on a strongly shared perception, both among planners and the population at large, that economic benefits from canals to the economy as a whole far outweigh the revenue receipts of the irrigation department from canal irrigation charges. Since the beginning of the 1980s, doubts have been raised even about this economic viability. Today, this viability is seriously doubted even outside environmentalist circles. A number of factors have contributed to such misgivings. It is not so much that crop yields realised within canal commands have been below the levels visualised in project reports, but that the society is now truly perturbed by soaring canal project costs on the one hand and huge incidental costs of such projects on the other. In short, it is basically from the cost side that doubts about the economic viability now arise.

To take a comprehensive view of supply and incidental costs cannot be faulted, though a rider here would be in order. Environmental costs of canal projects need to be assessed with realism. Firstly, loss of forest cover needs to be valued pragmatically. If project promoters have so far greatly erred in assigning a ridiculously low value to this loss (of a couple of hundred rupees per hectare), big dam opponents too can be faulted for valuing forest lands unrealistically at astronomical prices (over Rs. one crore/ha). Secondly, positive environmental benefits from canal irrigated agriculture also need to be reckoned with. This brings me to the issue of review and reassessment of the benefits side of canal projects in as much detail and depth as has been done on the cost side of such projects. Incidental benefits of such projects need not only be quantified but also given monetary value as far as possible, so that the costs and benefits become comparable in value terms.

INCIDENTAL BENEFITS

By incidental benefits I do not mean the secondary or induced benefits which arise from primary benefits of any investment project, including an irrigation project. To illustrate, a primary benefit in the shape of income increase due to canal irrigation can enhance savings and farm investments of farmers, which in turn further enhance their incomes. Likewise,

increase in output of crops not growable without irrigation can enhance trade and processing activities based on that crop. Here, sugarcane is an ideal case. Incidental benefits, on the other hand, are akin to primary benefits. Somehow these commonly get left out of the reckoning, either because of the difficulties in measuring them in monetary terms, or because of their intangible nature (food security, sense of self-reliance in foodgrains, poverty alleviation, etc.). Now that the issue of viability of irrigation investments has cropped up it is prudent to introduce these benefits in the conventional cost-benefit framework.

Private means of irrigation, particularly wells, have acquired critical importance following the advent of high-yielding varieties (HYV) farming. This has led to pressure on groundwater resources in regions which are not naturally well endowed with groundwater. Thus groundwater depletion is becoming a new source of ecological disturbance in several blocks of low rainfall states. Introduction of surface water based irrigation in such groundwater-short states not only reduces demand for groundwater irrigation but also substantially adds to groundwater replenishment. Thus canals act as a great source of 'artificial' groundwater recharge that helps in mitigating the rising pressure on groundwater resources. Simultaneously, this recharge not only improves returns to investments in well irrigation but also expands the very base for groundwater-based agriculture (Dhawan, 1986, 1989). This incidental benefit of canal irrigation is of immense significance. That a good portion of the large crop production from groundwater-irrigated lands in low rainfall tracts, like those of Punjab, Haryana, Western U.P., Tamil Nadu and Western Maharashtra, is owing to the seeped-in canal waters has not been duly recognised in India. For example, it is estimated that groundwater recharge from seeped-in canal waters in Punjab contributes at least as much as 1.4 times the direct contribution to crop output from canal irrigated areas of the state (Dhawan, 1989). The same contribution in the case of Mula canal command in Maharashtra is of factor one, i.e., crop output addition from groundwater recharge of canal origin is equal to that from canal irrigated area (Dhawan, 1989).

Another incidental benefit of canal irrigation is the reduction in instability in farm economy.[18] This stability gain implies reduction in year-to-year fluctuations in crop area, crop yield, crop output, farm incomes, and farm employment. A noteworthy dimension is protection against drought, a benefit which was so higly valued in the pre-Independence era that investments in irrigation were mainly motivated by this objective. However, the problem of assigning a money value to this stability gain from canal irrigation is still unresolved.[19] It is high time that research scholars of empirical bent of mind apply themselves to this measurement task, undoubtedly a difficult one.

