Chapter-III

AGRICULTURE TRANSFORMATION THROUGH IRRIGATION AND ECONOMIC DEVELOPMENT
Irrigation in an agrarian economy assumes the same importance as blood in human body. Agriculture by irrigation antedates recorded history and is probably one of the oldest occupations of the civilized man. Irrigation is the obvious means of making the country’s agriculture relatively independent of the vagaries of rains and of putting on a more secure footing the agriculture economy of the nation on which to great extent the welfare and happiness of the largest section of people in a predominantly agricultural country hinges.

The transition from the primitive hunting and food collecting way of to one based on agricultural food production was far reaching substantially influenced by the march of civilization. It was a cultural resolution by which mankind was able to progress beyond the cruel ecological limitations set by nature to the foraging primitive man, establishing the foundations for the eventual development of civilization.

In this way no less significant than this was the early revolution in food production that followed an evolution in agriculture on account of development of new technology. Irrigation has played a vital role in this continuous process of agricultural development. In most of the early civilizations of both hemispheres, as in many nations today.

---

1 Importance of Irrigation in an Agrarian Economy and Agriculture Development – Niranjan Panth, 1987, New Delhi.
Irrigated agriculture provided and continues to provide the agrarian basis of society.

Economic and social development to a great extent depends upon the creation of surplus agricultural produce. Water is essential for life on the earth. The importance of water has been recognized from the primitive days. Water is an important prerequisite for agricultural development.

Irrigation has provided benefits to the agricultural development of a country. In fact irrigation forms the datum line for sustained successful agriculture. It alleviates suffering, preserve life and advances the marital prosperity of the country. In a country like India, its important is all the more great. In fact, as pointed out by Sir Charles Trevelyn “Irrigation is everything in India” “Water is more valuable than land, because, when water is applied to land it increases its productiveness at least six fold and renders great extents of land productive, which otherwise would produce nothing or next to nothing” Dr. Knowks writes “The irrigation works have made securing of life, they have increased the yield and the value of land and the revenue derived from it. They have lessened the cost of famine relief and have helped to civilize the whole region. In addition, they yield handsome profit to the government”.

Irrigation is essential for the maximization of production of most farm crops. According to the I.C.A.R. the production of irrigated crops is an average 50 to 100 percent, higher than that of the unirrigated crops in the same locality. During the Fourth plan, the average yields of irrigated fields have shown a wide difference over the unirrigated
fields, such as in case of rice it has been of the order of 52.5 percent; wheat 53.1 percent; maize 53 percent and total production 92.6% during 1964-65. It has been estimated that if proper irrigation facilities are provided to rice and wheat production areas the additional production of the two crops may be increased by 10 and 6 million tonnes respectively.

Further, different crops require water in different quantities throughout their growing period. For example, grain crops require their maximum supply only during the time when, heads are formed, while sugarcane, cotton chillies require sufficient water for the entire duration. Most of the annual crops do not require water when they are maturing. The total water requirement of crops varies from 10.6 acre inches of other crops are: linseed 12.7; barely 14.1; oats 14.4%; wheat 14.8; maize 17.8; potato 26.7; chillies 38.8; tobacco 39.2; rice 41.7 and cotton 42.2 acre inches etc.

In addition to above crops, the water requirements of deciduies fruit tree is above 30 inches; and of citras and evergreen trees about 40 inches a year, touch crops such as beans, lettuce and watermelons require about 16 inches of water, common feeder grasses about 24 inches and perennial legumes such as lucerne and berseen closer about 36 inches of water per year.

The water requirements for given area vary greatly according to the nature of the soil and crop. Of all crops, rice is the most dependent upon irrigation, because the biology of the rice plant require that the whole fields should be actually under water during the planting season. Only under very rare circumstances can this result be brought about
by natural rainfall, and in almost every case irrigation from streams of wells is necessary.

Average water requirements for rice in tropical climate have been estimated by the international rice commission at Bangkok at 1.5 mm in all. These are the combined requirements for flooding the field at planting and for growing the crop, and are met by the rainfall during the growing season, a small amount receivable from water previously stored in the soil, with the balance having to be met by irrigation. Thus irrigation is the core of agriculture.

