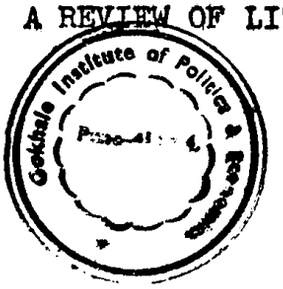
EFFECT OF IRRIGATION ON AGRICULTURAL PRODUCTION : A REVIEW OF LITERATURE



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CHAPTER I

INTRODUCTION

In a country like ours overall economic development is intimately linked with expansion of agricultural production. A shortfall in agricultural production and great deal of fluctuations in it are likely to very adversely affect the health of the economy.

Over a period of 3 decades the country has shown a remarkable secular trend rate of growth of around 3 per cent per annum in agricultural production which is comparable to the rates of growth achieved by the today's developed countries in the initial period of development.

However, since during the last two decades or so population has also been increasing at the rate of around 2.2 per cent per annum, per capita availability of agricultural production has remained more or less stagnant.

Although achievement in terms of a 3 per cent trend rate of growth is remarkable, there is hardly any sign of an accelerated growth during the last 15 years compared to the earlier period of 15 years from early 50s.

The rapid increase in agricultural production manifested by the growth rate have remained confined largely to a few regions endowed with better irrigation facilities etc.

Further, the product-mix has not developed in the desired direction along with the increase in agricultural production.

All the abovementioned observations clearly indicate not only the importance but also the urgency of increasing agricultural production according to the plan target.

(Since the possibility of increasing production by bringing additional area under cultivation seems to have largely been exhausted, the only way of increasing the same is through increasing the productivity of the land under cultivation and through intensive use of the net cultivated area.)

The above strategy of increasing agricultural production can be successfully adopted through the introduction of irrigation for assured supply of water in regions endowed with potential water availability.

The strategic role of irrigation as an essential input for agriculture hardly needs any emphasis. As a traditional protective input, it ensures a secure harvest and acts as an insurance against inadequate and inconsistent monsoon, thus brings about agricultural stability. Moreover, the advent of new crop technology, popularly known as "green revolution" has considerably enhanced the cruciability of irrigation as a basic productive input. Scientific practices such as the use of high yielding variety (HYV) seeds, fertilizers, insecticides etc. which have raised hopes for an ultimate

solution of our chronic agricultural shortage, are all primarily dependent on the availability of irrigation. Thus water is indispensable to agricultural production. Since independence the country has made the substantial progress in irrigation development.

In view of the above, an attempt has been made in this dissertation, to review some of the studies on the effect of irrigation on agricultural production in India.

The main purpose of this study is to undertake a detailed examination of the available main studies on the performance of irrigation in effecting such qualitative and quantitative changes in agricultural production.

The plan of the study is as follows:

Chapter II deals with the analysis of irrigation on development.

Chapter III deals with the effect of irrigation on production through increase in area under cultivation or gross cropped area.

Chapter IV contains an analysis regarding the effect of irrigation on production through increase in productivity per hectare i.e. yield effect of irrigation.

In Chapter V attempt has been made to review the effect of irrigation on production through change in crop-mix or change in cropping pattern.

CHAPTER II

DEVELOPMENT OF IRRIGATION

Pre-Independence Development

Irrigation has been practised in India for many centuries. By 1800 tanks, dams and wells were irrigating around 0.8 million hectares.[1] During the British period development of surface irrigation accelerated through the renovation of several existing canals early in the 19th century and later with the construction of several major irrigation works. Groundwater irrigation was also increasing at this time, with the addition of the first engine-driven shallow tubewells to the existing large stock of traditional-lift dug wells. At the beginning of 19th century, irrigation works included innumerable wells all over the country, a large number of tanks in South India and several inundation canals in North India. Some of these tanks and canals were constructed centuries back. Between 1836 and 1866, four large irrigation works were constructed in the country namely the Upper Ganga Canal, the Upper Bari Doab Canal and the Krishna and Godavari delta system.[2] In those days irrigation

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1 Leslie Abbie, James Q. Harrison, John W. Wall. Economic Return to Investment in Irrigation in India, World Bank Staff Working Papers No. 536, 1982, p. 3.

