PN-APA-032

AGRICULTURAL POLICY ANALYSIS PROJECT, PHASE II

Under contract to the Agency for International Development, Bureau for Science and Technology, Office of Agriculture
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DEVELOPMENT COSTS AND SUBSIDIES FOR IRRIGATION IN INDIA

February 1992

APAP II
Collaborative Research
Report No. 338

Prepared for

Agricultural Policy Analysis Project, Phase II (APAP II)
A.I.D. Contract No. DAN-4084-Z-00-8034-00

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DEVELOPMENT COSTS AND SUBSIDIES FOR IRRIGATION IN INDIA

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Prepared for:

AID/ANE and AID/R&D/AGR
under contract no. DAN-4084-Z-00-8034-00

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LIST OF ACRONYMS

CWC	Central Water Commission
ha	Hectare
kwh	Kilowatt Hours
O&M	Operation and Maintenance
Rs	Rupees
SEB	State Electricity Boards
TERI	Tata Energy Research Institute

EXECUTIVE SUMMARY

In the last forty years, the remarkable growth in area irrigated along with the adoption in the 1960s and 1970s of high-yielding cultivars and more intensive use of chemical fertilizers have contributed to greater grain self-sufficiency in India. While irrigation's contribution to productivity has been studied, its cost both in financial and economic terms has been largely overlooked. Recently debate has surfaced regarding the relative costs of small scale, groundwater based irrigation systems versus large and medium irrigation projects. However, little effort has been made to carefully work out estimates of the capital schemes. This study attempts to provide an accurate assessment of these costs by presenting a set of detailed, time-series of cost estimations for five geographic regions in India. It assesses the capital investment cost on a per hectare basis of irrigation potential created and irrigation potential utilized, as well as operational subsidies of major and medium Indian irrigation schemes. The magnitude of electricity subsidies is also examined.

In the last four decades, the Indian government has spent approximately Rs 262 billion on large and medium sized irrigation schemes, creating an additional 22.14 million hectares of irrigated potential. Most of the rapid growth in per annum hectare additions occurred in the 1966 to 1980 period, coinciding with the Green Revolution. In the 1980-1988 period, irrigated area growth slowed considerably but operational subsidies continued an upward trend. Higher inflation rates and the shrinking availability of land well suited for irrigation in the 1980s pushed up the investment cost per hectare.

To provide a detailed assessment of these investment costs and subsidies, appropriate inflation rates and weights of irrigation infrastructure, gestational lags, and the relevant social discount rates and depreciation schedules were estimated. Rates of inflation for capital outlays were estimated to allow comparability across time by converting actual expenditures in each state to constant 1988/89 prices. The rates calculated were based on component shares and price movement information for irrigation infrastructure as provided by engineers and irrigation authorities for four cost categories: labor, cement, iron and steel, and machinery and transport equipment. In order to determine the gestional lags, records for 136 large and medium size projects were examined. The averages derived, stratified by location, type, and size, were then used as estimates for similar projects in the same region. The average lag between investment of project completion was 12 years for large schemes and 5-7 years for medium schemes. The estimates were evaluated at three different social rates of discount: 5, 7.5, and 10 percent. In addition, capital investments were assumed to have straight line depreciation and a useful lifespan of 100 years for large schemes and 50 years for medium ones.

Overall, the results for India as a whole showed costs following a U-shaped pattern: declining rapidly for the first eleven years, followed by a leveling-off in the late 1970s, and then rising steeply from 1980 onwards. As for regional differences, the southern and western regions, two areas marked with undulating topography, had substantially higher per hectare

capital costs than the relatively flat northern and eastern regions. Not surprisingly, the area covering the foothills of the Himalayas, had the highest costs.

Operational subsidies, defined as the difference between operating and maintenance expenses and gross revenues from irrigation water tariffs, show a sharp and continued upward trend over the study years. On average, revenues only covered 44 percent of working expenses. This ratio varies widely across regions, from 92 and 83 percent in Tamil Nadu and West Bengal to close to zero in Uttar Pradesh, Orissa, and Madhya Pradesh. When capital costs are annualized, using an opportunity cost of capital of 8.5 percent, which is equivalent to the yield on government bonds, and then added to the operational subsidy, the total irrigation subsidy is ten times higher than the simple operational subsidy. When the 1988/89 replacement cost of capital is used instead of the historical nominal cost, the total irrigation subsidy is 4.5 times higher.

Minor irrigation schemes, which are mostly privately owned pump/well or pump/surface water operations, are subsidized through credit, public investments in tubewells and watershed protection, and electricity. Because of lack of data for a full accounting, the study focused on electricity subsidies accruing to the agricultural sector. The financial subsidy per unit of electricity, defined as the difference between the cost of supplying one kilowatt hour (kwh) by State Electricity Boards and the revenue from rural consumer per kilowatt hour charge, has risen 854 percent from Rs 3.6 billion in 1980 to Rs 34.8 billion in 1990. Currently, agriculture consumes 26 percent of the total electricity generated in India, up from 4 percent in 1950. In 1989/90, the average cost was 101.5 paise/(kwh) while the average tariff was 15.3 paise/kwh. This particular calculation is crude and needs further revision since electricity supplied to the agricultural sector is also used for threshing operations and other domestic household uses. The cost of public investments in tubewells is also missing.

Four main conclusions can be drawn from the study. First, previous estimations of capital expenditures per irrigated hectare understated the subsidy level because they did not account for inflation and gestional lags. Second, the trend in irrigation capital construction costs for large and medium sized schemes followed a U-shape pattern over the 1963-1990 period. On average, the average cost per hectare of irrigation potential created was Rs 35,000 in 1988/89 constant prices. Third, total irrigation subsidy estimations are quite sensitive to the particular components and cost estimates employed. Simple operational subsides are considerably lower than calculations using operational plus amortized capital subsidies at historical book value. These subsidy estimates increase even further when using capital replacement or a social rate of discount greater than 5 percent. Fourth, operational electricity subsidies for agriculture are rising at a rapid rate. The irrigation subsidy that accrues to Indian agriculture through cheap electricity reached Rs 35 billion by the end of 1980s and is expected to be above Rs 40 billion during 1990s in a conservative estimate. If one were to estimate this subsidy based on cost of supplying electricity to agricultural sector and add into that the capital losses on account of public tubewells, indications are that it may increase by two to three times the present estimate.

1. INTRODUCTION

The initial success of the green revolution during the late 1960s and its fast spread during the 1970s is attributed, to a large extent, to the irrigation network that existed in the north-west of India. Canals irrigation and tubewells, along with HYV seeds, became the catalysts of growth in Indian agriculture. A number of studies have highlighted the role of irrigation in enhancing India's foodgrains production,[1] but at what cost this has been achieved remains much less explored. Although controversy recently has started on the cost aspect of major and medium vis-a-vis minor (groundwater) irrigation works,[2] there has been little attempt by the participants in the debate so far to carefully work out estimates of the capital costs of irrigation schemes.[3] This controversy, however, has brought in focus the complexities involved in properly estimating the costs of irrigation. This study attempts to grapple with some of these complexities in an endeavor to assess the capital costs of irrigation. More precisely, this study proposes to estimate:

(a) the capital cost of major and medium irrigation schemes of India on per hectare basis of potential created and potential utilized (section 2);

(b) the subsidy to Indian agriculture for major and medium irrigation schemes (section 3); and,

(c) the subsidy provided to groundwater irrigation schemes in the form of lower power tariffs (section 4).

In what follows, we discuss each one of these in greater detail and try to obtain reasonable estimates of development cost of irrigation and subsidies therein. Finally, based on the range of these estimates derived through alternative exercises, some concluding observations are presented in Section 5.

2. CAPITAL COST OF IRRIGATION (MAJOR AND MEDIUM SCHEMES)

During the last forty years (1951-90), the nation has spent Rs 262.22 billion (in absolute terms, unadjusted for inflation) on major and medium irrigation schemes. The irrigation potential area has increased by 22.14 million hectares (reassessed by Government of India, 1989).[4] Irrigation potential increased, on an average, at 457 thousand hectares per annum during the first 15 years of planned development (1951-65), gradually accelerating to 517 thousand hectares during the next eight years (1966-74) and further to 983 thousand hectares during 1974-80. This, however, could not be sustained during the 1980s, during which the expansion declined to 524 thousand hectares per annum (1980-90).

Dividing the expenditure incurred in each plan on major and medium irrigation schemes by the potential created through these schemes in the same plan, the Working Group on Major and Medium Irrigation Programme for the Eighth Plan (Government of India, 1989) calculates apparent investment per irrigated hectare. Investment cost comes to Rs 1,530/ha for the First Plan, gradually rises to Rs 34,924 in the Sixth Plan and is expected to reach Rs 36,240 in the Seventh Plan (Table 1). These estimates obviously are non-comparable because of two serious limitations: (1) they are at different prices of various plan periods and have not been adjusted for inflation factor and (2) there exists a gestation lag between the time investment is undertaken and irrigation potential created, which is neglected in these estimates. Since a rupee invested in period t_0 and t_1 has different values due to the existence of "pure time preference" (PTP), this lag factor remains crucial even when the investments are viewed at constant prices.[5] The importance of this gestation lag has been recognized by many scholars[6] but none has attempted to incorporate it in estimating capital cost of irrigation. This study makes a modest attempt in this direction.

To begin with, two issues need to be sorted out. First, what is the rate of inflation relevant for capital outlay on irrigation during the last forty years (1951-90)? This is important to convert plan-wise expenditures at constant prices so that meaningful comparison of irrigation costs over time can be made. Second, what is the gestation lag in major and medium irrigation schemes between the time investment is undertaken and potential created, and what is the value that society attaches to PTP, i.e. at what rate society would discount future earnings?

2.1 Inflation Rate for Capital Outlay on Irrigation

In order to estimate the inflation rate relevant for capital outlay on major and medium irrigation schemes in India, one must first know the various components of their capital cost and their relative weights. While the cost items of irrigation schemes range from cement, iron and steel, machinery etc. to highly skilled engineering services, their relative weights differ widely from project to project. Ideally, a detailed analysis of cost structure of several projects with differing nature and design would be carried out, keeping the sample as representative of Indian irrigation schemes as possible, in order to obtain a very reliable weighting scheme. Due to data

limitations, we have not undertaken such an exercise. Instead, we talked to a number of irrigation engineers and assessed their estimated cost breakdowns.

Based on these interviews, various cost components of these irrigation schemes are classified broadly into four categories (a) labor and miscellaneous items not included under other heads, (b) cement, (c) iron and steel and (d) machinery and transport equipment. Their respective weights are estimated to be 0.6, 0.2, 0.15 and 0.05. The inflation rates by decade were then derived for labor and miscellaneous cost items, cement, iron and steel and machinery and transport equipment,[7] which were attached their respective weights of 0.6, 0.2, 0.15 and 0.05 to obtain a weighted inflation rate for capital outlay on major and medium irrigation schemes in India. This annual rate comes out to 3.018 in the first decade (D1 = 1950-59), 6.266 in the second decade (D2 = 1960-69), 8.538 in the third decade (D3 = 1970-79) and 11.127 in the fourth decade (D4 = 1980-88). The rate of inflation of irrigation cost for the entire period under consideration is 7.66 percent per annum (Table 2).