What is a basic input influencing crop production. It is an important constituent of protoplasm and is present to an extent of 85 to 90 percent in the fresh weight of actively increases as the water content decreases. Water is an essential reagent in the photosynthesis and in hydrolytic processes, such as in digestion of starch to sugar. All plant nutrients enter into the plants through water.

In an agrarian economy, irrigation may be a good source of employment as well.

Some of the important issues in this connection are:

(i) The most appropriate way of ensuring, effective participation by the farmers in the various activities of command area development in the 14 million, hectares to be covered by the government programme by the central government.

(ii) The way in which the farmers of other irrigated areas which are not covered by the programme could be motivated to take up such works immediately.

(iii) Whether government itself should take up the bulk of works on fields channels, land levelling and landshaping with cost recoverable from the beneficiaries when they have delayed taking up the works has to be determined.

(iv) A careful study of the impact on agricultural productivity of the various components of the Ayacut development programme, so that appropriate priorities are laid down and the available resources deployed to the maximum advantage.

(v) The most appropriate type of governmental organization to handle the activities.

(vi) The way in which the work of command area development agencies should dovetail in to the general administration system, to ensure co-ordination and smooth working.

(vii) The role of the field research stations and demonstration farms in bound to be crucial to the success of the command area development programme. These will have to properly oriented to serve as a focus for developing measures for the economic and efficient use of available waters in the regions around and for disseminating the result there to the reforms concerned.

(viii) It is also necessary that efforts of the research institutes at the national and state levels, state government department, and agricultural universities are all co-oriented and their findings
reach the farmers in a way we can understand and assimilate suitable improvements to the present extension organizations will have to be considered.

(ix) It is also necessary that efforts of the research institutes of the national and state levels, state government department, and agricultural universities are all co-ordinated and their findings reach the farmers in a way we can understand and assimilate suitable improvements to the present extension organizations will have to be considered.

(x) A farmer is impressed most by what occurs in his neighbourhood. The induction of progressive farmers on some of the lands in new projects, if necessary from states which have a long tradition of irrigated agriculture and high production, could be considered.

(xi) It is also worth exploring whether in the overall National interest, government should acquire power to specify the cropping patterns and to carry out all the necessary works for optimum utilization of water, in cases where persuasion takes along time in producing results.

It may be observed that in providing irrigation to every hectare of land government makes a direct investment of Rs.1,000 to Rs.3,000 per hectares and in addition, will be arranging for institutional finance of substantial magnitude for the command area development and the individual farmers, the activities of command area organization will have to be closely watched and monitored to ensure that the funds are used, as per scheduled programme and the benefits from the integrated
approach both qualitively and quantitively should form a part of the activities of the command area development agencies or the state governments.

As this new approach will eventually benefit individual farmers the way in which returns from farmers to government could be maximized also needs to be examined. The present levies on agriculture, like land revenue and water rates are admittedly low and a substantial step up in the direct revenues to government from irrigated lands is inescapable and unavoidable.

This would also enable funds to flow in, for undertaking the works needed on other irrigated lands at a much faster rate.

The other Consequences of new Agricultural Technology: The Question of Equity and Employment:

Regarding employment effects of new technology, it can be seen that in requiring more careful planting better weeding and water management, more vigorous plant protection measures etc., the adoption of H.Y.V. fertilizer-water package creates additional demand for labour in farming. Larger harvests resulting from the use of the new technology should also increase demand for labour in harvesting and post-harvesting operations. Moreover in so far as the new technology leads to increase in the cropping intensity, it increases labour demand over the years as a whole. Thus the spread of H.Y.V. fertilizer-water technology can be expected to increase employment opportunities for agricultural labours substantially, provided of course, the spread is not accompanied by labour displacing mechanization of farm operations.
Although adoption of new technology in the form of H.Y.V. seeds, fertilizer and water package does not necessitate much mechanization, some farmers particularly the large ones may find it convenient to replace labour by capital in different farm operations. There is some evidence to show that mechanization of Indian Agriculture, through the introduction of power driven tubewells, tractors, thrashers and combine harvestors in farming operations, has been on the rise since 1966. The states of Punjab, Haryana and Utter Pradesh in which the new agricultural strategy has already worked out fairly successfully, have been found to be in the lead in the mechanization process.

