II

IMPACT OF IRRIGATION: A REVIEW

Irrigation is a technological and institutional innovation which permits cultivation of marginal lands. In irrigation has been identified as one of the factors revitalising a static farm sector. In fact, it has been found that irrigation is a leading constraint on the growth of agricultural sector and the gradual relaxation of which results in changes in agrarian structure as well as in the economic conditions of the participant groups. For having proper perspective of development of irrigated agriculture and also an analytic frame to comprehend the sequence of events set in motion with the advent of irrigation, the role of irrigation at different phases of agricultural development and its interaction with the existing and emerging technologies have to be properly appreciated. The role of irrigation in strengthening the linkages of agricultural sector with the others, besides its secondary effects has to be considered in understanding the nexus between irrigation and agricultural development.


2.1 IRRIGATION AND AGRICULTURAL GROWTH

In the early stages of agricultural development with a low irrigation base, the emphasis would be on the increase of yield of (selected) traditional crops and also on the stability of agricultural output/incomes. Thus, in this phase of development, irrigation plays the protective role. At later stages or in irrigated farming where irrigation is made available for major part of the year, it plays the productive role and facilitates the process of rural transformation.

Irrigation influences the growth of output by altering the components of output viz., area, crop pattern and yield. Improvements in the quality of land and also in the intensity of land use are the immediate observable effects of irrigation. It brings more land under cultivation and also enhances the area sown more than once. It also provides an incentive for investment on land which enriches the quality of soil. Further, the acreage allocation among competing crops gets changed with the introduction of irrigation. Such shifts will have direct bearing on the total value of output generated in this sector.

Its impact on yield has to be measured by its direct and indirect contribution. In general, output expands when crop shifts take place from dry/unirrigated area to an irrigated land, for the given set of inputs. Its other effects include facilitation of (modern) technological adoption and maximisation of interaction effects with the inputs such as improved seeds and fertilisers, resulting in higher yield/production.
**Interaction Effects**: The interaction between irrigation and some of inputs of new technology merits special mention. In the absence of any interaction, the output will increase by a certain proportion. In other words, production curve shifts radically. But if the interaction is positive, then more output can be obtained. The following illustration drives home the point.

\[ Q_2 - Q_1 \] (Pure) irrigation effect

\[ Q_3 - Q_2 \] Interaction effect.

The curve 'A' in the figure depicts the output response for different combinations of input mix under the new technology, from unirrigated land. If irrigation is given to this land and inputs are unaltered then output will increase. Assuming irrigation has no interaction with the inputs of new agricultural technology, output increases are represented by curve B. For example, at \( I_0 \) level of input-mix, the output levels in unirrigated and irrigated conditions are \( Q_1 \) and \( Q_2 \). In real situation, output will be more than \( Q_2 \), say \( Q_3 \) at \( I_0 \) level of input combination owing to the interaction.
between irrigation and (new) technology. The curve 'C' indicates the output level in the presence of positive interaction between irrigation input and other inputs. Thus, the difference between output levels $Q_2$ and $Q_1$ ($Q_2 - Q_1$) refers to the pure effect of irrigation and that between $Q_3$ and $Q_1$ ($Q_3 - Q_2$) indicates the interaction effect. The total benefits realised from the combined use of technology and irrigation are greater than sum of the benefits from the application of both separately. The interaction effects may not be linear and may subject to scale of operation. Thus, in the presence of irrigation, the total factor productivity may increase at a faster rate. In case, diminishing returns to irrigation input are set in, a more equitable distribution of irrigation results in more output.\(^5\)

Source of Irrigation: The source of irrigation is an important aspect in planning crop patterns and input use.\(^6\) The source of irrigation suggests the degree of control the farm community has on the supply of water. Some crops demand water periodically and also in huge quantities, Control over supply of irrigation is useful in growing those crops which require continuously large quantities of water and in turn ensures optimal utilisation of inputs and higher level of output.