The estimated rates of inflation for capital outlay on major and medium irrigation schemes were then used to convert the actual expenditures in each state (shown in Table 3) to 1988-89 price levels The stream of expenditure in real terms at 1988-89 prices reveals that the Government spent Rs 615.13 billion on major and medium irrigation schemes over the period 1951-52 to 1989-90.

2.2 The Gestation Lag

The second important issue in costing irrigation construction relates to the gestation lag between expenditure incurred and potential created through major and medium irrigation schemes. While many major irrigation works have a long gestation period, which may exceed even two decades, the medium schemes generally can be completed within five to seven years. In fact, there is no unique gestation lag for the schemes that fall in the category of major and medium irrigation works. The lag differs widely from project to project and is influenced by several factors ranging from availability of finance to technical problems. In addition, while expenditures on projects spreads over a number of years, so does the creation of irrigation potential.[8] Further, the gestation lag itself might vary over time. In Indian conditions, for example, the average lag appears to have increased in case of projects undertaken during the post-1974 era due to launching of a large number of schemes without corresponding increase in the investment funds.[9] This led to thin spreading of funds over ongoing projects, resulting in delays and increases in the gestation lag.

Under such a situation, one really needs to undertake a project specific study to come to grips with the question of gestation lag, which spreads over a number of years, varies across projects and over time. It is perhaps only through such an exercise that one can empirically estimate the exact nature of lag unique to each project, and thereafter obtain a weighted average of the estimates. We attempted such an exercise for three states, Uttar Pradesh, Bihar and Tamil Nadu, covering 136 major and medium projects in total. The results of capital cost of irrigation development obtained through this project-specific study were used to firm up the estimates

derived from planwise analysis of expenditures incurred and potential created.[10] This analysis indicates that the gestation lag in major projects is 10 to 12 years under efficient conditions (particularly timely supply of funds) and above 18 to 20 years under inefficient conditions. The medium projects, however, usually are completed within 5 to 7 years. The average gestation lag across medium and major schemes is 12 years.[11]

The other important question associated with gestation period is that of the social rate of discount. Theoretically, the social discount rate equals the rate at which real per capita income of the society grows, multiplied by the elasticity of marginal utility with respect to real per capita income.[12] In symbols, it may be denoted as equal to $r_{pcy}*e_{mu,pcy}$, where r_{pcy} is the rate of growth of real per capita income and $e_{mu,pcy}$ is the elasticity of marginal utility with respect to real per capita income. The product of these two factors ($r_{pcy}*e_{mu,pcy}$) provides the rate of fall in marginal utility as a result of economic growth.

In India, per capita income has increased at about 1.5 percent over the last forty years, but increased to more that 2 percent per year during 1980s. Estimates of the elasticity of marginal utility with respect to per capita income are about 1.75, though a rate of up to 2.5 could be justified if one were to include the impact of various policies aimed at reducing income inequalities.[13] Based on this analytical framework, the social rate of discount would be about 5 percent based on this analytical framework. However, the Planning Commission in India has been using 12 percent as the social rate of discount for evaluating various projects, which gives an upper limit. Since our objective is not to estimate precisely what the social rate of compounding is, as it is influenced by a host of factors, we have preferred to carry out a sensitivity analysis by taking three alternative numbers for social rate of compounding, namely 5 percent, 7.5 percent and 10 percent.

2.3 Estimates of Capital Cost (Major and Medium Schemes)

Tables 4 and 5 present alternative annual estimates of capital cost on per hectare basis for major and medium irrigation schemes over the period 1963-64 to 1994-95. The estimates are for both all India (Table 4) and regional level (Table 5). Further, all-India estimates have been derived separately for per hectare of irrigation potential created, K(PC), as well as of potential utilized, at three alternative social discount rates. All these estimates, therefore, are at 1988-89 prices and also take account of the average 12-year gestation lag. To iron out year to year abrupt changes in these estimates, three yearly moving averages are calculated. Thus, the estimate against 1964-65 is in fact an average of 1963-64 to 1965-66, and so on.

The estimates of capital cost of irrigation development, so derived, reveal an interesting pattern. For example, at the all-India level the temporal behavior of this estimate is U-shaped with lower left arm (Figure 1). Costs decreased quite rapidly over the first 11 year period 1964-65 to 1975-76, remain relatively constant for the next three years and then rises steeply up to 1988-89. Table 4 and Figure 1 reveals clearly that the capital cost of irrigation through major and medium schemes was the lowest for the irrigation potential created during the Fifth Plan period (1974-78) and the highest during the Seventh Plan (1985-90). The onset of 1980s saw

an acceleration in cost as potential creation slowed down. As noted earlier, the potential creation dropped from 983 thousand hectares per annum during 1974-80 to only 524 thousand hectares (per annum) during 1980-90. This U-shaped behavior is true whether one considers capital cost with respect to potential creation or utilized. It may be interesting to note here that the estimates of capital cost in the 1980s are higher than those prevailing in either pre-1980 period or those likely to prevail during the Eighth Plan (1990-95). In particular, the estimates of capital cost of irrigation potential created during 1980s are more than two and a half times the corresponding estimates of irrigation potential created during 1974-80.

It would also be interesting at this juncture to compare the estimates obtained in this study with those which are given by the Central Water Commission (CWC). The CWC calculates the capital cost of irrigation development through major and medium schemes by simply dividing the expenditure incurred in a particular plan with irrigation potential created during the same plan. It neither adjusts for inflation nor for gestation lag. Further, for a particular five year plan, CWC's estimate of irrigation cost remains unidentified with any specific year's price level. If one takes these to be at the mid year's price level of the plan and compares it with our estimates, which are at 1988-89 prices, the two sets of estimates would diverge widely. But the CWC's estimate for the Seventh Plan, which is likely to be at 1987-88 price level (the mid year of the Plan), may be comparable to our estimate. Our lowest estimate is Rs 55,180, which is 52 percent higher than the corresponding estimate of Rs 36,240 given by the CWC. Even if one allows for one year's inflation because our estimate is at 1988-89 prices, our estimate still remains way above that of CWC. Our alternative estimates corresponding to 7.5 and 10 percent social rates of compounding (on per hectare of irrigation potential basis) turn out to be 102 and 166 percent higher respectively, than the CWC estimate. Thus, it appears that in all probability the CWC estimates, at least for the 1980s, understate the actual cost of irrigation development through major and medium schemes.[14]

We have also estimated the capital cost of irrigation development for different regions of India. For this purpose, we have grouped the major states of India into five regions: (i) Northern Region comprising of Punjab, Haryana and Uttar Pradesh; (ii) Eastern Region comprising of Bihar, Orissa, West Bengal and Assam; (iii) Southern Region that comprises of Andhra Pradesh, Karnataka, Tamil Nadu and Kerala; (iv) Western Region comprising of Rajasthan, Gujarat, Maharashtra and Madhya Pradesh and (v) Hill Region that comprises of Himachal Pradesh and Jammu & Kashmir. Looking at these regions from the point of view of topography, one finds that the larger part of the Deccan Plateau falls in the western and southern regions. The lands are rather undulating, which is expected to increase the cost of canal network. Thus, a priori, one expects the cost of irrigation development to be higher in the western and southern regions than in the northern and eastern regions. The hill region may be kept in the background due to its very low irrigation potential.

Our estimates of capital cost of irrigation development through major and medium schemes for the four main regions of India reveal that, on an average, for the period 1963-95, southern region has the highest cost per hectare of irrigation potential created (Rs 55,199), followed by western (Rs 39,211), eastern (Rs 29,440) and northern (Rs 22,426) regions in that

order (Table 6). This ranking broadly confirms higher costs in the southern and western regions than in the eastern or northern regions. The cost in the southern region is almost two and a half times the cost in the northern region.

During the 1980s, however, even this pattern of ranking gets distorted. For example, the cost per hectare of irrigation potential created in the southern region is Rs 61,375, followed by eastern region (Rs 56,672), northern region (Rs 52,062) and western region (Rs 50,966). This somewhat unusual behavior of cost in the 1980s results from a dramatic fall in the potential created in the northern region particularly during the first five years of 1980s. Irrigation potential created in this region declined from 388 thousand hectares (per annum) during 1974-80 to just 61.6 thousand hectares (per annum) during 1980-85. Although other regions also experienced falls in the potential created during the Sixth Plan compared to 1974-80 period, the magnitude of their decline was nowhere near that of the northern region. Our efforts to probe deeper into the reasons that led to a drastic decline in the irrigation potential created revealed that in Uttar Pradesh, for certain very big projects, the estimates of potential created were in fact revised downwards as it was realized that there had been significant over-reporting of potential created in their cases. This adjustment of over-reporting in a state like Punjab, turned the estimates of irrigation potential into negative during the Sixth Plan (see Table 3). Ignoring these oddities of the Sixth Plan, if one views the entire period from 1963-64 to 1994-95 the estimates of capital cost of irrigation development for the southern and western regions remain higher than the all India estimates, while those of the eastern and northern regions fall below it.[15]

3. IRRIGATION SUBSIDY (MAJOR AND MEDIUM SCHEMES)

The concept of subsidy can be looked at from at least three different angles: (a) from consumers' point of view; (b) from the irrigation authority's point of view and (c) from the society's angle. This study concentrates on estimation of the irrigation subsidy from irrigation project authority's point of view, which is the difference between the cost of supplying water and revenue received therefrom. This concept is important to know whether the supplying agency of irrigation water is making losses or profits, and how sustainable the authority would be in the medium to long run. However, there can be different opinions on what should constitute the cost of irrigation and accordingly the magnitude of subsidy might differ widely.

One view would be that the relevant concept of cost for estimating the irrigation subsidy is that of operations and maintenance (O&M). This view, thus, takes the entire capital cost as a sunk cost which should be financed from the general budget. This estimate draws its economic rationale from the marginal cost pricing rule, which recommends pricing of a resource on the basis of its marginal cost for welfare maximization. Viewed in the short run, it would probably imply charging only O&M cost to the farmers and to treat all capital cost incurred in the past as sunk costs. The irrigation subsidy under this approach therefore, would be the difference between gross receipts of irrigation projects and their working expenses (O&M cost).

Following this methodology, the financial records of all river valley projects, which include pure irrigation projects as well as multipurpose river projects, over the 16 year period (1974-75 to 1989-90)[16] shows a sharp increase in current terms in the irrigation subsidy at an all-India level from a mere Rs 168.2 million during the three-year period ending 1976-77 to Rs 3,172 million by the three-year period ending 1989-90, i.e. an increase of more than 18 times. If one accounts for inflation and converts these subsidy estimates at 1988-89 prices, the increase still increases five-fold (Table 6).

The reason underlying this acceleration in O&M subsidies is the rapidly rising bill of working expenses (from Rs 950 million to Rs 4930 million during 1975-76 to 1986-87) compared to gross receipts (which only increased from Rs 870 million to Rs 1670 million over the same period). On average, the subsidy relative to O&M was 44 percent, indicating that major and medium irrigation works have not been financing even their own O&M expenses, not to mention the capital cost.