Another noteworthy incidental benefit from development of canal irrigation derives from the fact that irrigation waters also serve other purposes. Multiple uses of irrigation water have been recently discussed by Meinzen-Dick (1997), among them improving water availability for civic needs of urban and rural populations, especially their drinking water needs.[20] As a matter of fact, meeting drinking water needs from a given reservoir has been accorded the highest priority in the new National Water Policy. And in the case of newly constructed reservoirs a certain portion of the impounded waters is specifically earmarked for meeting drinking water needs. The benefits arising from such non-irrigation use of canal waters are presently not fully counted. These are not negligible benefits, certainly not

anymore, because quantities involved are no longer of negligible order in new major irrigation works. For instance, one out of nine million acre-feet of Narmada water to be harnessed by Sardar Sarovar Project is meant to be used for meeting civic water needs of cities, towns and villages in Gujarat.

Employment benefits of irrigation have been widely noted. These benefits first arise during the construction phase. Typically, 60 per cent of the capital cost of a major irrigation project is in the shape of payment to construction workers. Against this one-shot employment benefit for the unemployed and the under-employed, sizeable recurring on-farm employment benefits are generated because labour use in irrigated farming is more than in unirrigated farming. Thus irrigation development in a tract stems outmigration of job seekers from that tract to distant centres.[21]

A major irrigation work today is usually backed by a big reservoir. This reservoir impounds flood waters of a river, thereby attenuating the peakedness of the river flow hydrograph. This does afford some benefit to the economy in flood plain area in the sense that flood plain area of a river basin shrinks. This shrinkage can be sizeable if the reservoir capacity for water storage is substantial compared to total flow of a river during a year. Because of this shrinkage in the flood plains, flood damage to life, land and property is reduced, especially in the portion of the old flood plains that is no longer endangered by flood because of the construction of the reservoir. However, the correct measurement of reduction in the value of flood damage to crops and property following the establishment of an irrigation project is not all that simple even if we have a time-series information in this regard.

The incidental benefits from major irrigation works, which are akin to primary on-farm benefits from irrigation, need to be duly evaluated in monetary terms while doing the cost-benefit analysis. Being very substantial vis-a-vis the primary benefits, their inclusion might remove the pall of doubt hanging over the issue of viability of public investments in canal irrigation works.[22]

POLICY PERSPECTIVE

Balanced development of irrigation sector has been a hallmark of Indian irrigation planning, thereby duly recognising hydrological linkage between surface water and groundwater resources. In the matter of implementation, however, deviations have occurred, water being a State matter. Lately, the states, with a few exceptions, have wavered in maintaining the pace of development of canal irrigation, leading to substantial shortfalls in addition to canal irrigation potential (e.g., 40 per cent shortfall is feared in the Eighth Plan). In the light of this experience, the Ninth Plan target of new canal capacity (9.5 mha as recommended by the Working Group on Major and Medium Irrigation) may appear too ambitious or unrealistic. However, it is quite feasible provided the factors contributing to the shortfalls in the last two Plans are tackled in all earnestness. In particular, the following factors deserve special attention:

(i) Checking the diversion of investible funds to subsidy payments (including hidden subsidies in canal irrigation) and to meet profligate ministerial and other government expenses;

(ii) Countering the increasing opposition to the big dam option;

(iii) Eliminating the mounting inefficiencies in project implementation (e.g., large time and cost over-runs) and in the management and maintenance of canals; and
(iv) Resolving speedily inter-state water disputes.

We can ill afford shortfalls in new canal capacities or breakdowns in already created canal system. To the extent that these problems can be resolved by extra fund mobilisation, it has to be done. What is needed is not so much a diversion of investment funds from other sectors of the economy to irrigation development as making concerted efforts in generating fresh funds through appropriate pricing of canal waters. In the first instance, we might need to concentrate on sheer cost recovery. Although full economic cost of canal irrigation is not recoverable at present, a substantial part of the book value of canal costs are. A certain degree of subsidisation of canal irrigation is presently therefore inevitable; yet the rate of subsidy can surely be much less than what it is today. Given the large base of already established canal system, even a modest reduction in the subsidy rate can greatly augment fund availability.