2 Report on the National Commission on Agriculture, 1976, pp. 13-14.

works were treated as commercial undertakings. But the great famine of 1876-78 gave the country a severe jolt. The First Famine Commission set up in 1880, emphasised the need for direct state initiative in the development of irrigation, particularly in the vulnerable areas. The 1880 Famine Commission and the Irrigation Commission of 1901 established in the wake of severe famines, encouraged the growth of protective irrigation through the construction of public surface schemes, which could be justified as measures to avoid famine. At the same time, productive public works satisfying standard financial return criteria were being further developed. The expansion of private irrigation as a means to avoid famine, later echoed in the 1928 Royal Commission on Agriculture and the Famine Enquiry Commission of 1944, was also given emphasis. Achievement by 1900, and subsequent expansion through 1945 are outlined in Table 2.1.

Table 2.1 : Progress of Irrigation Development in Undivided India Excluding Princely States

(Net irrigated area in million hectares)

Year	Public sector	Private sector	Total
1900	7.6 (57)	5.7 (43)	13.3 (100)
1920-21	10.4 (54)	8.9 (46)	19.3 (100)
1945	13.5 (58)	10.0 (42)	23.5 (100)

Source : National Commission on Agriculture, 1976, p. 14.

It is clear from the foregoing that many Indian farmers are long accustomed to irrigation. But much of the irrigation whether termed protective or productive, was designed to provide some protection from long breaks in the monsoon by delivering river water through earthern canals over long tracks of land during the monsoon period. The idea was to give as many farmer as possible at least some water to save their crop when the rains failed. The emphasis on the drought insurance aspect of irrigation has had not surprisingly lasting influence on the selection and design of irrigation projects. The older system nevertheless have proved to have certain advantages in their relatively straightforward operations, well established distribution of water and their inbuilt incentives to farmers to use water efficiently due to its scarcity.[3]

Post-Independence Development

After partition in 1947 India was left with 83 per cent of the population of undivided India and 84 per cent of net land area but only 69 per cent of irrigated area amounting to 19.4 million hectares. Over half of all area irrigation by government canals in undivided India was located in Pakistan. As many agriculturally surplus area ended up in Pakistan the need to accelerate the rate of irrigation development was actually felt after independence. A number

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3 Leslie Abbie, James Q. Harrison, John W. Wall, op.cit., pp. 3-4.

of projects were soon taken up after independence, some of them are quite large like Bhakra-Nangal, the Damodar Valley and Hirakud. A number of new projects were taken up in every succeeding plan.[4]

In each plan period there was successive increase in the number of projects initiated. Public support for the development of private irrigation was progressively increasing through investment in essential infrastructural and institutional services. As a result India now has the largest and most ambitious irrigation programme in the world.

Striking features of this development are the steady decline in the growth of area irrigated by publicly funded major and medium surface irrigation projects through the mid-1970s, followed by a mark acceleration thereafter; the rapid growth of groundwater irrigation, mainly private since the mid-1960s, tailing off somewhat in recent years; and tentative revival of minor surface irrigation after almost 20 years of near stagnation. The net result has been an increase in total area irrigated since 1951, along with a rise in the proportion covered by groundwater.

According to Niranjan Pant development of irrigation particularly in the planning era, has been marked by two conflicting trends.[5] On the one hand, huge investment and

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4 Report on the National Commission on Agriculture, 1976, Vol.V, p. 14.

5 Niranjan Pant. Issues in Irrigation Development, Economic and Political Weekly, July 23, 1983.

poor performance is noticeable in the major and medium irrigation sector, and on the other comparatively little investments have resulted in impressive performance in the minor irrigation mainly groundwater sector. During the plan period, upto 1980-81, 49 per cent of irrigation potential was developed through major and medium irrigation projects while about 76 per cent of outlay was spent on it and minor irrigation developed 51 per cent of the total irrigation potential while 24 per cent of total outlay was invested in this sector. The same trend is visible in Sixth Five Year Plan.

However, there are two trends of ideas in this regard. On the one hand some opine that the poor performance of major and medium irrigation projects is generally on account of deficiencies in the main system which in turn is the consequence of faulty planning. Hence they emphasize the need of a thorough presanction appraisal.

On the other hand advocates of ground-water development resent the government's preference for surface water sector and complain about the under-exploitation of ground-water potential.