Irrigation and Inter-sectoral linkages: Strong inter-sectoral linkages both forward and backward are identified as necessary and sufficient conditions for transformation of agriculture and sustained growth. Traditional agriculture

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was viewed to have weak growth stimulating linkages. Since the new agricultural technology demands greater purchase of capital goods from industry, the backward linkages are likely to be strengthened. The desired level of forward linkages will be achieved through better market infrastructure, support prices, establishment of relevant industries for absorbing the increased output. The linkage through consumption expenditure is significant. It was observed from consumer studies that increase in the demand for non-foodgrain agricultural commodities offers a major opportunity for an equilibrium with increased foodgrain production at higher levels of employment and small reduction in relative prices. Given the infant stage of dryland technology, the absorption of new technologies is more or less conditioned by availability of irrigation. Further, only in a few crops like wheat, rice and maize, technological advancement is maximum. The water requirements — quantity and frequency — of these crops are relatively higher and uncertainly in respect of its availability causes severe fluctuations in output. Thus, availability of irrigation motivates the farm community to opt for new variety seeds and use of modern inputs. And, once the backward and forward linkages are strengthened, the agricultural sector can have a higher growth which can be sustained.


8. Ibid.

9. It was observed that use of new varieties under unassured water supply conditions will accentuate the variability in the yield. See Hanumantha Rao, Ch., "Technological change and Distribution of gains in Indian Agriculture", MacMillan, New Delhi, 1975.
Irrigation, thus can be construed as the basic input next only to land in supporting the process of agricultural transformation. Given the limited supply of land, the impact of irrigation on farm economy can be best analysed through changes in the basic parameters such as cropping intensity, crop pattern, input use (range and combination of inputs), yield of main crops, and overall agricultural growth.

2.2 IRRIGATION AND FACTOR SHARES

In the process of agricultural transformation it is likely that the relative importance of factors of production viz., land, human labour, bullock labour, capital (working and fixed) and management gets changed. From the point of equity and also long-run growth prospects, a study of the changes in factor shares is important.

In the traditional agriculture, land and labour (human and animal power) account for major farm expenditure or contribute more to output and thus claim higher share in farm output. Contribution of capital given its low productivity, is limited in this agricultural situation. Introduction of irrigation is expected to induce growth impulses and alter the use of factors of production. Land is likely to gain absolutely on account of higher rental value and also due to investments on land development activities. Similarly human labour input use may increase owing to changes in crop pattern, and crop intensity besides the additional manpower needed.

* Since, one of the objectives of development planning is maximisation of employment opportunities, the impact of irrigation on productive absorption of labour force in agriculture further strengthens the case of irrigation in transforming static (over populated and low productive) agriculture into a dynamic and modernised one.
for irrigation input. If irrigation is supplemented with new technological inputs — bio-chemical and mechanical —, the net effect determines the total labour absorption and in turn its absolute earnings/share. The factors may gain absolutely in the growth process but their relative shares depend on the growth of output and initial level of factor earnings as well. Since the new technology is known to be capital intensive, capital — in the form of current inputs such as fertilisers and physical durable assets like pumps sets — may improve its share in absolute as well as relative terms. Irrigation, usually viewed as physical durable capital, can also be included as a factor of production and its share in the output can be evaluated.*

The factor 'Management' does not really reflect either the contribution of entrepreneurial skills to output or the expenditure incurred/imputed on the activities like supervision. It is merely a residual term capturing the effects of unmeasured factors such as weather, institutional factors etc., on the output level.

Study of changes in factor shares during the agricultural transition indicates the specific factor bias of the irrigation-induced technology, if any, and identify the beneficiaries of this growth process. Determination of factor shares, thus not only helps in evaluating the built in bias of the new technology but also in assessing the consequences of such biases on the future growth of farm sector. If new technology favours a factor whose supply is limited in relation to its demand and/or if the factor is skewedly distributed among the various socio-economic strata, then it acts as a

* The problems of measurement of this input's contributions are illustrated in chapter VII.
constraint on the growth. Further, it also provides objective evidence to the issue whether agriculture is getting modernised or not by observing the relative share of traditional vis-a-vis modern capital inputs in agriculture.