The situation is not very different at the state level. Most of the states are subsidizing canal water in varying degrees. The only exception to this appears to be Uttar Pradesh, which in most of the years recovered its working expenses. But lately, beginning in 1986-87, even this state has begun to provide subsidies (Table 6). The estimated irrigation subsidy is the highest in Tamil Nadu, where it is 92 percent of working expenses. West Bengal, which has a ratio of 83 percent, and Andhra Pradesh, with a subsidy ratio of 76 percent, are the next highest. On the other hand, states like Uttar Pradesh, Orissa, and Madhya Pradesh have on the average covered their working expenses (Table 7).

The fact that irrigation subsidy covers only 44 percent of the working expenses clearly indicates that pricing of canal water is insufficient to generate resources for financing even operational costs, and therefore recovery of capital cost through pricing of water seems highly unlikely. And if this type of pricing is leading to sub-optimal use of water, creating distortions in the cropping patterns, serious rethinking on the part of planners is necessary.

The other variant of irrigation subsidy from the irrigation agency point of view includes annualized (amortized) cost of capital on major and medium irrigation schemes together with working expenses in the computation. However, there can be a difference of opinion as to which cost of capital one should account for. While historical cost at the prices in those years in which they were incurred (book value), would set the lower limit, the upper limit would perhaps be determined by the replacement cost at today's constant prices. We have worked with both concepts and derived estimates of irrigation subsidy separately. Estimate II corresponds to valuation of capital at historical prices (book value) and Estimate III corresponds to the replacement value of capital.[17]

In either case, an important issue is that of deciding what is the appropriate rate of interest that should be used to annualize (amortize) this capital? And also what should be the rate of depreciation on that capital, as depreciation is to be added in the annualized cost of capital? We have taken a figure of 8.5 percent, which is an average redemption yield on Government bonds as well as an approximate cost of borrowing funds by the Government.[18] Depreciation on straight line basis would be about 1.5 percent, assuming an average life span of 100 years for major projects and 50 years for medium ones. The interest cost and depreciation together, thus, would be about 10 percent, which is used in this exercise to computed annualized (amortized) cost of capital inclusive of depreciation charge.

Estimate II of irrigation subsidy through major and medium schemes is derived as 10 percent of cumulative capital outlay on these schemes plus working expenses minus gross receipts. The cumulative capital outlay, in turn, is estimated by simply adding capital outlays over relevant years at their historical prices (book values). To make them comparable over time, these have been adjusted for inflation using the procedures described above. The estimates of irrigation subsidy so derived at 1988-89 prices are presented in Table 8. It reveals that the irrigation subsidy (Estimate-II) at 1988-89 prices increased from Rs 15,920 billion in 1974-75 to a maximum of Rs 29,013 billion in 1986-87, with an average of Rs 23,044 billion for the 16 year period 1974-75 to 1989-90. On average, Maharashtra, Andhra Pradesh, Uttar Pradesh, Bihar, Gujarat and Karnataka account for more than half of all India irrigation subsidy.

Inclusion of annualized (amortized) capital cost in subsidy estimates increases the total subsidy ten-fold compared to the O&M subsidy. Utilizing replacement cost of capital rather than historical cost, the subsidy estimate is even higher. This is shown in Table 8, where the replacement-cost estimate of irrigation subsidy is Rs 105.605 billion at the all-India level for the period 1974-75 to 1989-90 (at 1988-89 prices). This is more than 4.5 times the historical-cost total subsidy estimate.

4. SUBSIDY ON MINOR IRRIGATION SCHEMES

In this section an attempt is made to work out the subsidy that flows to Indian irrigation through minor schemes. Minor schemes comprise of the ones that are based on ground water such as wells (dugwells and tubewells) as also those related to surface water such as tanks, watersheds etc. Accordingly, subsidies to minor irrigation may come from various channels. Subsidies may come through electricity, which is supplied to agriculture for irrigation at a price below its cost. They may also flow through capital investments that the Government makes in public tubewells or other minor irrigation schemes such as watersheds, which are rarely recovered from cultivators. Finally, subsidies may take the form of cheap credit that is often made available to cultivators for undertaking minor irrigation schemes. While a comprehensive study of subsidies on minor irrigation should cover the various forms in which this subsidy flows, the purpose of present study is to quantify only that segment of irrigation subsidy that comes through the supply of subsidized electricity. This is done for all major states of India for the 1980s.

Keeping symmetry with the earlier concept of irrigation subsidy for major and medium schemes, we have viewed electricity subsidy for minor irrigation also from the electricity producers' point. Thus, it is defined as the difference between cost of electricity to the project authority (in this case State Electricity Boards) and the revenue tariff received from cultivators for the electricity. This represents the financial losses to various SEBs on account of supplying electricity to agriculture at a price below its cost. This study does not intend to estimate the economic subsidy from electricity, which would involve the use of shadow prices of the inputs that go into the production and distribution of electricity to obtain its true economic cost.

The temporal behavior of electricity subsidy and its absolute level depends upon three factors: (a) how much electricity is being consumed by Indian agriculture for irrigation purpose; (b) what is the cost of producing and distributing electricity and (c) what price the cultivator is paying for each unit of electricity consumed for irrigation.

Of all the electricity sold to different categories of consumers in 1989-90, 26 percent (41.8 billion Kwh) was accounted for by the agricultural sector. This share has gradually increased over time. In 1950, agriculture consumed only 3.9 percent of total electricity sold while industry consumed 62.6 percent. Industry's share increased up to 70.8 percent by 1965-66, but declined thereafter. The share of agriculture improved to 7.1 percent in 1965-66 and accelerated to 18.7 percent by 1984-85 and further to 26 percent by 1989-90. This is a significant increase by any standards, and during the 1980s, this seems to be coming at the expense of industry as the share of industry declined from 55.6 percent in 1984-85 to 42 percent by 1989-90.

Of the major states that account for the bulk of electricity consumed in Indian agricultural sector, Uttar Pradesh, with its share of 16 percent, comes at the top. It is followed by Maharashtra (13.3 percent), Punjab (11.7 percent), Andhra Pradesh (11.5 percent), Gujarat (10.8

percent) and Tamil Nadu (8.6 percent). Thus, together these six states consume about 72 percent of electricity being used by agriculture at the all-India level. Punjab and Haryana provide more than 40 percent of their electricity to agricultural sector. Other states that have relatively high sales of electricity to agriculture (1989-90) are Uttar Pradesh (37 percent), Andhra Pradesh (34 percent), Gujarat (32 percent) and Rajasthan (30 percent), as against 26 percent at the all-India level.

The average cost of producing and distributing electricity at the all-India level comes to 101.5 paise/Kwh in 1989-90. It has risen by 143 percent over its 1980-81 figure, when it was just 41.8 paise/Kwh. The revised estimates of 1989-90 reveal that across states, electricity costs highest (246 paise/Kwh) in Assam and lowest (62.2 paise/Kwh) in Kerala. But in major states like Uttar Pradesh and Maharashtra, it is quite close to the all-India figure. It is only in Andhra Pradesh, an important electricity consuming state, that it costs about 30 percent less than that at the all-India level.

The average tariff revenue rate[19] for sale of electricity to agriculture (1989-90) turns out to be only one-fifth (15.3 paise/kwh) of the overall average rate of 75.1 paise/kwh for all purposes. Across states, the tariff differs widely with Andhra Pradesh having the lowest tariff revenue rate (4.5 paise/kwh) for agriculture and Orissa the highest (32.1 paise/kwh). In Punjab it is 7.9 paise/kwh, while in Haryana it is 30 paise/kwh and in Uttar Pradesh 22.2 paise/kwh.

The difference between average cost and average tariff revenue (from agriculture) provides us with the subsidy per unit of electricity supplied to agriculture. Multiplying this number with the total amount of electricity sold to agriculture, one obtains the total electricity subsidy on account of agriculture. On this basis, Table 10 reveals that the electricity subsidy increased from Rs 3,642 billion in 1980-81 to Rs 34,750 billion by 1989-90 and was expected to reach Rs 40 billion in 1990-91. Uttar Pradesh accounts for the largest portion (16 percent) of this electricity subsidy, followed by Maharashtra (14.5 percent), Punjab (13.5 percent), Gujarat (10.5 percent) and Tamil Nadu (9.8 percent).

At this juncture two things may be noted: (a) the cost considered in this study is the average for various categories of consumers and (b) the electricity consumed in Indian agriculture does not go entirely for irrigation, a part of that also goes for threshing operations etc. The adjustment of subsidy estimates on these two counts would obviously yield different set of estimates. While it is agreed that cost of producing and supplying electricity specifically to agriculture is higher than the average for all categories, the magnitude of difference remains somewhat controversial.

A study by Tata Energy Research Institute (TERI, 1988) attempted to estimate the cost of electricity specific to the agricultural sector by making adjustments in the additional investment required in the central generating facility due to its demand from agriculture, investments required in the transmission and distribution network, connection costs for rural loads and the energy cost comprising of operating the generators and accounting for losses in transmission and distribution network. The exercise covered four states - Haryana from north,

Gujarat from west, Karnataka from south and Orissa from east. Operating under several assumptions, the study pointed out that cost would be about 164 paise/kwh in Haryana, 261 paise/kwh in Gujarat, 417 paise/kwh in Karnataka and 464 paise/kwh in Orissa. These costs are two to six times higher than their average costs. If one uses these cost figures, estimates of electricity subsidy would be about three times of what are provided in Table 9.

On the other hand, if one makes an adjustment on account of point (b), i.e. all that goes to agriculture is not only for irrigation, the subsidy estimates would be somewhat lower (say 0.8 times), but would still remain more than double of those given in Table 9. We have not undertaken these adjustments as it requires more detailed work to derive reliable estimates of costs which area specific to agriculture.

5. CONCLUDING REMARKS

Estimation of the development cost of irrigation through major and medium schemes in India is a complex problem. It requires determination of the rate of inflation that is appropriate to the capital cost of irrigation and the gestation lag between the time investment is undertaken and potential created, as well as the social rate of discounting. Employing a methodology which accounts for these factors, the study has shown that the trend in irrigation capital construction costs for major and medium schemes follows a U-shape over the period 1963-64 to 1994-95. The average cost per hectare of irrigation potential created through major and medium schemes over this three decade period was about Rs 35000 at 1988-89 prices. The lowest estimates of capital cost are for the irrigation potential created during 1974-80 and the highest for the potential created during 1980s. Across regions, southern India has highest cost of construction, followed by western, eastern and northern regions. The exercise also reveals that for 1980s at least, official estimates understate the capital cost of irrigation development.

The estimates of irrigation subsidy for major and medium schemes differ widely depending upon what components of cost are included in the estimate. For example, if the entire capital cost is assumed as sunk cost, so that the subsidy is derived only as the difference between working expenses and gross revenue of all river valley projects, the subsidy is Rs 2.237 billion at 1988-89 prices (average of 1974-75 to 1989-90). If one includes annualized (amortized) cost of capital at historical prices (book value) along with working expenses and gross revenue in estimating irrigation subsidy, it increases ten fold (to Rs 23.044 billion at 1988-89 prices) compared to the earlier estimate. The estimated subsidy increases further to Rs 105.604 billion at 1988-89 prices (average of 1974-75 to 1988-89), if one annualizes replacement cost of capital along with working expenses and gross revenue. Subsidy estimates would increase further if a social rate of discount of more than 5 percent was utilized. The total subsidy has increased rapidly over time.