Development of Irrigation Potential

According to the Planning Commission "Irrigation potential is the gross area that can be irrigated from a project in a design year (July 1 to June 30 of the succeeding year)

for the projected cropping pattern and assumed water allowance on its full development. The gross irrigated area will be the aggregate of the areas irrigated in different cropping seasons, the areas under two seasonal and perennial crops being counted only once in a year."[6]

Out of geographical area of about 329 million hectares the cultivable area, net sown area and gross cropped area comprise 186 million hectares, 143 million hectares and 175 million hectares, respectively. The ultimate irrigation potential from major, medium and minor irrigation schemes is estimated at 113.5 million hectares of which 58.5 million hectares is from minor irrigation schemes. With a view to optimally utilising the available water resources of the country by storage and inter-basin transfer from surplus to deficit and drought-prone areas, a national perspective for water resource development has been prepared. It has two components, viz. Himalayan Rivers Development and Peninsular River Development. The national perspective envisages an additional benefit of 25 million hectares from surface water and 10 million hectares by increased use of ground-water, which is expected to raise ultimate irrigation potential from 113.5 million hectares to 148 million hectares. Since available water resources would not be able to serve the entire cultivable area envisaged, greater emphasis has to be

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6 Report of the High Power Committee, Irrigation Department, Government of Maharashtra, November 1981, p. 5.

laid on optimum use of the irrigation facilities created so that the food production needs of the country are adequately met. It is proposed to utilise the available water resources fully by 2010 A.D. or so and to create an ultimate irrigation potential of 113.5 million hectares. For this is to be possible, a large volume of resources would be required.[7]

Table 2.2 outlines the development of irrigation potential from the beginning of the first plan.

Table 2.2 indicates that irrigation potential has increased from 26.26 million hectares to 67.90 million hectares during the period 1950-51 and 1980-85. This reflects the rapidity with which irrigation potential has developed in India.

Major and Medium Surface Irrigation

At the beginning of the First Plan, 9.7 million hectares of potential had been created by major and medium irrigation projects. Around 75 per cent of this potential was accounted for by 24 major projects alone, while 70 per cent was concentrated in four states - Andhra Pradesh, Punjab, Tamil Nadu and Uttar Pradesh. A substantial number of projects were started immediately upon independence and during the first and second plans.

The First Plan sought to achieve an additional irrigation of 3.44 million hectares. The actual achievement was,

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7 Seventh Five Year Plan 1985-90. Planning Commission, Government of India, Vol.I, pp. 72-73.

Table 2.2 : Development of Irrigation Potential

Period	Irrigation potential million hectares		Cumulative total
	Major and medium irrigation	Minor irrigation	
Pre-plan benefits	9.7	12.9	22.6
First Plan	12.20	14.6	26.26
Second Plan	14.30	14.79	29.09
Third Plan	16.60	17.01	33.61
Annual Plan (1966-69)	18.10	19.00	37.10
Fourth Plan (1969-74)	20.70	23.50	44.20
Fifth Plan (1974-78)	24.82	27.30	52.12
Annual Plan (1978-79)	25.86	28.60	54.46
Annual Plan (1979-80)	26.60	30.00	56.60
Sixth Plan (1980-85)	30.50	37.40	67.90
Ultimate Potential	58.50	55.0	113.50

Source : Seventh Five Year Plan 1985-90. Planning Commission, Government of India, Vol.I, Table 3.2, p. 73.

however, only 1.25 million hectares, against the additional irrigation potential of 2.63 million hectares.

The target for major and medium schemes in the Second Plan was 4.20 million hectares, achievement was 50 per cent of

of this.[8] The total irrigation potential remaining to be utilised at the end of Second Plan was 3.2 million acres. During the Third Plan additional irrigation potential of about 13.8 million acres was expected to be created from continuing schemes and 2.4 million acres from new schemes of Third Plan. The total utilisation in the Third Plan period was expected to be 12.8 million acres gross.[9]

During the Fourth Plan, about 4.8 million hectares irrigation potential was to be created, of which 4.7 million hectares were from continuing schemes and 0.1 million hectares from new schemes. Utilisation was expected to be about 3.9 million hectares.[10]

A potential of about 8 million hectares was created from major and medium irrigation sources during the plan period. Of the 8 million, 6 million hectares were to come from ongoing projects, 1.4 million from new schemes, and 0.6 million from modernisation of old scheme.[11] However, additional irrigation potential created during the Fifth Plan was 4.07 million hectares from major and medium irrigation schemes.[12]

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8 Report of the Irrigation Commission. Vol.I, 1972, p.74.

9 Third Five Year Plan. Planning Commission, Government of India, p. 383.

10 Fourth Five Year Plan 1969-74. Planning Commission, Government of India, pp. 251-52.

11 Shyamal Roy. Irrigation Development Under India's New Plan (1978-83), An Appraisal ; Agricultural Situation in India, August 1979, p. 303.