Opposition to major irrigation works, as discussed earlier, can be substantively countered by presenting the case empirically, objectively and comprehensively, particularly vis-a-vis the available alternatives, such as minor irrigation. This would not only dispel the prevailing disinformation about dams, but instead show that this option is economically viable and deserves public investment support. What is further indispensable to meet this opposition is a commitment to tackle the problem of dam oustees sincerely and imaginatively. Not only substantial resources have to be directed to (a) their resettlement and to (b) initiating, on the upstream side, development works in a bold way for the benefit of the dam-affected people, but states must also strive purposively to reduce the very size of this problem, such as by lowering dam height. These activities, save the last, are not one-shot affairs but need to be continued over generations; and funds for sustaining these activities could best be provided as a fraction of the revenue receipts from canal fees and hydro-electricity sales. As for inter-state water disputes, there is no magic formula for their resolution either with the judiciary or with economists. Neither can do no more than act primarily as facilitating agents at water parleys among political leaders who ultimately have to resolve their differences in a spirit of give and take, mindful of the larger context of increasing interdependence and mutuality we live in today.

NOTES

1. More correctly, it is the steep increase in budgetary deficits on revenue account that has adversely affected government investments in agriculture (Dhawan, 1998). But then these deficits arise as much due to proliferation of government subsidies in recent years (Srivastava and Sen, 1997) as due to bureaucratic and ministerial profligacy in expenditures.

2. Evidently, this implies that land productivity on irrigated fields is twice that of unirrigated fields, a differential that holds good at the global level also (Kay *et al.*, 1997).

3. Its use dates back to the times when government investments in minor irrigation works were truly minor in comparison to those on major irrigation works. Though it is no more so, yet the share of minor irrigation in total government outlays on irrigation, as estimated by Ramesh Chand, remains low (14 to 15 per cent).

4. Canal irrigation too is vulnerable to drought, though its vulnerability is far lower in the case of canals fed by big reservoirs. How far canal irrigated area of Gujarat fell below the potential capacity during its drought of 1986-87 is not known. All we know is that the state canal irrigated area diminished by 27 per cent over the preceding figure of 1985-86, suggestive of a vulnerability comparable to that of tubewell irrigation.

5. One such assumption pertained to the assessment of capacity of major and medium irrigation works at the very beginning of the planning process in 1951. Knowing as we do how problematic it is to assess output capacity of assets of any activity, the initial capacity of major and medium irrigation works existing at the start of the planning era was deemed to be equal to the actual area irrigated by such works during 1950-51. This was a pragmatic working assumption, made solely for the limited purpose of monitoring plan progress in major and medium irrigation capacity, notwithstanding the fact that it gives rise to the incredible implication of full capacity utilisation. A similar working assumption was made in respect of minor irrigation, with the added proviso that capacity so created during the course of planning was also fully utilised. This proviso, which was in vogue till 1980, was based on an *a priori* reasoning that the farmers would normally ensure full capacity utilisation of the means of irrigation they own themselves. That serious supply-side constraints could nullify this motivation for full utilisation was not anticipated by the early planners.

6. Gulati *et al.* (1995 a) adopt another route, namely, capitalising the interest cost of the gestation phase. They could do so because they had access to projectwise data on time profile for 348 canal investment projects.

7. How good the proxy is depends on the relative share of ongoing projects vis-a-vis completed projects at any point of time. Satisfactory methods have to be innovated to grapple with this problem that indeed presently seems intractable.

8. Book value of capital is at historical prices at which it was built over the past, and likewise interest rate used in computing interest cost is an average of interest rates in different years in the past at which capital borrowings for investment took place.

9. Gulati *et al.* (1995 c) have assessed the magnitude of hiatus between book value of 'K' and its current value for 1989-90. The latter turned out to be Rs. 600 billion as against Rs. 262 billion for the former, i.e., the book value is 44 per cent of the current value of canal assets in 1989-90. Likewise, Vaidyanathan Committee felt it imperative to reassess interest cost burden of developing canal irrigation in 1986-87 at the borrowing rate of that year (about 7.5 per cent) rather than accept the book value rate (about 5.5 per cent) (Government of India, 1992).

10. The Centre has been urging the States to make such a compilation. While many of them have obliged, others have yet to do so.

11. Canal benefited area figures of this source are markedly higher than those derived from Land Utilisation Statistics.

12. Is it symptomatic of some sort of scam at work? Or, is it really indicative of real changes like (i) a marked locational shift in canal irrigation to high cost regions of the country, and (ii) commensurate improvements in quality of new canal works? This could be a pulsating research topic for probing minds that can sift grain from chaff in the heaps of data.