The irrigation subsidy that accrues to Indian agriculture through cheap electricity reached Rs 35 billion by the end of 1980s and is expected to be above Rs 40 billion during 1990s. This is a rather conservative estimate based on average cost of supplying electricity to all categories of consumers. If one were to estimate this subsidy based on cost of supplying electricity to agricultural sector and add into that the capital losses on account of public tubewells, indications are that it may increase by two to three times the present estimate.

FIGURES AND TABLES

Figure 1 All India--Trends in Capital Cost Major & Minor Irrigation Schemes

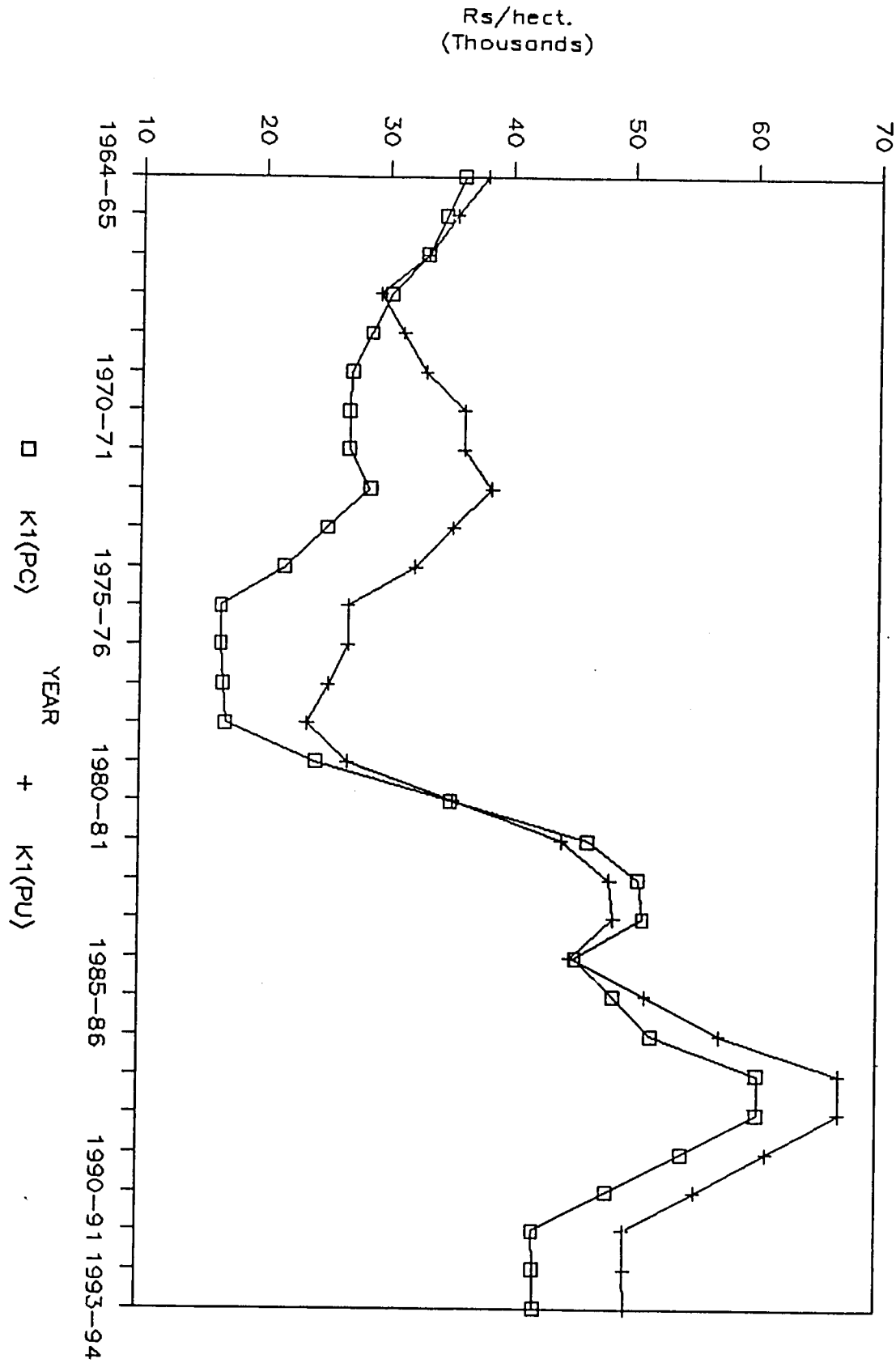


Table 1 Capital Cost of Irrigation Development (Major and Medium Schemes)

Plan Period	Expenditure (Rs Crores)		Potential Created (m.ha)	Apparent Investment (Rs) per ha. of potential created		Capital cost as derived in this study (Rs/ha. at 1988-89 prices)		
	Actual	at 1970-71 prices		Actual	at 1970-71 prices	K1(PC)	K2(PC)	K3(PC)
1	2	3	4	5 (=2/4)	6 (=3/4)	7	8	9
First Plan(1951-56)	380	827 (165.4)	2.48	1,530	3,340	--	--	--
Second Plan(1956-61)	380	706 (141.2)	2.14	1,780	3,300	--	--	--
Third Plan(1961-66)	581	883 (176.6)	2.24	2,590	3,940	--	--	--
Annual Plans(1966-69)	434	526 (175.3)	1.53	2,840	3,440	30,658	40,660	53,577
Fourth Plan(1969-74)	1,237	1,124 (224.8)	2.61	4,740	4,310	26,909	35,688	47,026
Fifth Plan(1974-78)	2,442	1,392 (348.0)	4.01	6,090	3,470	(		
Annual Plans(1978-80)	2,056	867 (433.5)	1.89	10,880	4,590	(18,822	24,963	32,894
Sixth Plan(1980-85)	7,369	1,969 (393.8)	2.11(a)	34,924	9,330	45,836	60,790	80,102
Seventh Plan(1985-90) (anticipated)	11,343	1,682 (336.4)	3.13	36,240	5,380	55,180	73,184	96,433

Source: Government of India (1989): Report of the Working Group on Major and Medium Irrigation Programme for the Eighth Plan (1990-95).

Note: 1. Expenditures at 1970-71 prices (column 3) are taken from the Report of the Working Group on Major and Medium Irrigation Programme for the Eighth Plan (1990-95) (p.II-10). It does not explain what sort of deflator it uses to convert yearwise expenditures at 1970-71 constant prices. Instead, it gives the source of the deflator as Perspective Planning Division in Planning Commission. Our enquiries with PPD revealed that they had worked out only an overall GDP deflator, and not the one specific to irrigation costs of major and medium irrigation schemes.

2. Estimates of capital cost in column 7, 8 and 9 are at 1988-89 prices, after adjusting for inflation in irrigation cost and a lag of 12 years between expenditure incurred and potential created. Use of three alternative social rates of compounding (5, 7.5 and 10 per cent) to take care of pure time preference for a lag of 12 years results in three respective estimates of capital cost (see text for details).

3. The figure of irrigation potential created in the Sixth Plan (2.11 m.ha) is the reassessed one, which is about 38 per cent lower than the one released earlier (3.40 m.ha).

4. The figures in parentheses are annual averages of real expenditure (at 1970-71 prices) incurred on major and medium schemes within the relevant plan.

Table 2
Rate of Inflation for Capital Cost of Major and Medium Irrigation Schemes in India

Period	Decade	Agricultural Wages	Cement	Iron & Steel	Machinery & Transp. Equipment	Wt. Rate of Inflation
weights -->		0.6	0.2	0.15	0.05	1.00
1951-59	D1	1.541	4.250	7.083	3.614	3.018
1960-69	D2	7.351	4.850	4.595	3.924	6.266
1970-79	D3	7.658	9.128	11.073	9.140	8.538
1980-88	D4	12.100	9.186	11.028	7.511	11.127
1951-88	D1-D4	7.844	6.940	8.410	6.073	7.660

Sources : (i) Agricultural Wages in India (various issues), DES, Ministry of Agriculture, Govt. of India.

(ii) Revised Index Numbers of Wholesale Prices in India (various issues), Ministry of Industry, Govt. of India.

Table 3 Statement of Planwise Expenditure Incurred, Potential Created and Potential Utilised of Major and Medium Irrigation Projects in India

(Expenditure in Rs crores; PC and PU in thousand hectares)

State	Ultimate Potential (Th. ha.)	Pre-Plan PC=PU (R)	First Plan (1951-56)			Second Plan (1956-61)		
			Exp	PC	PU	Exp	PC	PU
NORTHERN REGION	18,500.0	4,240.0	60.3	1,567.0	705.0	63.3	372.0	694.0
Haryana	3,000.0	436.0	**	-	-	**	-	-
Punjab	3,000.0	1,251.0	31.9	1,238.0	576.0	38.2	100.0	375.0
Uttar Pradesh	12,500.0	2,553.0	28.4	329.0	129.0	25.1	272.0	319.0
EASTERN REGION	13,380.0	721.0	115.4	288.0	178.0	70.0	982.0	796.0
Assam	970.0	-	-	-	-	1.0	-	-
Bihar	6,500.0	403.0	15.6	125.0	87.0	26.5	269.0	180.0
Orissa	3,600.0	180.0	55.3	4.0	4.0	20.0	363.0	280.0
West Bengal	2,310.0	138.0	44.5	159.0	87.0	22.5	350.0	336.0
SOUTHERN REGION	10,000.0	2,649.0	113.4	343.0	244.0	107.9	495.0	432.0
Andhra Pradesh	5,000.0	1,331.0	37.5	77.0	59.0	57.4	181.0	129.0
Karnataka	2,500.0	217.0	38.7	48.0	21.0	27.4	140.0	97.0
Kerala	1,000.0	-	11.8	93.0	61.0	7.9	49.0	81.0
Tamil Nadu	1,500.0	1,101.0	25.4	125.0	103.0	15.2	125.0	125.0
WESTERN REGION	15,850.0	950.0	84.4	286.0	151.0	120.5	292.0	145.0
Gujarat	3,000.0	20.0	44.7	64.0	25.0	12.4	185.0	41.0
Madhya Pradesh	6,000.0	358.0	8.7	4.0	4.0	30.1	30.0	21.0
Maharashtra	4,100.0	252.0	-	21.0	17.0	52.7	47.0	21.0
Rajasthan	2,750.0	320.0	31.0	197.0	105.0	25.3	30.0	62.0
HILL REGION	300.0	62.0	2.2	2.0	2.0	1.0	2.0	0.0
Himachal Pradesh	50.0	-	-	-	-	-	-	-
Jammu & Kashmir	250.0	62.0	2.2	2.0	2.0	1.0	2.0	-
OTHERS	445.0	0.0	0.6	0.0	0.0	17.3	0.0	0.0
Grand Total	58,475.0	8,622.0	376.2	2,486.0	1,280.0	380.0	2,143.0	2,067.0
Taken by Planning Commission			380.0			380.0		

Table 3 (continued)

(Expenditure in Rs. Crores; PC and PU in thousand hectares)