12 Draft Sixth Five Year Plan 1978-83 (Revised), p.236.

The Sixth Plan envisaged a target for creation of an additional irrigation potential of 5.74 million hectares. However, due to resource constraint, the anticipated achievement of additional irrigation potential was 4.0 million hectares.[13]

However, in spite of the constraint, etc. the rate of growth in the irrigation sector has been, on average 2.2 million hectares per year during the Sixth Plan, which represents a sizable improvement on the performance over the earlier plans. The utilisation of irrigation potential created continued to below during the Sixth Plan period, and the gap between potential and utilisation figures has continued to be of the order of about 5 million hectares, for major and medium irrigation schemes. Concerted efforts would, therefore, be necessary during the Seventh Plan period to bridge this gap as far as possible.

Minor Irrigation During Planning Period

The Grow More Food Enquiry Committee recommended in 1952, that priority should be given to new minor irrigation schemes, and to the repairing of existing works. Minor flow irrigation schemes were recommended for a still higher priority.[14]

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13 Seventh Five Year Plan 1985-90. Planning Commission, Government of India, Vol.I, p. 72.

14 Report of the Irrigation Commission, 1972, Vol.I,p.75.

The Committee also suggested that substantial Union Government funds should be earmarked for minor works of high priority. The bulk of the Union Government assistance to agriculture during the First Plan was, therefore, devoted to minor irrigation programmes in the states. An important scheme taken up during the period, was the construction of tube-wells with foreign assistance. In order to mobilise public cooperation and to involve the Community Development Organisation at the district level, the allocation for minor irrigation in the Second Plan were made partly under the Community Development Programme and partly under the agricultural programmes of the states. The outlays on minor irrigation during the first and second plans were Rs.550 million and Rs. 950 million respectively.

The Third Plan laid greater stress on various aspects of the minor irrigation programme, including maintenance repair, renovation, full utilisation of existing works, and the peoples participation in the construction of new works. Problems like salinity and waterlogging in irrigated areas also received attention.

The financial ceiling for individual minor irrigation works hitherto in vogue was Rs. 15 lakhs. It has been decided to increase this ceiling to 25 lakhs in the plains and Rs. 30 lakhs in hill areas with effect from April 1970.[15]

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15 Fourth Five Year Plan 1969-74. Planning Commission, Government of India, p. 253.

On the eve of the Fifth Plan, the total cropped area which was to benefit from minor irrigation was likely to be 23.5 million hectares. In the Fifth Plan an increase of six million hectares was envisaged as against a likely achievement of 4.5 million hectares in the Fourth Plan.[16]

The Sixth Plan envisaged a target of 8 million hectares with a public sector outlay of Rs. 1811 crores. Due to constraint of resources, there has been a marginal shortfall in the target for public sector outlay as compared in the Sixth Plan allocation. The cumulative achievement of potential under this programme by the end of 1984-85 was 37.4 million hectares, which includes an addition to potential of 7.4 million hectares created during the Sixth Plan.[17]

Utilisation of Potential

Table 2.3 indicates the position of utilisation of potential during planning period.

Table 2.3 indicates that so far potential utilisation is concerned performance of minor irrigation is very satisfactory. But the performance of major and medium schemes is far from to be satisfactory. According to N. R. Hota there is often a time lag between creation of irrigation

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16 Draft Fifth Five Year Plan, Planning Commission, Government of India, p. 110.

17 Seventh Five Year Plan 1985-90, Planning Commission, Government of India, p. 77.

Table 2.3 : Irrigation Potential Created and Utilised

(Unit-million hectares)

Year	Major and medium schemes		Minor schemes (including ground-water)	
	Potential	Utilisation	Potential	Utilisation
1950-51	9.7	9.7	12.9	12.9
1968-69	18.1	17.0	19.0	19.0
1973-74	21.4	19.6	23.5	23.5
1979-80	26.5	22.2	30.0	30.0
1980-81	27.3	22.7	31.4	31.4
1981-82	28.2	23.2	32.8	32.8
1982-83	29.1	24.0	34.2	34.2
1983-84	30.0	24.9	35.6	35.6
1984-85	30.9	25.8	37.1	31.7
Ultimate potential	(Maj & Med) 58.5		(Minor) 55.0	Total 113.5

Source : C. B. Mamoria. Agricultural Problems of India, 1979, p. 191 and Rural Development Statistics, 1985, p. 81.

potential and its utilisation.[18] According to him farmers need to adopt to conditions of irrigated agriculture, through education and experience which take some time. According to

18 N. R. Hota. Political Economy of Irrigation in India, Aquaworld, A Monthly on Water from India, December 1986, Table 4, p. 12.