The question, therefore arises as to what extent mechanization negates the positive employment effect of H.Y.V. seed fertilizer and water package. The question however, cannot be answered a priori. For instance, tractorisation has both employment generation effects and labour displacing effects. It displaces labour employment in ploughing and transportation. On the other hand, it facilities multiple cropping by reducing land preparation time and raises yield per unit of land because of better ploughing of land. These effects are likely to generate more employment opportunity. Thus the net effect of tractorisation on employment may go either way depending on the magnitudes of labour displacing effects and employment generating effects. Empirical evidence on the nature of the net employment effect of tractors is conclusive. While employment effect of tractorisation is ambiguous mechanization through the use of combine harvestors and thrashers almost certainly displaces labour employment.

In the face of severity of the problems of rural poverty and employment in India, appropriate measures are called for to restrict indiscriminate mechanization of farming operations in the country.

The New Technology and Environment:

Of late, the new technology and Indian agriculture has come under serious criticism from the environmentalists. In the early years, the implications of the new agricultural strategy for ecology and environment escaped largely unnoticed by the public eye. But with the growing environment consciousness in the country in the last few years, the conservationalists criticisms of the new technology have gained wider public attention and support. It has been alleged that the new agricultural strategy involving the use H.Y.V.'s water chemical fertilizers and pesticides has resulted in steady depletion of micro-nutrients from the soil and Utter degradation of its natural chemistry. Lowering of the water table to new depths, sometimes as low as hundred or even two hundred feet, inadequate resurging of underground acquitiers due to high evaporation losses, distribution of contours of the land leading to excessive water run off and top soil erosion, spread of salinity and water logging and poisoning of the air, water, land and vegetation by Toxic agro-chemical at an extensive scale.

Although all this may appear as a bit too strongly worded, the environmentalists allegations against the new agricultural technology are not without any substance. The danger posed to the environment by the new agricultural technology cannot, therefore, be lightly dismissed. It is necessary to take stock of the damage already done and
whatever redressing measure is possible should be taken up with a sense of urgency. Further spread of the new technology should proceed along with caution so as to keep its environmental degradation effects to the unavoidable minimum. Research on development of crop varieties more resistant to pest and diseases and less intensive in agrochemicals and intensification of soil and water conservation measures, assume added importance in this context.

Thus it can be said that the new agricultural strategy in India popularly referred as the green revolution, did not exactly succeed in bringing about a full blown agricultural revolution, but it was contributed significantly in sustaining the growth of agricultural production in the country since the last 1960's. To realize its full potentials, the new agricultural technology needs to be extended to areas in which the strategy is yet to make its mark. But the spread of the new technology should now be pursued with more caution so as to avoid further degradation of the environment in the country. The problems concerning equity and social justice associated with the new strategy are more of institutional rather than technological origin and therefore, these can be solved through appropriate policy measures. As Ladejinsky put it "It is not the fault of the technology that the credit service doesn't, serve those for whom it was originally intended, that the extension service is not living up to expectation tenurial legislation in general is deliberately miscarried, or that wage scales are hardly sufficient to keep body and soul together. All these are to considerable degree man-made institutional inequalities. If only some of them are dealt with a measure of economic or social justice would be used with economic necessity, thereby adding another essential demention to the
green revolution. Adoption of such corrective measures and their implementation in letter and spirit, is however, a potential and administrative matter, involving political will of the government and honesty and efficiency of the bureaucracy.

The innovative credit based farm development schemes announced in the budget for 2002-03 would considerably help broaden the base of extension services so vitally required by farmers share croppers/ tenant farmers and small/marginal farmers to optimally increase the size of their tiny holdings so essential for ensuring viability of farming system and improve cold storage facilities, especially for export of fruits and vegetable.

**Imperative Need:**

Despite the fact that Indian agriculture has acquired strength and resilience after independence, there is no option export concentrating on the development of sustainable agriculture, enhancing the level of farm productivity per unit of available resources and improving quality of farm products substantially.

On the going reform process in the farm sector places heavy demand on rural financial institutions (RFI) to meet the growing demand for farm credit. The working group set up by the planning commission for formation of the Tenth Five year Plan has recognized that fairly large amount of credit is needed for crop production, apart from the long term investment in irrigation land development, Wasteland, Horticulture, Forestry, Fishery, Dairy, Poultry etc.