State	Third Plan (1961-66)			Annual Plan (1966-69)			Fourth Plan (1969-74)		
	Exp	PC	PU	Exp	PC	PU	Exp	PC	PU
NORTHERN REGION	74.3	517.0	857.0	64.4	258.0	332.0	255.3	854.0	698.0
Haryana	**	864.0	818.0	10.5	56.0	78.0	65.9	173.0	159.0
Punjab	19.2	(658.0)	(301.0)	6.9	60.0	74.0	31.7	184.0	196.0
Uttar Pradesh	55.1	311.0	340.0	46.9	142.0	180.0	157.7	497.0	343.0
EASTERN REGION	111.1	459.0	486.0	89.8	458.0	401.0	180.5	776.0	394.0
Assam	1.4	-	-	1.9	20.0	6.0	4.0	13.0	6.0
Bihar	68.1	239.0	248.0	56.0	259.0	160.0	130.5	569.0	157.0
Orissa	26.2	127.0	129.0	20.4	131.0	147.0	20.9	59.0	113.0
West Bengal	15.3	93.0	109.0	11.5	48.0	88.0	25.2	135.0	118.0
SOUTHERN REGION	163.5	582.0	292.0	114.6	168.0	358.0	307.3	303.0	379.0
Andhra Pradesh	91.5	368.0	91.0	60.9	78.0	350.0	118.7	190.0	217.0
Karnataka	30.9	177.0	156.0	32.0	132.0	57.0	134.3	42.0	79.0
Kerala	10.3	15.0	15.0	9.2	23.0	23.0	27.4	41.0	41.0
Tamil Nadu	30.9	22.0	30.0	12.5	(65.0)	(72.0)	27.0	30.0	42.0
WESTERN REGION	218.3	663.0	483.0	160.0	640.0	474.0	489.0	644.0	437.0
Gujarat	46.0	92.0	126.0	47.9	99.0	120.0	125.9	182.0	89.0
Madhya Pradesh	37.0	208.0	32.0	20.5	187.0	115.0	77.6	45.0	111.0
Maharashtra	63.1	129.0	85.0	58.0	119.0	32.0	166.3	266.0	77.0
Rajasthan	72.2	234.0	240.0	33.6	235.0	207.0	119.2	151.0	160.0
HILL REGION	1.6	10.0	5.0	0.4	6.0	11.0	6.6	21.0	19.0
Himachal Pradesh	-	-	-	-	-	-	-	-	-
Jammu & Kashmir	1.6	10.0	5.0	0.4	6.0	11.0	6.6	21.0	19.0
OTHERS	7.2	0.0	0.0	0.6	0.0	0.0	3.5	10.0	10.0
Grand Total	576.0	2,231.0	2,123.0	429.8	1,530.0	1,576.0	1,242.3	2,608.0	1,937.0
Taken by Planning Commission	581.0						1,237.0		

Table 3 (continued)

(Expenditure in Rs. Crores; PC and PU in thousand hectares)

State	Fifth Plan (1974-78)			Annual Plan (1978-80)			Sixth Plan (1980-85)		
	Exp	PC	PU	Exp	PC	PU	Exp	PC(R)	PU(R)
NORTHERN REGION	532.5	1,658.0	678.0	442.7	672.0	702.0	1,386.5	308.0	644.0
Haryana	111.4	181.0	35.0	93.5	59.0	104.0	253.4	154.0	115.0
Punjab	49.6	109.0	108.0	53.2	56.0	56.0	208.9	(32.0)	(44.0)
Uttar Pradesh	371.6	1,368.0	535.0	296.1	557.0	542.0	924.3	186.0	573.0
EASTERN REGION	348.0	847.0	758.0	295.4	384.0	289.0	1,252.7	176.0	520.0
Assam	24.8	28.0	19.0	15.6	28.0	18.0	68.9	12.0	8.0
Bihar	203.9	437.0	319.0	164.5	150.0	165.0	719.2	76.0	455.0
Orissa	70.6	187.0	198.0	67.8	100.0	100.0	322.9	127.0	82.0
West Bengal	48.6	195.0	222.0	47.5	106.0	6.0	141.7	(39.0)	(25.0)
SOUTHERN REGION	587.5	477.0	482.0	498.7	247.0	281.0	1,567.1	559.0	314.0
Andhra Pradesh	269.1	213.0	175.0	257.7	154.0	149.0	729.6	305.0	173.0
Karnataka	188.5	161.0	235.0	138.4	66.0	99.0	413.5	185.0	66.0
Kerala	75.1	53.0	31.0	75.0	26.0	28.0	259.5	77.0	77.0
Tamil Nadu	54.8	50.0	41.0	27.7	1.0	5.0	164.5	(8.0)	(2.0)
WESTERN REGION	972.1	1,016.0	545.0	784.5	580.0	198.0	2,960.0	1,008.0	710.0
Gujarat	236.1	302.0	100.0	194.2	73.0	28.0	727.1	64.0	134.0
Madhya Pradesh	198.4	269.0	210.0	183.8	186.0	37.0	666.7	305.0	160.0
Maharashtra	361.6	286.0	163.0	292.3	112.0	(35.0)	1,187.2	461.0	346.0
Rajasthan	176.0	159.0	72.0	114.2	209.0	168.0	379.1	178.0	70.0
HILL REGION	26.0	16.0	12.0	21.8	6.0	6.0	60.5	14.0	1.0
Himachal Pradesh	1.5	-	-	4.1	-	-	6.2	6.0	4.0
Jammu & Kashmir	24.5	16.0	12.0	17.7	6.0	6.0	54.4	8.0	(3.0)
OTHERS	50.2	0.0	0.0	34.9	6.0	6.0	141.9	44.0	23.0
Grand Total	2,516.2	4,014.0	2,475.0	2,078.1	1,895.0	1,482.0	7,368.8	2,109.0	2,212.0
Taken by Planning Commission	2,442.0			2,056.0			7,369.0		

Table 3 (continued) (Expenditure in Rs. Crores; PC and PU in thousand hectares)

State	Seventh Plan (1985-90)			Eighth Plan (1990-95)		
	Exp	PC(LA)	PU(LA)	Exp	PC(AD)	PU(AD)
NORTHERN REGION	1,934.0	868.0	576.0	3,464.0	1,556.3	1,322.8
Haryana	447.0	146.0	61.0	569.0	315.0	267.8
Punjab	232.0	181.0	105.0	368.0	167.3	142.2
Uttar Pradesh	1,255.0	541.0	410.0	2,527.0	1,074.0	912.9
EASTERN REGION	2,344.0	644.0	675.0	4,606.0	1,176.8	1,000.2
Assam	125.0	82.0	63.0	264.0	93.8	79.7
Bihar	1,376.0	281.0	410.0	2,456.0	459.8	390.8
Orissa	598.0	144.0	102.0	1,347.0	423.0	359.6
West Bengal	245.0	137.0	100.0	539.0	200.3	170.2
SOUTHERN REGION	2,410.0	515.0	478.0	4,529.0	963.0	818.6
Andhra Pradesh	1,398.0	184.0	159.0	2,384.0	585.8	497.9
Karnataka	544.0	171.0	235.0	1,103.0	205.5	174.7
Kerala	269.0	106.0	66.0	557.0	154.5	131.3
Tamil Nadu	199.0	54.0	18.0	485.0	17.3	14.7
WESTERN REGION	4,378.0	1,035.0	1,042.0	9,715.0	2,001.8	1,701.5
Gujarat	1,075.0	194.0	194.0	2,147.0	519.8	441.8
Madhya Pradesh	1,163.0	380.0	283.0	2,823.0	501.0	425.9
Maharashtra	1,498.0	239.0	401.0	3,104.0	472.5	401.6
Rajasthan	642.0	222.0	164.0	1,641.0	508.5	432.2
HILL REGION	89.0	24.0	17.0	162.0	57.8	49.1
Himachal Pradesh	10.0	2.0	-	35.0	20.3	17.2
Jammu & Kashmir	79.0	22.0	17.0	127.0	37.5	31.9
OTHERS	188.0	40.0	33.0	378.0	62.3	52.9
Grand Total	11,343.0	3,126.0	2,821.0	22,854.0	5,817.8	4,945.1

Source: (i) India, Government of (1989): Report of the Working Group on Major and Medium Irrigation Programme for the Eighth Plan (1990-95). (pp. A-11 to A-12, A-16 to A-17,A-108 for Expenditure data; pp. A-8, A-113 and A-108 for data on PC; pp. A-113 to A-114, A-108 for data on PU of V1, VII and VIII Plans)

(ii) Central Water Commission (1989): Water and Related Statistics. (pp. 31 for PU data of I Plan to Annual Plans, 1978-80).

Notes: 1. PC = Potential Created; PU = Potential Utilised; Exp = Expenditure Incurred; R = Revised; LA = Likely Achievement; UTs = Union Territories; AD = Adjusted: PC(AD) is derived as 0.75 of targetted PC assuming a slippage factor of 25 percent; PU(AD) is taken as 0.85 of PC(AD) assuming the utilisation ratio to be 85 percent.

2. The category of OTHERS includes Arunachal Pradesh, Manipur, Meghalay, Mizoram, Nagaland, Tripura, Sikkim, Goa, Union Territories and the Central Sector.

3. Parentheses indicate negative numbers.

Table 4 All India: Capital Cost of Irrigation Development Major & Medium Schemes; Three Yearly Moving Average

Social Discount Rate	Potential Area Created			Potential Area Utilized		
Year	5%	7.5%	10%	5%	7.5%	10%
	(Rs/ha;1988-89 prices)					
1964-65	36,104.6	47,884.3	63,096.3	37,941.3	50,320.2	66,306.1
1965-66	34,599.1	45,887.6	60,465.2	35,516.2	47,103.9	62,068.0
1966-67	33,093.6	43,890.8	57,834.1	33,091.1	43,887.6	57,829.9
1967-68	30,224.1	40,085.2	52,819.5	29,342.0	38,915.2	51,277.9
1968-69	28,656.4	38,006.0	50,079.8	31,186.0	41,360.9	54,500.5
Av.66-69	30,658.0	40,660.7	53,577.8	31,206.4	41,387.9	54,536.1
1969-70	27,088.7	35,926.8	47,340.1	33,030.0	43,806.5	57,723.1
1970-71	26,884.9	35,656.5	46,983.9	36,198.1	48,008.3	63,259.6
1971-72	26,884.9	35,656.5	46,983.9	36,198.1	48,008.3	63,259.6
1972-73	28,559.7	37,877.7	49,910.8	38,453.2	50,999.0	67,200.5
1973-74	25,126.7	33,324.7	43,911.3	35,353.5	46,888.1	61,783.7
Av.69-74	26,909.0	35,688.4	47,026.0	35,846.6	47,542.1	62,645.3
1974-75	21,693.7	28,771.6	37,911.9	32,253.9	42,777.3	56,366.8
1975-76	16,585.9	21,997.3	28,985.4	26,899.3	35,675.6	47,009.1
1976-77	16,585.9	21,997.3	28,985.4	26,899.3	35,675.6	47,009.1
1977-78	16,781.9	22,257.3	29,328.0	25,252.9	33,492.0	44,131.8
1978-79	16,978.0	22,517.2	29,670.6	23,606.4	31,308.4	41,254.5
1979-80	24,308.8	32,239.8	42,481.9	26,900.6	35,677.4	47,011.4
Av.74-80	18,822.4	24,963.4	32,893.9	26,968.7	35,767.7	47,130.4
1980-81	35,256.4	46,759.3	61,613.8	35,476.6	47,051.3	61,998.7
1981-82	46,560.4	61,751.5	81,368.8	44,392.4	58,876.0	77,579.9
1982-83	50,729.7	67,281.0	88,655.0	48,367.5	64,148.1	84,526.8
1983-84	51,086.2	67,753.8	89,277.9	48,707.4	64,598.9	85,120.8
1984-85	45,546.1	60,406.2	79,596.2	45,202.4	59,950.3	78,995.5
Av.80-85	45,835.8	60,790.3	80,102.3	44,429.3	58,924.9	77,644.3
1985-86	48,685.6	64,570.0	85,082.7	51,315.4	68,057.7	89,678.4
1986-87	51,825.1	68,733.8	90,569.3	57,428.3	76,165.1	100,361.4
1987-88	60,504.7	80,245.2	105,737.6	67,046.3	88,921.1	117,169.7
1988-89	60,504.7	80,245.2	105,737.6	67,046.3	88,921.1	117,169.7
1989-90	54,382.8	72,125.9	95,039.0	61,222.6	81,197.4	106,992.2
Av.85-90	55,180.6	73,184.0	96,433.3	60,811.8	80,652.5	106,274.3
1990-91	48,260.9	64,006.7	84,340.4	55,398.9	73,473.6	96,814.9
1991-92	42,214.4	55,987.5	73,773.7	49,664.0	65,867.6	86,792.5
1992-93	42,289.8	56,087.5	73,905.5	49,752.7	65,985.3	86,947.6
1993-94	42,365.3	56,187.5	74,037.3	49,841.5	66,103.0	87,102.7
Wt.Avg.						
1963-95	35,084.8	46,531.8	61,314.1	42,049.5	55,768.7	73,485.4