2.3 REVIEW OF STUDIES CONDUCTED IN STUDY AREA

A number of studies were conducted in the left canal area of Nagarjuna Sagar Project. Some of these studies, which have examined the transformation in agriculture with reference to factor use, factor shares and/or factor productivity are reviewed briefly. As a prelude to the review, a brief outline on Nagarjuna Sagar Project is given.

Nagarjunasagar Project: Around 1930, the Government of Nizam proposed to construct a major storage dam and reservoir on river Krishna at Nandikonda. In 1951, the Government of India appointed a Committee headed by Mr. Khosla to examine the proposals submitted by the erstwhile Government of Andhra and Hyderabad. Accordingly, the Committee had submitted its report in 1952. Soon-after, the Planning Commission also gave its award on the distribution of Krishna waters among the three riparian States - Andhra Pradesh, Maharashtra and Karnataka. As per the award, 264 thousand million cubic feet of water was allocated to Andhra Pradesh with permission to utilise excess water up to the year 1995.\(^\text{10}\) The construction work was initiated in 1955. It is one of the biggest multi-purpose irrigation projects in India and the dam is one of the largest masonry dams in the world. It impounds water in about 250 sq. kms. man-made lake with a storage

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capacity of 9 million acre-feet. The project was envisaged to provide
irrigation to 21.54 lakh acres through two main gravity flow canals viz.,
Right Canal (Jawahar Lal Nehru Canal) and Left Canal (Lal Bahadur Shastri
Canal). The planned extents of ayacut under these canals were 11.74 lakh
acres covering Guntur and Prakasam districts, and 9.8 lakh acres engulfing
Nalgonda, Khammam and Krishna Districts respectively. The district map
of Nalgonda is shown in Figure 1.

Irrigation water was released to the left canal in August, 1967.
Out of the 21 irrigation blocks in left canal area, 14 blocks are situated in
Nalgonda district. The total commandable and localised areas in these
14 irrigation blocks are of the order of 1834 and 1131 sq. kms. respectively.

Review of Studies The study by Nagabhushanam and Sarveswara Rao
(1966)\textsuperscript{12} was one of the comprehensive studies undertaken in the left canal
area. It was a bench-mark survey of social conditions and economic activi-
ties in the ayacut area prior to release of water. It also aimed at appraising
the resource-use position, and input-output relations for various crops
in the pre-irrigation period and assessing the agricultural potential and
the resource requirements such as credit for efficient utilisation of water
in the project area.

The study treated the entire left canal area as one homogeneous
region and 10 villages were randomly drawn from the ayacut area (proposed)
and another three villages which would not get the benefit of water from

\begin{itemize}
\item[11.] \textit{Ibid.}
\item[12.] Nagabhushanam, K. and D. Sarveswara Rao, \textit{"Report on the Socio-
Economic study of the Nagarjuna Sagar Project Area"}, Vols. 1 to
5, Andhra University, Waltair, 1966. It covered the regions likely
to be benefitted by the left canal and right canal of Krishna river.
FIG. 1
project in this region were chosen as control villages. A Census survey was
launched in the Sample villages eliciting information on demographic particu-
lars, income etc., from all the households for the reference year 1958-59. 
Based on this data, intensive farm surveys were attempted from May 1959
to April 1960 in four rounds and data were collected from sample households
for the crop year 1959-60.