---

Table-3.1 provides gross capital formation in Indian Agriculture and Fig.3.1 provides pre-chart of investment in agriculture as % of total GDP.

Table-3.1

Table shows gross capital formation in Indian agriculture

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>Public (%)</th>
<th>Private (%)</th>
<th>Investment in Agricultural as % total GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994-95</td>
<td>14.969</td>
<td>4.947 (33.0)</td>
<td>10.022 (57.0)</td>
<td>1.6</td>
</tr>
<tr>
<td>1995-96</td>
<td>15.690</td>
<td>4.849 (30.9)</td>
<td>10.841 (69.1)</td>
<td>1.6</td>
</tr>
<tr>
<td>1996-97</td>
<td>16.176</td>
<td>4.668 (28.9)</td>
<td>11.508 (71.7)</td>
<td>1.5</td>
</tr>
<tr>
<td>1997-98</td>
<td>15.942</td>
<td>3.979 (25.0)</td>
<td>11.963 (75.0)</td>
<td>1.4</td>
</tr>
<tr>
<td>1998-99</td>
<td>14.895</td>
<td>3.869 (26.0)</td>
<td>11.026 (74.0)</td>
<td>1.3</td>
</tr>
<tr>
<td>1999-2000</td>
<td>16.582</td>
<td>4.112 (24.8)</td>
<td>12.470 (75.2)</td>
<td>1.3</td>
</tr>
<tr>
<td>2000-2001</td>
<td>16.545</td>
<td>4.007 (24.2)</td>
<td>12.538 (75.8)</td>
<td>1.3</td>
</tr>
</tbody>
</table>

Source: Survey of Agriculture (DPR).
Fig. 3.1:
Pie diagram showing investment in Agriculture as % total GDP
Currently the department of agriculture and co-operation in the ministry of agricultural is undertaking extension activities through a number of schemes. Under the World Bank assisted National Agricultural Technology (N.A.T.P.) decentralized and demand driven structure for agricultural extension is being pilot - tested are to strength research and extension capabilities restructure public extension services and test new institutional arrangements for technology transfer by involving governmental and nongovernmental agencies and by establishing Agricultural Technology Management Agencies (ATMAS) at the district level.

The former's information and advisory centres and farmers advisory committees function at the block level whereas at the grass-root level, extension operations are centered around farmers groups. The State Agricultural Management and Training and Extension Training Institutes (SAMETIS) have been established in the NATP - states SAMETIS are autonomous bodies which function as state level apex training institutes and provide capacity building in areas like project planning and implementation. Agriculture Technology Management Agencies are operational in 28 districts.

Under agri-clinic /Agri business schemes, Agriculture graduates are trained to undertake bankable projects for providing extension services to farmers on a payment basis and also to undertake other agri-business activities. Under the agricultural extension through farmers organizations' schemes, financial assistance is provided to selected farmers organizations to implement activities relating to agricultural production. Under the agricultural extension through
voluntary organizations scheme efforts are made by selected NGO's to develop models of integrated extension services.

Training schemes are being operated to equip extension functionaries to meet new challenges faced by farmers, specially due to rapid globalization and liberalization. An apex level National Institute of Agricultural Extension Management was set up in Hyderabad in 1985 to cater to the training needs of senior extension managers. State agricultural universities are involved in providing training to middle and gross root level extension functionaries and farmers. Extension education institutes have also been set up on the regional basis to cater to the training needs of middle level extension functionaries.

Exhibitions and shows are organized video films and audio cassettes are produced. Budgetary support has been provided to strengthening transfer of technology efforts to woman farmers. Central schemes and externally aided projects are also in operation for the benefit woman farmers.

The National Policy on agriculture announced in 2000 aims at a growth rate of over 4 percent per year in the agricultural sector, efficient use of resources, conservation of soil, water and bio-diversity, growth with equity and sustainable growth which laters to domestic markets and maximizes benefits from export of agricultural products. If these objectives are to be achieved, agricultural extension will have to play key role. The larger section of small and marginal farmers and land less labourers will have to be effectively serviced. Extension efforts will have to be driven by farmers needs. These will have to be location – specific and address diversification demands, as farmers will be
required to adopt a wider range of inputs and practices and develop
skills in their efficient use. The efforts made by the government will
require to be adequately supplemented by N.G.O’s, private sector and
farmers organizations.