Table 5 Behaviour of Regional Capital Cost of Irrigation Development (Major & Medium Schemes; Three Yearly Moving Average) (Rs/ha;1988-89 prices), based on potential area created and 5% social discount rate

Year	All India	Nothern Region	Eastern Region	Southern Region	Western Region	Hill Region
1963-64						
1964-65	36104.64	24962.05	53802.51	41703.52	27266.68	46671.75
1965-66	34599.10	26645.54	46652.33	56696.93	23827.10	46671.75
1966-67	33093.56	28329.02	39502.16	71690.35	20387.52	46671.75
1967-68	30224.13	29063.89	27209.80	81497.17	18244.47	37141.99
1968-69	28656.42	23619.30	21975.53	74510.97	24099.66	24454.98
Av.66-69	30658.04	27004.07	29562.50	75899.50	20910.55	36089.57
1969-70	27088.71	18174.71	16741.25	67524.77	29954.84	11767.96
1970-71	26884.87	13678.75	16649.16	65725.15	34513.50	8610.707
1971-72	26884.87	13678.75	16649.16	65725.15	34513.50	8610.707
1972-73	28559.72	13308.03	17993.83	69808.63	39330.90	9432.705
1973-74	25126.72	10474.52	17497.28	61108.69	36103.02	10439.31
Av.69-74	26908.98	13862.95	17106.14	65978.48	34883.15	9772.280
1974-75	21693.73	7641.020	17000.73	52408.75	32875.14	11445.92
1975-76	16585.89	5178.228	15159.51	39625.33	24829.86	11630.53
1976-77	16585.89	5178.228	15159.51	39625.33	24829.86	11630.53
1977-78	16781.92	5870.571	16010.70	38127.24	23515.01	9562.528
1978-79	16977.95	6562.913	16861.88	36629.15	22200.17	7494.520
1979-80	24308.76	18028.21	44014.28	36356.56	23938.01	5555.714
Av.74-80	18822.36	8076.528	20701.10	40462.06	25364.67	9553.293
1980-81	35256.37	39069.78	67137.41	40206.21	30708.07	17150.53
1981-82	46560.44	60612.94	90881.15	44388.54	37771.72	28991.50
1982-83	50729.72	71383.14	88323.68	47345.36	41782.69	40723.26
1983-84	51086.18	71884.73	88944.29	47678.04	42076.28	41009.41
1984-85	45546.12	56425.64	67398.78	49035.86	41710.40	35313.65
Av.80-85	45835.77	59875.25	80537.06	45730.80	38809.83	32633.67
1985-86	48685.62	47836.09	51289.58	61724.26	51217.93	48777.61
1986-87	51825.11	39246.54	35180.38	74412.65	60725.46	62241.56
1987-88	60504.66	46116.07	40616.69	85743.22	70598.87	81401.26
1988-89	60504.66	46116.07	40616.69	85743.22	70598.87	81401.26
1989-90	54382.76	41931.08	36949.92	77526.40	62477.38	69111.81
Av.85-90	55180.56	44249.17	40930.65	77029.95	63123.70	68586.70
1990-91	48260.86	37746.09	33283.16	69309.58	54355.89	56822.36
1991-92	42214.40	32307.33	31613.20	58871.89	47309.55	41372.63
1992-93	42289.83	31053.56	33609.99	56651.03	48384.70	38212.34
1993-94	42365.27	29799.79	35606.79	54430.17	49459.85	35052.05
1994-95						
Wt.Avg.						
1963-95	35084.82	22426.01	29440.26	55198.86	39210.86	35203.23

Table 6 Irrigation Subsidy through Major & Medium Schemes

(Estimate I = Working Expenses minus Gross Receipts of the Irrigation Agency)

Years	All-India		Andhra Pradesh	Bihar	Gujarat	Haryana	Jammu & Kashmir	Karnatka	Kerala
	Rs. (1)	(1a)*	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			(Rs Million at 1988-89 constant prices)						
1974-75	1289.22	(35.84)	276.58	86.50	45.67	154.16	28.00	3.22	34.00
1975-76	297.85	(8.91)	262.98	17.11	7.99	82.78	26.05	-49.72	12.20
1976-77	259.99	(7.14)	402.82	112.43	27.83	55.55	25.07	26.01	30.25
1977-78	898.95	(23.77)	420.93	81.66	15.69	122.80	25.61	37.89	-6.93
1978-79	1290.78	(30.36)	381.25	184.33	51.92	132.71	32.07	8.80	20.62
1979-80	1004.81	(28.33)	397.63	176.80	53.56	162.55	36.78	27.04	-12.26
1980-81	2846.32	(54.21)	398.86	141.55	276.28	130.08	40.19	1112.08	31.36
1981-82	3037.55	(54.71)	459.14	230.52	861.76	167.12	43.00	51.06	75.93
1982-83	2272.18	(50.75)	424.13	197.95	346.89	197.80	39.87	161.40	41.49
1983-84	1844.32	(39.73)	-90.93	133.79	288.79	180.23	35.11	120.03	4.21
1984-85	3115.34	(61.17)	368.33	251.09	253.31	281.62	32.06	213.95	-67.95
1985-86@	4149.75	(57.35)	336.39	316.68	284.69	188.93	32.80	1258.83	46.60
1986-87@	4025.49	(66.16)	327.78	413.54	224.55	127.36	31.63	165.49	88.11
1987-88*	3247.22	(61.63)	263.82	274.26	295.30	169.07	30.84	430.93	30.35
1988-89*	3172.04	(62.44)	249.05	267.63	287.11	162.79	29.43	422.61	29.48
1989-90*	3041.19	(63.15)	231.70	256.37	274.16	154.14	27.65	406.53	28.13
Av.74-89	2237.06		319.40	196.39	224.72	154.36	32.26	274.76	24.10

Years	Maha-rashtra	Madhya Pradesh	Orissa	Punjab	Raja-sthan	Tamil Nadu	Uttar Pradesh	West Bengal
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1974-75	-104.76	-26.64	320.88	117.45	180.74	225.75	-104.98	52.64
1975-76	-52.88	-112.94	48.02	-33.26	-20.56	323.11	-263.32	50.29
1976-77	2.51	-266.52	127.98	-16.70	-26.36	354.39	-671.25	75.98
1977-78	5.31	-138.32	108.65	-16.60	182.41	391.80	-418.05	86.11
1978-79	49.45	-120.66	228.00	20.61	146.70	407.91	-509.00	256.06
1979-80	16.01	-160.79	83.21	52.63	140.21	277.03	-395.60	150.01
1980-81	15.64	128.83	83.94	79.12	178.09	221.11	-178.49	187.68
1981-82	17.25	276.73	34.66	98.43	208.25	611.63	-284.67	186.75
1982-83	67.30	237.91	18.96	71.16	213.66	174.60	-64.15	143.19
1983-84	140.59	276.40	3.95	158.22	273.93	427.36	-315.06	207.70
1984-85	188.98	356.67	28.19	54.72	282.70	190.81	515.34	165.52
1985-86@	218.68	275.53	-30.62	166.52	712.40	221.92	-71.29	191.72
1986-87@	240.78	307.55	-117.03	141.89	924.94	327.58	580.88	240.45
1987-88*	178.36	295.00	-46.64	163.81	525.28	254.20	193.84	188.82
1988-89*	176.89	293.66	-50.79	159.75	517.03	240.15	204.53	182.71
1989-90*	171.76	286.06	-52.98	152.94	498.92	223.56	208.50	173.74
Av.74-89	83.24	119.28	49.27	85.67	308.65	304.56	-98.30	158.71

Source : Combined Finance and Revenue Accounts of the Union and State Governments in India (different years).

Notes : @ indicates provisional figures and * indicates estimated ones (see text for details).

* Figures in parentheses give irrigation subsidy as percentage of working expenses.