The crop pattern was dominated by jowar (43%), pulses (19%) and
groundnut (16%). Area under commercial crops like cotton and tobacco was
about 19 per cent. The yield levels were low* and investment on land
per acre between 1954-55 to 1959-60 was hardly Rs. 2.20. Paddy cultivation
used to provide employment to the tune of 73 man-days (of 8 hours each)
and absorbed services of bullock labour for 21.5 days per acre. The shares
of land, human labour and bullock labour in the cost of cultivation worked
out to 32, 29 and 21 per cent respectively, indicating the dominance of
these traditional inputs.

One of the merits of this study is that it analysed the resource-use
position and predicted a) the changes in resource use position after release
of water from the canal and b) the changes in cropping pattern. In the
assessment of input use under various crops, it reviewed the cultural practi-
ces, their awareness about modern inputs etc. The study expected a decline
in labour use in paddy cultivation from 73 to 50 man-days and an increase
from 21 to 50 man-days per acre in the case of groundnut. A substantial
reduction in the bullock labour use per acre of principal crops like paddy

<table>
<thead>
<tr>
<th>Crop</th>
<th>Paddy</th>
<th>Jowar</th>
<th>Bajra</th>
<th>Groundnut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield (Quintal/acre)</td>
<td>2.6</td>
<td>1.6</td>
<td>0.6</td>
<td>6.3</td>
</tr>
</tbody>
</table>
and groundnut was also envisaged. Using a linear programming model with maximisation of value added from farm sector as an objective function, an optimal crop pattern was designed and on this basis, the resource gap was estimated. The optimal crop pattern was dominated by paddy (61%) followed by jowar (28%) and groundnut (6%) as mixed crops.

The study of George and Raju (1980) focussed its attention on the impact of irrigation on employment. It examined the changes in crop pattern and consequently labour absorption with age of irrigation. The villages in the command area of Nagarjuna Sagar Project left canal were stratified into three groups. Stratum -0, refers to the set of villages which did not receive irrigation at the time of survey but eventually will be provided. Stratum -1, consists of villages which received canal water one or two years prior to the year of study (1978-79), representing a transition phase from dry cultivation to irrigated agriculture. Stratum -5, comprises of villages where irrigation has been available for more than five years. Two villages from each category were selected randomly and from each village, 75 households were chosen randomly. The important findings of this study are:

1. Crop pattern changed with age of irrigation. A mono-crop system (rice) has almost emerged in Kharif. And rice, groundnut and grains are the leading crops in rabi.

2. Shifts in crop pattern have influenced the total labour absorption in agriculture. Labour input per acre per annum increased significantly.

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with the age of irrigation and variations in labour use across the three strata were mainly due to inter-cultural practices promoted by irrigation (weeding, manuring,...). Thus intensity of labour use in crop production is greater in irrigated agriculture owing to prolonged irrigation and positive changes in crop pattern consequent to release of water.

Another comprehensive study of recent origin covering the areas on left and right canals of the NSP was done by Prasada Rao and Mohan Rao (1982). It was an enquiry of impact of irrigation, resource use and economics of crop production. It was also intended to investigate improvements effected towards better utilisation of water and related inputs together with changes in crop pattern through the operation of command area development (CA) programmes.

A two-stage stratified random sampling technique was followed. All the villages in the ayacut area were grouped into four strata on the basis of age of irrigation. This was done separately for the two command areas. Stratum-1, consists of villages which received canal water in 1967-68. The second stratum comprises of villages which received irrigation between 1967-68 and 1977-78; Stratum-3 includes the villages benefitted by irrigation in 1973-79 and 1979-80. The fourth stratum contains villages which are yet to receive canal water. From each strata five villages were selected.


G The utility of this stratification was not made clear, more particularly the strata one and two. The results of the study are not of direct use to us since the data from left and right canals were clubbed.
and from these sample villages 20 holdings were chosen randomly. Some of the important findings of this study are:

1. Crop pattern has shifted in favour of remunerative crops with age of irrigation and yield of crops increased after the receipt of irrigation.

2. Intensity of the use of fertilisers varied significantly across strata. Use of human labour and machine labour increased with irrigation level.