Periodic skill up-gradation to policy makers and planners in the
field of agricultural extension will be essential. Sharing of experience
about good practices will be have to be facilitated.

Extension efforts will have to focus on obtaining remunerative
prices for farm produce, equipping farmers with latest knowledge on
post harvest management, marketing of agricultural produce and value
addition. As the task of extension becomes more complex, the entire
extension system will have to be revitalized and made financially
sustainable in consultation with the state departments of agriculture,
state agricultural universities and private sector agencies. A massive
campaign will have to be launched for skill up-gradation and capacity
building of extension functionaries using resources of the existing
training institutes. The success of extension efforts will largely depend
on the success in carrying out innovations required to service the
emerging needs of the farming community.

Minor Irrigation Schemes:

The minor irrigation schemes continued to be executed by the
revenue department during third plan also with the same speed and
vigour. The unified minor irrigation agency was further expanded
during the plan a sum of Rs.839 lakhs was available in Third Plan
under this head. An additional sum or Rs.870.83 lakhs was likely to be
available from the C.D. Programme. The subsidy allowed during the
required to adopt a wider range of inputs and practices and develop skills in their efficient use. The efforts made by the government will require to be adequately supplemented by N.G.O’s, private sector and farmers organizations.

Periodic skill up-gradation to policy makers and planners in the field of agricultural extension will be essential. Sharing of experience about good practices will be have to be facilitated.

Extension efforts will have to focus on obtaining remunerative prices for farm produce, equipping farmers with latest knowledge on post harvest management, marketing of agricultural produce and value addition. As the task of extension becomes more complex, the entire extension system will have to be revitalized and made financially sustainable in consultation with the state departments of agriculture, state agricultural universities and private sector agencies. A massive campaign will have to be launched for skill up-gradation and capacity building of extension functionaries using resources of the existing training institutes. The success of extension efforts will largely depend on the success in carrying out innovations required to service the emerging needs of the farming community.

**Minor Irrigation Schemes:**

The minor irrigation schemes continued to be executed by the revenue department during third plan also with the same speed and vigour. The unified minor irrigation agency was further expanded during the plan a sum of Rs.839 lakhs was available in Third Plan under this head. An additional sum or Rs.870.83 lakhs was likely to be available from the C.D. Programme. The subsidy allowed during the
second plan was proposed to be continued to Third Plan also except in the case of minor ahars, phnes and bundhs costing less than Rs.1000. The additional production potential to be created by execution of minor irrigation schemes was to be 1.28 lakhs tonnes of food grains and 0.85 lakhs tonnes of non-food grains by providing irrigation to 10.64 lakh acres.

It might be mentioned that only the state owned minor irrigation schemes provided fairly assured and stabilized irrigation. Privately owned minor irrigation schemes, which were not maintained, depreciated and went out of use subsequently these schemes were replaced by major or medium irrigation schemes.

In this way, like previous two plans considerable emphasis was given in the third plan also on development of irrigational facilities and flood control. Most of the major projects continuing from previous plans had been more or less completed by the end of the third plans period. The gross area irrigated from new major and medium projects at the end of the third plan was 6.15 lakh acres. Taking the first three plans together, the irrigation potential created was approximately 6 lakh acres under ground water (resources) schemes, e.g., wells, tubewell, provision of Rahat, pumps, etc., and about 10 lakh acres under small reservoir and weir schemes. The potential created by minor irrigation schemes had been of the order of 8.62 lakh acres during the third plan.

The Tubewell Technology:

5Where as the dug well technology necessities the collection of water held by the water bearing start a first into a dugout pit in the

5 Development of Tubewell Irrigation in India, B.D. Dhawan /Agricole Publisher Academy 1982, Pp.2-3.
ground, this stage is practically avoided in the tube well technology, which is a rather very direct mode of tapping groundwater. More specifically drug well is an excavated pit, with its bottom sizeable below the level of ground water table, where by water from the aquifers, slowly accumulates in to the pit.

The water so collected is then lifted to the ground surface by some water lifting mechanism, called a water lift. As water in the well is about to be emptied, water lifting operation is halted till the well gets replenished by fresh in flow from the equifers surrounding the well. No such halt and recuperation is entailed in a tubewell which provides a continuous flow through pipes inserted into the aquifers.