Table 7 Irrigation Subsidy through Major & Medium Schemes
(Estimate -II = 10% of Cumulative Capital Outlay at historical prices plus Working Expenses minus Gross Receipts)

Years	All India (1)	Andhra Pradesh (2)	Bihar (3)	Gujarat (4)	Haryana (5)	Jammu & Kashmir (6)	Karnatka (7)	Kerala (8)
				(Rs Million at 1988-89 constant prices)				
1974-75	15919.70	1845.21	1963.72	1242.36	547.75	129.75	1213.72	345.40
1975-76	15902.34	1900.23	1940.13	1264.22	514.85	106.26	1202.34	328.45
1976-77	16842.93	2143.71	2084.17	1350.00	591.27	121.22	1345.68	389.75
1977-78	18730.32	2338.48	2126.62	1466.77	722.32	144.16	1453.92	417.99
1978-79	20377.25	2485.19	2319.03	1584.45	795.68	167.45	1558.16	506.34
1979-80	21426.33	2669.62	2361.89	1695.19	877.65	183.48	1709.72	526.23
1980-81	24584.04	2789.55	2404.64	2039.86	897.50	196.68	2887.29	621.97
1981-82	25620.45	2882.56	2549.69	2707.83	962.31	204.48	1876.93	701.83
1982-83	25516.38	2858.64	2550.46	2306.00	1033.96	206.33	2021.28	695.71
1983-84	25675.63	2338.41	2516.36	2347.96	1004.09	203.99	2003.74	692.49
1984-85	27408.67	2832.84	2678.24	2373.59	1099.34	201.60	2121.59	645.54
1985-86@	28809.78	2830.35	2829.67	2369.65	1084.36	202.68	3193.03	778.19
1986-87@	29012.73	2891.54	3026.82	2282.01	1084.01	200.34	2116.84	810.75
1987-88*	25346.28	2529.86	2493.72	2163.64	979.18	185.87	2170.12	684.06
1988-89*	24413.89	2423.98	2393.46	2084.91	944.03	178.64	2092.91	661.01
1989-90*	23124.18	2285.29	2259.95	1975.49	894.88	168.88	1984.51	627.85
Av.74-89	23044.43	2502.84	2406.16	1953.37	877.07	175.11	1934.49	589.60

Years	Maha-rashtra (9)	Madhya Pradesh (10)	Orissa (11)	Punjab (12)	Raja-sthan (13)	Tamil Nadu (14)	Uttar Pradesh (15)	West Bengal (16)
1974-75	1340.34	946.48	1259.60	838.62	1480.90	924.27	1522.85	318.74
1975-76	1507.79	926.81	1004.47	65[illegible]18	1311.71	1023.49	1503.94	713.49
1976-77	1749.10	896.12	1101.75	664.03	1354.38	1091.88	1237.16	722.71
1977-78	1981.66	1141.14	1107.66	681.74	1638.85	1128.39	1651.49	729.13
1978-79	2231.95	1292.22	1298.28	717.55	1658.84	1134.19	1739.60	888.34
1979-80	2413.98	1389.48	1254.56	774.06	1701.74	989.47	2110.17	769.10
1980-81	2622.38	1798.51	1402.82	835.24	1799.78	918.67	2557.31	811.82
1981-82	2817.36	2043.66	1450.79	884.90	1871.36	1281.28	2577.32	808.15
1982-83	3038.36	2078.04	1514.36	871.99	1917.05	845.02	2840.54	738.66
1983-84	3330.00	2219.69	1540.86	946.68	2003.78	1099.95	2654.98	772.66
1984-85	3496.34	2443.16	1613.68	837.84	1975.13	857.16	3528.28	704.34
1985-86@	3581.17	2467.50	1587.22	982.93	2389.88	884.75	2907.39	721.00
1986-87@	3639.91	2580.19	1559.93	945.53	2580.43	984.85	3540.00	769.57
1987-88*	3191.86	2229.97	1404.28	870.67	2029.95	829.99	2907.59	675.51
1988-89*	3088.49	2163.15	1347.59	834.81	1955.68	785.80	2815.04	644.39
1989-90*	2936.99	2061.51	1272.24	787.52	1852.71	732.95	2678.28	605.13
Av.74-89	2685.48	1792.35	1357.51	820.52	1845.13	969.51	2423.25	712.04

Source : Combined Finance and Revenue Accounts of the Union and State Governments in India (different years).

Note :@ indicates provisional figures and * indicates estimated ones (see text for details).

Table 8 Irrigation Subsidy through Major and Medium Schemes (Estimate III) using Replacement Cost of Capital

(Rs million at 1988-89 constant prices)

Years	Nothern Region			Eastern Region				Southern Region			
	Punjab	Haryana	Uttar Pradesh	Bihar	Orissa	West Bengal	Assam	Karna-taka	Andhra Pradesh	Tamil Nadu	Kerala
				(RS Million at 1988-89 prices)							
1974-75	3099.48	2188.88	5318.79	3356.52	2565.56	2369.44	41.66	3220.94	10696.92	6509.87	1107.36
1975-76	2784.25	1993.00	4968.39	2379.31	1660.66	1722.22	36.42	2869.78	9143.05	5615.08	939.62
1976-77	2835.00	1976.84	4729.83	2609.73	1824.47	1841.92	44.47	3175.90	9454.46	5686.55	988.05
1977-78	2434.94	1764.32	4313.98	3055.74	2120.08	2187.49	59.33	3178.69	8990.75	5383.57	911.26
1978-79	2062.56	1529.42	3624.48	3676.12	2577.20	2605.26	85.35	3076.75	8548.44	5027.52	915.93
1979-80	2606.90	1945.62	5009.38	4747.76	3143.82	3085.63	130.29	4218.54	11305.99	6274.23	1208.99
1980-81	4695.23	3410.29	9853.84	5312.77	3419.23	3327.55	144.57	7056.97	15871.93	8609.38	1833.99
1981-82	6816.29	5025.64	14703.12	6077.95	3676.00	3551.87	160.57	7853.78	20769.61	11470.96	2531.96
1982-83	7952.67	5998.15	17978.04	6152.87	3606.86	3398.66	160.83	8595.14	22379.16	11753.92	2790.93
1983-84	8064.85	6100.41	18247.89	6404.50	3666.43	3471.00	166.78	8725 07	22312.06	12084.65	2903.68
1984-85	8241.05	6516.96	20218.27	6294.80	3455.92	3165.14	158.46	7934.10	20469.28	10511.90	2615.69
1985-86	11134.06	9524.64	26474.71	7238.61	3815.10	3563.71	213.55	9600.83	21352.94	10914.28	2922.02
1986-87	13939.80	10592.01	34161.91	8260.96	4158.44	3996.33	275.90	9152.84	22275.84	11393.00	3161.93
1987-88	16522.78	12550.18	40222.59	9652.08	4968.56	4602.60	367.36	11220.94	25847.60	13037.78	3694.15
1988-89	16664.66	12628.69	40803.14	9963.22	5043.46	4673.99	416.19	11646.81	26126.61	13056.99	3815.23
1989-90	14406.94	10898.18	35450.85	9933.06	4946.40	4588.91	449.38	11202.28	24466.54	12122.84	3646.68
Av.74-89	7766.34	5852.70	17879.95	5944.75	3415.51	3259.48	181.94	7045.59	17500.70	9340.78	2249.22

Years	Western Region				Hill Region		All India
	Rajasthan	Gujarat	Maharashtra	Madhya Pradesh	Himachal Pradesh	Jammu & Kashmir	
1974-75	6286.98	2494.75	2776.76	3781.53	0.00	175.08	55990.51
1975-76	5210.02	2188.17	2564.72	3340.17	0.00	188.88	47603.75
1976-77	5287.54	2323.73	2808.74	3429.60	0.00	192.55	49209.38
1977-78	6158.39	2685.92	3321.31	4223.22	0.00	160.44	50949.42
1978-79	7173.65	3059.46	3588.23	4767.29	0.00	132.24	52449.89
1979-80	7477.72	3073.28	3382.25	4723.56	0.00	396.56	62730.51
1980-81	7471.60	3391.71	3701.35	5106.59	17.31	2558.07	85782.37
1981-82	7512.00	4093.21	4041.29	5381.85	64.94	4743.10	108474.15
1982-83	8376.05	4080.46	4929.14	6074.97	136.83	6607.72	120972.40
1983-84	8577.30	4208.69	5449.97	6345.62	183.72	6614.66	123527.28
1984-85	7778.95	3899.99	5303.94	5952.17	157.60	4523.80	117198.00
1985-86	8881.30	4388.47	6121.35	6555.71	96.38	2861.45	134659.11
1986-87	9789.21	4812.30	6986.70	7311.62	35.15	1093.11	151397.04
1987-88	11060.80	5901.06	8583.49	8834.77	45.97	1458.14	178570.86
1988-89	11282.56	6164.95	9144.42	9230.34	45.97	1495.80	182203.02
1989-90	10672.24	5964.22	8989.07	8921.70	37.63	1260.06	167956.97
Av.74-89	8062.27	3920.65	5105.79	5873.79	51.34	2153.85	105604.67

Table 9 Electricity Subsidy to Indian Agriculture/Irrigation

SEBs	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90 (RE)	1990-91 (AP)
					(Rs Million, current prices)						
Andhra Pradesh	171.11	205.36	410.94	602.14	749.58	1240.93	1696.93	2284.52	2590.27	3177.25	3540.21
Assam	4.10	2.97	3.40	17.96	20.22	10.27	17.58	21.14	21.97	27.45	30.72
Bihar	171.57	256.76	447.74	536.52	551.95	889.42	1194.80	1438.43	1938.50	1838.16	2021.10
Gujarat	205.08	102.00	214.19	226.24	370.75	517.71	671.41	2628.61	3059.39	3641.18	4232.62
Haryana	190.51	403.73	422.55	439.74	617.38	624.26	896.90	1605.01	1472.75	1671.34	2067.25
Himachal Pradesh	NA	NA	NA	NA	NA	12.18	16.86	23.88	14.24	14.65	19.50
J & K	NA	NA	NA	NA	NA	32.24	39.29	65.86	106.88	147.24	161.70
Karnataka	11.52	52.40	69.96	97.80	197.88	870.49	1325.40	1771.06	1954.41	2059.43	2307.59
Kerala	NA	NA	NA	NA	NA	6.26	37.99	59.83	74.38	85.22	97.86
Madhya Pradesh	48.14	91.26	186.36	187.04	267.59	325.46	487.06	557.03	848.55	954.11	1031.02
Maharashtra	266.97	373.64	662.80	847.20	1565.71	1912.09	2470.15	2919.70	4072.43	5038.74	5321.84
Meghalaya	NA	NA	NA	NA	NA	NA	0.64	0.39	0.58	1.71	1.02
Orissa	5.19	8.51	14.75	16.13	17.09	26.85	71.48	84.17	71.81	90.31	96.14
Punjab	526.97	467.00	657.77	755.66	978.99	1359.58	2189.02	3115.10	3494.99	4692.87	5649.70
Rajasthan	231.15	277.02	402.72	568.97	641.25	689.20	750.50	1046.45	1396.77	1870.87	2344.13
Tamil Nadu	673.74	830.96	1101.62	1317.80	1464.32	1811.38	1915.11	2240.88	2644.80	3412.80	3969.35
Uttar Pradesh	1123.06	1166.65	1485.36	1609.25	1730.15	2125.83	2854.16	3985.05	4727.27	5557.73	6583.90
West Bengal	13.28	21.39	36.52	56.93	48.64	80.90	93.71	219.19	361.18	468.72	593.32
Total of SEBs	3642.39	4259.65	6116.67	7279.38	9221.48	12535.05	16728.99	24066.29	28851.16	34749.80	40068.96

ENDNOTES

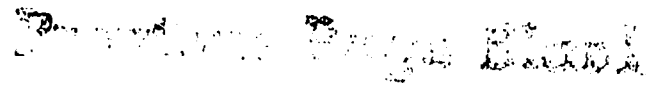
1. In particular see B.D. Dhawan (1988) and the studies referred therein.