3. Market dependency for inputs use was high and it did not vary between irrigated and unirrigated zones; and

4. Shares of land and human labour had increased with irrigation but the bullock labour's share declined moderately. The share of modern input did not differ much between irrigated and unirrigated regions.

A resurvey of Miryalaguda taluka in the command area (after ten years) was conducted by Sudhir Wanamall (1983)\textsuperscript{13} This study compared the results of 1973 survey with those of 1963 study.\textsuperscript{16} It was found that advent of irrigation mainly benefitted paddy. Other sources of irrigation (Tanks and Wells) lost their importance in the process of development. The 1963 study predicted the emergence of a two-crop economy, sequel to expansion


of irrigation and also less diversified crop pattern. Contrary to this, 1973 study observed impressive diversification. It observed a significant level of adoption of high yielding varieties by the farm community.

The other studies reviewed below, mainly confined their attention to economics of paddy crop, an important one in the command area accounting for major share in the cropped area and also the one benefitted by the green revolution.

The study by Suryanarayana (1980) examined the productivity and profitability of new technology in producing foodgrains including the economic feasibility of yield increasing methods. Three crops viz., rice, jowar and maize, were selected for the investigation. In the case of rice, West Godavari, Chittoor and Nalgonda were considered where the crop was predominately grown. The talukas in each district were grouped into two categories on the basis of degree of adoption of new technology (HYV Seeds): high spread and low spread talukas. From each category, one taluka was selected and then two villages were drawn randomly. A sample of farm households was chosen from these villages and data were collected for three years (1975-78) on farm practices, inputs used and quantum of output realised. Some of the salient findings of this study are:

1. In command area, crop pattern is dominated by rice.

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* The high spread taluka is Miryalaguda located in the command area and low spread taluka is Ramanapet situated in non-command area.
ii. Despite higher irrigation intensity, the cropping intensity was marginally higher (135%) in the command area as compared to the non-command area (147%).

iii. Percentage of area under HYV was more in rabi season. The use of fertilizers and pesticides was fairly spread in the two regions but the actual doses of these inputs were lower than the recommended ones. The labour use per acre was higher for local varieties in kharif and its absorption was more under HYV in rabi.

iv. Taking into account the current inputs, the share of inputs from industry increased with technology shift. Thus, the new technology increased the dependency on market for inputs and strengthened the linkage between farm and manufacturing sectors.

v. The new technology is scale neutral but not resource neutral, and

vi. The marginal productivity of labour has improved with technological advancement.

The impact of technological change in the case of rice was also studied by Chakradhar Rao (1982). He followed a comparative analysis and examined the economics of paddy cultivation with traditional and HYV technologies in the command and non-command areas in Nalgonda district for the year 1977-78. A sample of 211 households from 6 villages located in command area and another 104 from 3 villages situated in the non-command

area of the district were contacted to elicit information on crop pattern, cost of cultivation etc.

The study observed that cropping intensity was very high (186%) in command area as compared to that in non-command area (113%). It was also found that irrigation increased the crop intensity by 66 per cent. In command area, 90 per cent of the area was under rice in kharif and due to localisation policy it was reduced to 66% in rabi. Groundnut was the next important crop in command area. Against this, in uplands, there was crop diversification in kharif season and crop specialisation in rabi (90% of area was under rice). The adoption of HYV technology (of rice) was more in rabi season. Market dependency for inputs increased with technological change and it was higher in command area. The per acre yield of rice responded to irrigation and technological advances. The labour use per acre declined with new technology and irrigation level. The use of bullock power was drastically reduced with irrigation. Share of wages was higher in non-command area.

The above studies, were conducted at different points of time and thus reflect the agricultural situations during those specific periods; and did not examine the entire process of agricultural transformation. The present study attempts to integrate these works with the analysis of secondary data carried out for a period of 23 years in order to understand the growth process in the study area.