The dugwell concept can be used to exploit ground water in all types of geological formations. But the tubewell concept is forless universal in its application as it can exploit water held in sandy aquifers only, and not in water bearing start a encountered in rock formations. More precisely tubewell is technically in feasible in cemented formations, described by geologists as consolidated formations that cover a land area of about 1.2 million square kms of this country, including almost the whole of peninsular India. Tubewell is thus an alternative to dugwell technology in regions of India that are underlain with unconsolidated or semi-consolidated sedimentary material. It is estimated that 0.85 million square kms of India territory has unconsolidated formations whose spatial distribution is shown in Table-3.2 (1972 data).

The states of Punjab, Haryana, Utter Pradesh, Bihar and West Bengal have mostly unconsolidated formations.
### Table-3.2

**Statewise Composition of Groundwater Bearing Formations.**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>State</th>
<th>Area under formations (1000 Sq. Kms)</th>
<th>Unconsolidated</th>
<th>Semi-consolidated</th>
<th>Consolidated</th>
<th>Total [3+4+5]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Andhra Pradesh</td>
<td></td>
<td>25</td>
<td>13</td>
<td>170</td>
<td>208</td>
</tr>
<tr>
<td>2</td>
<td>Assam</td>
<td></td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>Bihar</td>
<td></td>
<td>75</td>
<td>5</td>
<td>55</td>
<td>135</td>
</tr>
<tr>
<td>4</td>
<td>Gujarat</td>
<td></td>
<td>85</td>
<td>7</td>
<td>50</td>
<td>142</td>
</tr>
<tr>
<td>5</td>
<td>Haryana</td>
<td></td>
<td>40</td>
<td>-</td>
<td>1</td>
<td>41</td>
</tr>
<tr>
<td>6</td>
<td>Himachal Pradesh</td>
<td></td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>Jammu Kashmir</td>
<td></td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>Kerala</td>
<td></td>
<td>8</td>
<td>-</td>
<td>22</td>
<td>30</td>
</tr>
<tr>
<td>9</td>
<td>Madhya Pradesh</td>
<td></td>
<td>25</td>
<td>4</td>
<td>300</td>
<td>329</td>
</tr>
<tr>
<td>10</td>
<td>Maharashtra</td>
<td></td>
<td>15</td>
<td>5</td>
<td>215</td>
<td>235</td>
</tr>
<tr>
<td>11</td>
<td>Karnataka (Mysore)</td>
<td></td>
<td>4</td>
<td>4</td>
<td>140</td>
<td>148</td>
</tr>
<tr>
<td>12</td>
<td>Orissa</td>
<td></td>
<td>25</td>
<td>4</td>
<td>90</td>
<td>119</td>
</tr>
<tr>
<td>13</td>
<td>Punjab</td>
<td></td>
<td>60</td>
<td>1</td>
<td>-</td>
<td>61</td>
</tr>
<tr>
<td>14</td>
<td>Rajasthan</td>
<td></td>
<td>175</td>
<td>10</td>
<td>70</td>
<td>255</td>
</tr>
<tr>
<td>15</td>
<td>Tamil Nadu</td>
<td></td>
<td>25</td>
<td>3</td>
<td>75</td>
<td>103</td>
</tr>
<tr>
<td>16</td>
<td>Uttar Pradesh</td>
<td></td>
<td>170</td>
<td>-</td>
<td>25</td>
<td>195</td>
</tr>
<tr>
<td>17</td>
<td>West Bengal</td>
<td></td>
<td>62</td>
<td>1</td>
<td>5</td>
<td>68</td>
</tr>
<tr>
<td>All India</td>
<td></td>
<td></td>
<td>850</td>
<td>55</td>
<td>1,218</td>
<td>2,123</td>
</tr>
</tbody>
</table>

**Source:** India Planning Commission 1972.
In some coastal plains that are underlain with too much of time and tubewell technology may be the only method of tapping the ground water resources. This technical superiority emerges because of dugwell technology becoming rather infeasible in these areas. The sources of this infeasibility is the phenomena of caring and sinking of a dugwell.