2. See B.D. Dhawan's "Major and Minor Irrigation Works: Cost Aspects of the Controversy" and Ramaswamy R. Iyer's "Large Dams: the Right Perspective" in EPW of September 30, 1989 followed by Satyajit K. Singh's article "Evaluating Large Dams in India'in EPW of March 17, 1990 and later by Ashok K. Mitra in the discussion column of EPW of April 21, 1990 and finally the reply by Dhawan in EPW of September 29, 1990. This controversy is reproduced in Dhawan's (1990) edited book Big Dams: Claims, Counterclaims. It may be worth noting here that Dhawan does not view this controversy as "big vs. small" or "major vs. minor" due to two main factors. One, there exists a high degree of linkage between these sources of irrigation and second, that the total requirement of irrigation in this country far exceeds the ultimate irrigation potential, indicating thereby that development of full irrigation potential through all sources of irrigation will be necessary to meet our growing needs of food and fibre. But he does venture to provide a hypothesis of relative costs of the two sources of irrigation being in the ratio of 2:3, i.e. cost of irrigation through major and medium irrigation works would be lower than that through minor (ground water) schemes by about 33 percent. Ramaswamy, while concentrating only on the capital cost of irrigation development, opines "whatever the methodological questions and the adjustment needed, it seems abundantly clear that the investment per hectare of irrigation potential created by a major irrigation project is a multiple (four-fold or more) of the figure under minor irrigation project." Mitra also expresses somewhat similar hunch. Both these views are contrary to Dhawan's hypothesis of relatively lower irrigation cost for major and medium schemes. But none of the participants in the debate has provided any carefully worked out estimates in support of their viewpoints.

3. The only attempt in this direction seems to be that by Kannan and Pushpagadan (1989) for Kerala state.

4. It may be pointed out here that the Government of India had been feeling for quite some time that the irrigation potential as reported to have been created under major and medium schemes contains an element of over-reporting. To correct for this over-reporting irrigation potential was reassessed. The reassessment was done by carrying out corrections in the pre-Plan period and the potential created during the Sixth Plan. This in fact seems to have brought some anomalies at the state level wherein for some states like Punjab, Tamil Nadu and west Bengal, irrigation potential created is reported as a negative figure (see GOI, 1989).

5. The gestation lag factor would not matter much if the relative size of investment (in terms of irrigation potential to be created) remains almost constant in each plan and also that the real investment cost per hectare does not change over time. But both these assumptions may not be realistic. In Indian case this is revealed to some extent in the



rapid decline in per annum potential created during 1980s (524 th.ha.) compared to (983 th.ha.) during 1974-80. Thus the results of investment cost per hectare change substantially.

6. See, for example, the controversy cited in endnote (2). Besides these, it may be mentioned here that Dhawan (1990) and Svendsen (1991) feel that in Indian situation, where size of investment plans for major and medium irrigation schemes has been increasing over time, incorporation of gestation lag would result in lowering the unit cost of irrigation potential created than the one given by CWC. Mitra (1990), however, feels that this cost would go up as incorporation of gestation lag would also mean application of some interest rate on past expenditure. But none of them has computed these. In the present study, however, we feel that the unit cost may go up or down depending upon (a) the rate at which investment plan accelerates, (b) the exact value of gestation lag and (c) the value of social rate of compounding applied to past expenditures in order to account for gestation lag. While factor (a) would work towards lowering the unit cost of irrigation, factors (b) and (c) would jointly push it upwards. The final result would heavily rest on the relative rates of the two sets of factors, i.e. the rate at which investment plan accelerates vis-a-vis the rate at which past expenditures get compounded.

7. The Economic Adviser's wholesale price index series for cement, iron, steel and ferro alloys, machinery and transport equipment were used by estimating their respective inflation rates for the period 1950-51 to 1988-89. It turned out to be 6.94 percent for cement, 8.41 percent for iron, steel and ferro alloys and 6.07 percent for transport and machinery equipment. However, temporal behavior of these prices revealed significant differences over four decades. For example, cement prices increased by 4.25 percent during 1950-59, 4.85 percent per annum during 1960-69, which accelerated to 9.128 percent during 1970-79 and 9.186 percent during 1980-88. Thus the post-1970 inflation rate for cement was significantly higher than that in pre-1970 period. Similarly, price rise of machinery and transport equipment was higher during 1970-88 than during 1950-69. It was 3.614 percent (per annum) during 1950-59, 3.928 percent during 1960-69, 9.140 percent during 1970-79 and 7.511 percent during 1980-88. However, rate of inflation of iron, steel and ferro alloys was 7.083 percent during 1950-59, which was higher than 4.595 percent for 1960-69. Like cement, machinery and transport equipment, the rate of inflation for iron and steel was higher for the period 1970-88 than during 1950-69. Accordingly, it is these decadal rates of inflation which were used (in lieu of single rate for the entire period from 1951-90) to convert yearwise irrigation expenditures at 1988-89 prices. It is hoped that the so estimated figures would make the cost comparisons over time meaningful.

8. In a typical major project, it may happen that expenditure continues for say 10 years without creating any irrigation potential. Thereafter, expenditure continues till say the 20th year, but creation of irrigation potential also starts from 11th to 20th year. Every year from 11th to 20th year, potential created may differ substantially without any fixed pattern. Thus, in practice, for every project one observes a range of years during which expenditure has been incurred and potential created.

9. To be precise, the period 1974-78 saw the start of 73 major and 331 medium new schemes, which was way above the number of projects started in any other plan period. This must be viewed along with the fact that at the start of the Fifth Plan in 1974, there were already 93 major and 165 medium schemes spilling over from the earlier plans. Their spillover cost in the Fifth Plan alone was Rs 2,902 crores. The cost of new projects taken up in the Fifth Plan was estimated to be around Rs 8,136 crores. But actual investment in the Fifth Plan on these irrigation schemes was only Rs 2,442 crores, which was not sufficient even for the spillover schemes, not to mention the new ones. In the Sixth Plan another 41 major and 141 medium new schemes were started. This led to thin spreading of funds and increase in gestation lag.

10. Of the 136 projects taken up in project-specific exercise, 51 were major each having irrigation potential of more than 10,000 hectares and the rest as medium. Forty-eight projects were selected from Uttar Pradesh, fifty-seven from Bihar and thirty-one from Tamil Nadu. Together these projects have an irrigation potential of 7.6 million hectares. Projects from Uttar Pradesh accounted for 4.369 million hectares, those from Bihar for 3.18 million hectares and very little (only 60 thousand hectares) came from projects in Tamil Nadu. Project-specific exercise stretched over the period 1969-70 to 1989-90. Of the total irrigation potential of 7.6 million hectares of the 136 projects selected, 4.486 million hectares (59 percent) had actually been created by 1989-90.

11. It may be emphasized here that the results of this exercise are likely to be very sensitive to this number,i.e, the exact period of gestation lag. One way to circumvent this problem would be to carry out a sensitivity analysis corresponding to different periods of gestation lag and thus present the capital cost of irrigation development as estimates within a range. The other way out would be to cross check our results of capital cost corresponding to a gestation lag of 12 years with those obtained from the project-specific exercise. It is this latter approach that we adopted at least in case of three states - Uttar Pradesh, Bihar and Tamil Nadu.

12. There are various other ways of getting social rate of discount in literature. Sometimes it is also equated to the marginal productivity of capital also. For greater details, see Sen, Marglin and Das Gupta (1978)

13. See Murthy (1982) for greater details.

14. Dhawan (1990) and Svendsen (1991) had an impression that this acceleration in expenditure on account of adjustments for inflation factor and social rate of compounding (gestation lag) would be lower than the rate at which size of investment plans for irrigation has increased over time. Thus, they in fact expected that the estimates of irrigation cost so derived would be lower than those provided by CWC. But our exercise has revealed exactly the reverse.

15. It may be mentioned here that the state-level estimates of capital cost (not reported here), which form the basis of regional and all India estimates, have to be interpreted with extreme caution. This is because in certain states, particularly Punjab, Tamil Nadu and West Bengal, negative figures for irrigation potential have been reported during certain plan periods. For example, Punjab reported creation of irrigation potential to the tune of (-)658 thousand hectares during the Third Plan (1961-66) and (-)32 thousand hectares during the Sixth Plan. Similarly, Tamil Nadu reported potential creation of (-)65 thousand hectares during Annual Plans (1966-69) and (-)8 thousand hectares during the Sixth Plan. West Bengal reported (-)39 thousand hectares in the Sixth Plan. If one applies these negative figures of potential creation on expenditure incurred, one gets absurd results of capital cost in negative. While one needs to probe deeper into the reasons that cause negative potential creation, for our purpose it would be more appropriate to treat regional costs as the relevant costs of irrigation development for those states which form that particular region. Under such a situation, therefore, regional cost structure would also differ depending upon which states are clubbed in which region. And there may be differences amongst engineers/economists in grouping of states in a particular region. While this study groups Rajasthan, Gujarat, Maharashtra and Madhya Pradesh in western region, Svendsen (1991) treats this region comprising of only Gujarat, Maharashtra and Karnataka. He combines Madhya Pradesh with Rajasthan to form central region, while treats Uttar Pradesh as a separate region. Obviously his regional estimates of irrigation development cost, although derived on the basis of a different methodology, are not comparable with those derived in this study due to differences in the composition of regions.

16. The figures for 1987-88 to 1989-90 are projected estimates. These are derived by deducting the projected gross revenue from projected working expenses for the same period. Projections are made by fitting a linear trend on the actual values of gross revenue and working expenses for the period 1974-75 to 1986-87.

17. In this context, it may be recalled here that even at constant prices capital cost of irrigation had varied quite a bit over different years (Section-I). And since exogenous factors over a long period do not remain constant, it raises question as to whether the capital cost (at 1988-89 constant prices) of the irrigation potential created in different years can be taken as their replacement cost. Strictly speaking, it should not. This is for the simple reason that replacement cost, by definition, is a cost at which irrigation potential can be created today. But it may so happen that the area which is being covered today for irrigation is a difficult terrain compared to the area covered in the past, whose replacement cost is being talked about. In that case, treating cost of today's area as replacement cost of potential created in yester years would overestimate the development cost of irrigation. The best way, therefore, appears to be of taking the cost at 1988-89 constant prices of the irrigation potential created over time as their relevant replacement cost. This is what is finally taken in this study. It may also be recalled here that this cost was derived (in Section-I) by taking care of the 12 years gestation lag between investment incurred and potential created, and that alternative social rates of

compounding (5, 7.5 and 10 percent) were applied for 12 years to match the investment and potential creation on comparable basis. It is this 12 years compounding process that is generally neglected when one works with the historical cost approach, and in our opinion that is a serious lapse.

18. One may suggest that the relevant rate of interest would perhaps be the rate at which government borrows its funds from the public or from international organizations, or say a weighted average of the two. The problem with this interest rate, however, is that it encompasses a hidden subsidy as the domestic borrowings of the government are at an artificially suppressed rate. This is inherent in the very mechanism of government borrowing, which makes it binding on the part of financial institutions to accept government securities and give a loan at a very low rate. If one works on the figures of gross interest paid by the Government on gross internal public debt (GIPD), as provided in Bhattacharya and Guha (1990), one finds the interest rate to be 7.22 percent of GIPD for the period of 1980-81 to 1987-88. But they also comment that this is an understatement of the cost of borrowing because of (a) increasing share of zero coupen securities (like Indira Vikas Patra and National Saving Scheme Certificates), which give entire interest at the time of maturity (say after five years) and (b) other fiscal concessions that usually accompany these schemes. They opine (personal communication) that the marginal cost of borrowing funds would be anywhere between 8.5 to 10 percent in late 1980s.

19. In most of the states electricity tariff for agriculture is not volumetric based. It is on flat rate basis,linked to the horsepower of the motor. The average revenue tariff rate for agriculture is estimated by dividing the total revenue received from agriculture on account of electricity with the total quantum of electricity supplied to agriculture.

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