K. N. Kabra, "In an irrigation project, the additional output is raised by a large number of farmers on farms of varying size, under diverse tenurial conditions. The farmers also display many other socio-economic differences having a bearing on their response to and capacity of using new irrigation facilities. It is on account of such factors that there emerges a time lag between the availability of irrigation facilities and their actual use.[19]

The analysis available for major and medium project reveals that the gap between target and achievement of potential has been considerably narrowed down during the Fourth Plan and thereafter as may be seen from Table 2.4.

Table 2.4 : Gap between Targets and Achievement During Plan Periods

(Million hectares)

	Potential	
	Target	Achievement
First Plan	3.4	2.5
Second Plan	4.2	2.1
Third Plan	5.2	2.3
Annual Plans (1966-69)	2.5	1.5
Fourth Plan	2.8	2.6
Fifth Plan	5.8	4.12(74-78)
Sixth Plan	5.74	4.0

Source : Aquaworld, December 1986, Table 4, p.12, For Sixth Plan, Seventh Five Year Plan 1985-90,Vol.I, p.72.

19 K. N. Kabra. of.cit. p. 46 quoted by N. R. Hota, Political Economy of Irrigation in India, Aquaworld,p.12.

As is apparent from Table 2.4 the overall position, however, still remains unsatisfactory.

The Ministers Committee set up in 1973 to study this problem of underutilisation of created irrigation potential gave the following causes for underutilisation.[20]

a) Inadequate planning of the project.

b) Excessive use of wastage of water and efficient distribution system.

c) Neglect of proper operation and maintenance of the irrigation and drainage system.

d) Construction of field channels not keeping pace with water availability facility.

e) Mal-distribution of available supplies.

f) Lack of input and infrastructural facilities.

Committee recommended the stronger political will and administrative support to improve the economy of irrigation by reducing the lag between potential and utilisation. It also recommended the establishment of Command Area Development, need for special legal and financial measures for construction of field channel.

Mitra's study suggests that the percentage of area irrigated to the potential created does not give a correct

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20 Report of the Ministers Committee on Underutilisation of Created Irrigation Potential, June 1973, Part I, p. 58.

measure of the extent of utilisation of irrigation potential.[21] The definition of irrigation potential created assumes that land development (levelling, construction of field channels, etc.) below the outlet head is complete and that the 'Chak' is ready to receive the irrigation water, whereas in actual practice this may not be the case. Secondly, because the cropping pattern that actually develops may be considerably different from that assumed while ascertaining potential created. In view of these two factors, the utilisation percentage may turn out to be lower than it actually is. It would therefore be more meaningful to estimate the extent of utilisation by taking into account the water released compared to the planned release and area actually irrigated. If the water actually released is more or less equal to the planned release during the year and the area actually irrigated is smaller than the area that could have been irrigated on the basis of observed cropping pattern and assumed duty and transmission and distribution losses, than there is underutilisation and that can be estimated by expressing area actually irrigated as percentage of area that could have been irrigated.

Relative Importance of Sources of Irrigation

System of irrigation developed in different parts of

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21 Ashok K. Mitra. Underutilisation Revisited Surface Irrigation in Drought Prone Areas of Western Maharashtra, Economic and Political Weekly, April 26, 1986, Vol.XXI, No.17, p. 756.

the country is governed by local, meteorological, geological and other physical conditions. Therefore, there cannot be any uniformity in the system of irrigation in different tracts. Alluvial tracts in the Gangetic and coastal plains is especially suited for canals and wells; in crystalline areas of the Deccan plateau irrigation from tanks is most extensive and in the northern parts and black cotton tracts of Deccan submontane regions of the eastern and western sides of the Western Ghats and the Punjab a considerable proportion of land is irrigated by wells.[22]

Table 2.5 indicates the relative importance of various sources of irrigation. From the table it may be inferred that the area irrigated by wells and tube-wells is the highest, followed by canals. Tanks supply a comparatively small proportion (8.8 per cent in 1981-82). Other sources are of minor importance, with only 6.5 per cent. This reflects the importance of canal and well irrigation in the economy of irrigation in India.

Ground-water Irrigation

Leslie Abbie, James Q. Harrison, John W. Wall in their World Bank Staff Working Papers observe that ground-water investment is mainly a private investment activity which is determined by financial returns accruing to individuals.

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22 C. B. Mamoria. Agricultural Problems of India, 1979, p. 195.