**Tubewell Reliability and Modern Agriculture:**

The reliability of tubewell irrigation makes tubewell an ideal source of irrigation in all crop seasons, thereby enabling multiple cropping of land resources. It confers tremendous control, on its owner to meet water needs of his crops. It is this assurance of timely and adequate irrigation that enables its owner to practice intensive cultivation, especially with crops that consume heavy dose of chemical fertilizers whose application farmers invariably curtail when ever they have un-certainly about timely availability of irrigation. Private tubewell is thus ideally suited for supporting the high-yielding crops that require heavy fertilization and make rather exacting demand on the irrigation system. In point of fact, the successful propagation of H.Y.V. programme in the wheat belt has been both a cause and an effect of the tubewell spurt in this area ever since the advent of H.Y.V. seeds in the mid-sixtees.

A shallow tubewell, better known as a fitterpoint in the coastal tracts of Andhra and Tamil Nadu, is generally of a much smaller depth and discharge compared to a deep tubewell. Generally the depth of a shallow tubewell ranges from 50 to 100 feet ion this country, while most deep tubewells have depth in the 250-350 feet range. Where as a shallow tubewell taps an upper aquifer or two, a deep tubewell,
generally taps a series of aquifers. Since the deeper aquifers are left practically unaffected in a year of drought, a deep tubewell becomes a reliable source of irrigation during a period when the need for irrigation increases sharply. In fact, one can argue that deep tubewell irrigation is inherently more, reliable than surface irrigation backed by storage reserviours which too are vulnerable to drought in their catchment areas, the valneravcity varying with the severity of the drought and the reliability with which the storage is planned to cope with bad years.

But, then, actual reliability can turn out to be much less than the intrinsic reliability. Thus shortage of power arising from either diminished hydel supplies during drought or lack of coal supplies to thermal power stations, can cripple the working of tubewells. At first though it appears that one can eliminate this source of unreliability by using a diesel engine instead of an electric motor. Apart from transporting diesel oil to the tubewell site on rural roads, the reliability is being secured at an extra cost of energy and enhanced repair and maintenance cost of a diesel pumpset. And availability of diesel oil, dependent as it is on imports to a large extent, cannot be taken for granted. Infact, a transient shortage, occasioned by a strike in refining industry, may occur precisely at the peak irrigation time.

Anyway, man, made deficiencies in repair and maintenance facilities that are so crucial for the smooth running of tubewells during peak season can render public tubewell irrigation much less reliable than gravity canal irrigation that does not make any exacting demand on power and repair facilities in its normal functioning.
May a question of wider concern emanates from the basis issue of the role of the state in promoting tubewell irrigation in India. So far, the state has essentially continued itself to facilitating the tubewell growth under the private aegis. This has indeed been a support of vital significance in the diffusion of the tubewell technology especially since the early sixties. In view of its success in the past there need be no surprise at the continuation of this indirect support to the development of tubewell irrigation during the on-going Five Year Plan. It is however, not so easy to spell out the myriad ways by which the expansion of private tubewell irrigation got a boost during the era of planning. In a nutshell, the conscious endeavour has been to improve investments in farming remunerative. In the particular case of tubewells such investments became attractive propositions because of land consolidation work, infrastructural facilities such as rural electrification and institutional credit for long term investment and short-term crop production loans; growth of domestic industries that could supply components and material for the installation of tubewells; etc.

The main reservation about this indirect role of the state stems from an accentuation in inter-personal and inter regional inequities in the rural economy of the country. There is no denying that small farmers are ill placed to take due advantage of the supporting facilities that promote private tubewell irrigation partly because of their farm size disability and partly because of lack of access to the credit institutions, agricultural extension services, etc. As regards the special equality, there is no doubt that the level of tubewell development
diminishes in force as one traverses east words in the Indo-Gangetic plains, a pattern that happens to coincide with a like pattern in the matter of agricultural growth.

Squarely without a proper understanding of the internal and the external economics of tubewell irrigation. The need for understanding the external economics is all the greater because of the unique circumstance of dualism, whereby the traditional and the modern methods of groundwater irrigation co-exist. The decline in water in the wake of excessive development of private tubewell irrigation has been indeed experienced elsewhere (U.S.A., Latin America etc.) but not with in a dualistic framework. Thus we have to assess how the capital and operating costs of various models of groundwater irrigation are influenced by depth to water table. Thus in India Agriculture transformation through irrigation brings about economic development.

Thus macro analysis has been made use in analysis of India and Karnataka’s irrigation system.