13. It may be noted that this connotation took some time to emerge. In early Plans, the benefits from large canal projects were viewed in terms of crop area to be irrigated by a project. This approach to measure benefits may appear a bit intriguing. But it made sense in the pre-Green Revolution era of subsistence farming, when the extent of area irrigated indicated the extent to which the farm economy was insulated against periodic droughts. An improvement of sorts was introduced by the late Professor D.R. Gadgil in his pioneering work on benefits from canal irrigation. He assessed these in terms of *gross* addition to crop output. This too made eminent sense in those times when associated input costs of irrigation were low in comparison to their present-day levels in which chemical fertilisers occupy a prominent position. It was at about the time of the onset of HYV farming that the benefits from irrigation began to be assessed as net addition to crop output.

14. Preliminary work in this regard shows that incremental costs of cultivation may be reckoned at 50 per cent of the gross output gains from canal irrigation.

15. Until the beginning of the 1980s, discerning irrigation administrators had noticed that prices of foodgrains rose annually by about two percentage points less than the cost of construction of major and medium irrigation works. This price differential could be easily accounted for by two factors: (1) government's desire to restrict rise in grain prices during the course of planning, and (2) irrigation development itself exerting a downward pull on grain prices, especially of wheat and rice, because irrigation expanded foodgrains supply. But the increase in price disparity trend since 1980-81 can be squarely attributed to the worsened ethical climate, as a result of which costs of public goods and services hardly reflect their true resource costs, being distorted by corruption, graft and administrative inefficiencies in public projects.

16. The dynamics of cost recovery can be instructively worked out by assigning different values to the parameters in the following expression:

$$P = B.\, f_1.(1-f_2) \qquad \ldots.(2)$$

where P stands for maximum canal fee recoverable from canal farmers (Rs./ha),
B stands for mean value of income benefits due to canal irrigation (Rs./ha),
f_1 stands for small and marginal farmers' benefits relative to 'B' (fraction),
f_2 stands for retention margin of benefits allowed to small and marginal farmers (fraction).

The expression (2) throws a good deal of light on the practical economic problem of cost recovery in the case of canal irrigation in India. In my judgement, a value of two-third for 'f_1' and a value of one-third for 'f_2' are quite realistic for underscoring the true import of our formulation with regard to farmers' ability to pay for canal waters.

17. This danger of adverse output effect is far more in the case of reduction in subsidy in chemical fertilisers for which prices are quantity related. Effecting reduction in fertiliser subsidy appears less difficult to implement in Indian conditions as it is a Union subsidy, in contrast to irrigation subsidy which is a State matter. Yet, from the viewpoint of minimising the adverse output effects it is more prudent to concentrate on reduction in canal irrigation subsidy rather than on fertiliser subsidy.

18. In Dhawan (1988) reduction in instability for many states has been quantified. In an ongoing work (in collaboration with Suresh Sharma) based on data given in Islam (1997), we find that canals lowered the probability of total crop failure in Punjab Province from 0.26 to 0.07.

19.In the absence of monetary value of drought proofing by canal irrigation, the financial criterion for project approval was considerably lowered in the case of canal projects meant for drought-prone tracts. These days the benefit-cost ratio criterion is lowered for them.

20. Cattle, especially milch animals, too benefit from canal waters, thereby augmenting milk supplies in the Indian sub-continent, more so in tracts underlain with brackish water (Meinzen-Dick, 1997; Bhatia, 1997).

21. These employment benefits can be reasonably well expressed in monetary terms by using shadow wage rates. That is to say, the wage bills of farmers' cost of cultivation and of investments in irrigation can be reassessed in terms of the opportunity cost of labour resource. The shadow price of labour being lower than the nominal wage rate paid to workers, the economic cost of irrigation development becomes less than the financial cost. Likewise, the economic value of incremental on-farm benefits from irrigation should exceed its nominal/financial magnitude when incremental cost of farm labour is reassessed in terms of shadow wage rate instead of market wage rate.

22. According to Bhatia (1997), the total value of irrigation water in Haryana amounts to US cents 6.2 per cubic metre, three times the on-farm income benefits of 1.9 cents/m^3 and marginally above the supply cost of irrigation (5.5 cents/m^3). These are, however, very tentative estimates which need to be firmed up.

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