Table 2.5 : Irrigation Sources (Land irrigated in million hectares)

Source	1950-51	1960-61	1965-66	1970-71	1979-80	1980-81*	1981-82*
Government canals	7.2 (34.44)	9.2 (37.4)	9.9 (37.0)	12.0 (38.5)	13.9 (36.2)	14.5 (37.3)	14.7 (37.0)
Private canals	1.1 (5.26)	1.2 (5.0)	1.1 (4.0)	0.9 (2.8)	0.8 (2.2)	0.8 (2.2)	0.8 (2.1)
Tanks	3.6 (17.0)	4.6 (17.6)	4.4 (16.0)	4.1 (13.2)	3.5 (9.0)	3.2 (8.2)	3.5 (8.8)
Wells and tube-wells	6.0 (28.7)	7.3 (30.0)	8.7 (31.9)	11.9 (38.2)	17.8 (46.3)	17.7 (45.7)	18.1 (45.6)
Others	3.0 (14.3)	2.4 (10.0)	2.5 (11.1)	2.3 (7.3)	2.4 (6.3)	2.6 (6.7)	2.6 (6.5)
Total net irrigated area	20.9 (100.00)	24.7 (100.00)	26.6 (100.00)	31.0 (100.00)	38.5 (100.00)	38.8 (100.00)	39.7 (100.00)

* Provisional

Source : Statistical Pocket Book India 1971, p. 25. Statistical Outline of India 1986-87, p. 59 (Tata Services Ltd. Dept. of Economics and Statistics).

Overtime, however the role of government has expanded through the provision of infrastructure (e.g. rural electrification), subsidy programmes for small farmers, and institutional support for small farmers, and institutional support in the form of technical ground-water services, long term credit for the financing of investment and extension.[23]

Table 2.6 represents data on growth of ground-water development since 1951. These data document the high growth of private tube-wells and growth in the last half of the 1960s and early 1970s, followed by some lessening of the rate of increase, and the rising relative importance of electric pumpsets, which now operate on about 60 per cent of mechanised wells.

According to author, until the mid 1960s the main forces accelerating tube-well development were of a cost reducing kind. Expansion and technical progress in the domestic pump-set and well construction industries brought cheaper and lower capacity equipment on to the market, enabling more small farmers to capture the benefits of private irrigation. Additional stimuli were provided by the spread of cheap power through rural electrification, and rapid progress in the land consolidation in north-western states, together with the emergence of waterlogging problem caused by surface irrigation.

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23 Leslie Abbie, James Q. Harrison, John W. Wall. op.cit., pp. 6-8.

Table 2.6 : Indicators of Ground-water Irrigation Development Since 1951

Period	Dugwells		Private tube-wells		Public tube-wells		Electric pumpsets		Diesel pump-sets	
	Thousands of units (cumulative)	Average annual % change	Thousands of units (cumulative)	Average annual % change	Thousands of units (cumulative)	Average annual % change	Thousands of units (cumulative)	Average annual % change	Thousands of units (cumulative)	Average annual % change
1950-51	3,860	-	3	-	2	-	21	-	66	-
1960-61	4,540	1.6	22	22.1	9	16.2	200	25.3	230	13.3
1968-69	6,100	3.8	360	41.8	15	6.6	1,090	23.6	720	15.3
1973-74	6,700	1.9	1,140	25.9	22	8.0	2,430	17.4	1,750	19.4
1977-78	7,425	2.6	1,700	10.5	30	8.1	3,300	8.0	2,350	7.7
1979-80	7,780	2.4	2,110	11.4	36	9.5	3,950	9.4	2,650	6.2
1984-85 target	8,980	2.8	3,310	9.4	51	7.2	6,460	10.3	3,550	6.0

Note : The electric and diesel pumpsets are used on various types of wells, so that the total number of wells is the sum of dugwells and tube-wells both public and private. The total number of power pumps wells is the sum of diesel and electric pumpsets. Pumpsets are also used for surface lifts (i.e. where no wells exist).

Source : Report of the Working Group on Minor Irrigation for the Sixth Five Year Plan 1980-85, Quoted by Leslie Abbie, James Q. Harrison and John W. Wall, World Bank Staff Working Papers Number 536, 1982, Table 4, p. 7.

After the mid-1960s, the main engine of growth was the greatly enhanced profit from newly available high yielding wheat and rice varieties under conditions of high fertilization and good water management. At the same time, institutional credit for minor irrigation began to grow rapidly. Funds for refinance to and on lending by State Cooperative Land Development Banks and latter commercial banks, were increasingly channeled through the Agricultural Refinance and Development Corporation (ARDC). From negligible levels, ARDC refinance for minor irrigation rose to 50 per cent of total institutional financing for minor irrigation by 1974, and to 90 per cent by 1980-81. This encouraged the growth of ground-water development after mid-1960s.

Regionwise Development of Irrigation

For the purpose of the convenience of the study states have been formed into groups : Southern states, comprising Andhra Pradesh, Karnataka, Kerala and Tamil Nadu, Northern states comprising Haryana, Himachal Pradesh, Jammu and Kashmir, Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh, Western states comprising Gujarat and Maharashtra; and Eastern states comprising Assam, Bihar, Orissa and West Bengal.[24]

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24 Dharam Narayan and Shyamal Roy, Impact of Irrigation and Labor Availability on Multiple Cropping - A Case Study of India, IFPRI, November 1980, p. 15.

Table 2.7 gives the clear picture of regionwise development.

Table 2.7 : Irrigation Potential and Achievement

(Million hectares)

Region	Ultimate irrigation potential			Total potential created upto 1984-85		
	Minor	Major	Total	Minor	Major	Total
Northern states	25.9	27.7	53.6	21.0 (81.00)	14.9 (53.70)	35.9
Western states	5.0	7.1	12.1	3.7 (74.0)	3.0 (42.25)	6.7
Eastern states	13.7	13.4	27.1	6.6 (54.80)	6.2 (46.00)	12.8
Southern states	9.8	10.0	19.8	5.8 (57.20)	6.4 (64.00)	12.2
Total	54.4	58.2	112.6	37.1 (68.00)	30.5 (52.6)	67.6 (60.00)

Note : 1) These four regions include 17 states only.

2) Figures in brackets indicate the percentage of potential created to total ultimate potential.

Source : Statistical Outline of India 1986-87, p. 60.

Tata Services Ltd. Dept. of Economics & Statistics.

Table 2.7 suggests that much of the potential is remained to be exploited. Ultimate irrigation from minor irrigation of all these regions is estimated to be 54.4 million hectares, out of which 37.1 million hectares i.e. 68 per cent is exploited so far. (However, there is some discrepancy in the data as our earlier source states the irrigation potential to be 113.5. But this source gives it as 112.6 million hectares because only 17 states are included). Regarding major and medium irrigation ultimate irrigation potential is estimated to be 58.2 million hectares out of which 30.5 million hectares i.e. 52.6 per cent is exploited so far. Nearly half of the irrigation of this major and medium project is still to be exploited. So far as creation of minor irrigation potential is concerned, the position of Northern state (81 per cent) is quite better followed by Western states (74 per cent). In regard to major and medium irrigation potential created, Southern states (64 per cent) rank first followed by Northern states (53 per cent), Eastern and Western states. This reflects the uneven development of irrigation and its potential creation.

Targets and Achievements in Terms of Area Irrigated and Crops Irrigated in Each Plan Period

Arun S. Patel observes that in each plan the share of the minor schemes and medium major schemes put together in the total targeted area varied. In the first two plans the medium and major schemes constituted more than 50 per cent

share in the total targets. Since then in rest of the plans including 6th plan and three annual plans of 1966-69, except the fifth one, this share went down below 50 per cent, while that of minor irrigation schemes went upto more than 50 per cent.[25] Table 2.8 makes the position clear.

Compared to targets the statistics of achievement are more noteworthy. Looked from this angle, the share of minor schemes put together was higher than 70 per cent in all the plans except the second and fifth ones. In the second plan and the fifth plan the corresponding shares worked out to 63 per cent and 48 per cent respectively. Thus from the point of view of achievements the minor schemes remained ahead of the other ones.

A difference observed in respect of targets and achievements pinpoints that the achievement are very low in respect of medium and major schemes. For these schemes the achievements in the first three plans were lower than 56 per cent of targets. In the period of 1966-69 it was 61 per cent, while in the Fourth Plan and Fifth Plan it was 53 per cent and 95 per cent respectively. Thus except in the Fifth Plan the progress in respect of the medium and major irrigation schemes remained limited. The position thus obtained was mainly due to (1) the higher target kept at the

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25 Arun S. Patel. Irrigation in India - Scope and Importance, The Economic Times, 18 July 1985.

Table 2.8 : Irrigation Projects - Targets and Achievements

Types of irrigation project	First Plan 1951-56	Second Plan 1956-61	Third Plan 1961-66	Annual Plan 1966-69	Fourth Plan 1969-74	Fifth Plan 1974-79	Sixth Plan 1982-83 over 1979-80
1. Medium & major schemes target	3.50	4.90	4.50	2.54	4.77	5.80	6.93
2. Minor scheme target	3.35	3.64	5.16	4.30	7.20	5.00	4.33
3. Total (1+2) target	6.85	8.54	9.66	6.84	11.97	10.80	11.22
4. 1 — 3 x 100	51.09	57.38	46.58	37.13	39.85	53.80	67.35
5. 2 — 3 x 100	48.91	42.62	53.42	62.87	60.15	46.20	32.65
6. Achievement of medium and major scheme	1.30 (37.14)	2.10 (42.86)	2.10 (46.67)	1.54 (60.63)	2.55 (53.46)	5.50 (94.83)	-
7. Achievement of minor schemes	3.83 (114.33)	3.64 (100.00)	5.20 (100.78)	4.05 (91.19)	8.23 (100.42)	5.00 (100.00)	-
8. Total (6+7) achievement	5.13 (74.89)	5.74 (67.21)	7.31 (75.67)	5.59 (81.73)	9.78 (81.70)	10.50 (97.22)	-
9. 6 — 8 x 100	25.34	36.50	28.73	27.35	26.07	52.38	-
10. 7 — 8 x 100	74.66	63.41	71.27	72.45	73.93	47.62	-

Note : Figures in parentheses indicate percentage to targets.

Source : Arun S. Patel. Irrigation in India, Economic Times, July 18, 1985, p. 7.

time of planning, and (2) the obstacles in the implementation of these schemes.

In respect of minor irrigation schemes, the targets were either fully achieved, more than fully achieved or marginally lagged behind during the different plan periods. This is because the problem generally faced in the implementation of medium and major schemes do not appear in respect of minor schemes. In short, in terms of achievements minor schemes remained important in India.

Progress in Irrigated Area and Gross Cropped Area in India

After discussing targets and achievements, an attempt is made here to look into the actual progress in irrigation in the country. Arun S. Patel uses the three different indicators to judge this progress.[26]

1) Proportion of gross cropped area under irrigation,

2) Cropping intensity or the proportion of area under two or more crops in net cropped area, and

3) The proportion of irrigated area under two or more crops to net irrigated area to net irrigated area.

Table 2.9 indicates the picture at the all India level in respect of the above 3 indicators.

Table 2.9 indicates that in 1951-52 the irrigated area

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26 Ibid., p. 7.

Table 2.9 : Progress in Irrigated Area and Gross Cropped Area During 1950-51 to 1983-84

Year	Area under sowing			Area under irrigation		
	Total	Net	Area under two/more crops	Total	Net	Area under two or more crops
1951-52	133.23	119.40	13.83	23.18	21.05	2.13
1955-56	147.31	129.16	18.15	25.64	22.76	2.88
1960-61	152.77	133.20	19.57	27.98	24.66	3.32
1965-66	155.28	136.20	19.08	30.90	26.34	4.56
1968-69	159.53	137.31	22.22	35.48	29.01	4.47
1973-74	169.56	142.76	26.80	40.22	32.49	7.73
1975-76	171.16	142.25	28.91	42.94	34.45	8.49
1978-79	175.18	142.94	32.24	48.09	37.96	10.13
1982-83	181.00	145.00	36.00	66.00	-	-
1983-84	177.05	143.00	34.05	54.02	41.00	13.02

Source : Estimates of Area under Production of Principal Crops in India, 1981-82, Directorate of Economics and Statistics, Ministry of Agriculture and Irrigation, New Delhi, Quoted by Arun S. Patel, Economic Times, 18 July 1985, p. 7.

Figures for 1983-84 are taken from Statistical Outline of India, 1984, p. 55 and 1986-87, p. 58.

constituted 17.40 per cent of gross cropped area (GCA) which increased to 36.46 per cent in 1982-83. Thus in 1982-83, 36 per cent of GCA obtained irrigation facilities, which in other words means that still 64 per cent of our gross cropped area was left dry. The area under two or more crops constituted 12 per cent of net cropped area which was 25 per cent in 1982-83, indicating thereby a single cropping in 75 per cent of net cropped area even after more than 32 years of development.

Author also points out that the character of our irrigation is such that most of the irrigated area in our country gets water in one season only. In 1979-80 out of total irrigated area only 25 per cent obtained water for two or more crops, while the rest 75 per cent obtained water only for one crop season.[27]

After reviewing the literature regarding the development of irrigation, we propose to examine the effect of irrigation on production. This effect of irrigation on production is brought about by increase in area under cultivation (area or acreage effect), increase in productivity per hectare (yield effect), and change in crop mix (cropping pattern effect).

In the next chapter we shall examine the effect of irrigation on production brought about by increase in area under cultivation or area effect.

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27 Ibid.

CHAPTER III

AREA EFFECT OR ACREAGE EFFECT OF IRRIGATION

It is generally said that irrigation helps to expand area under cultivation. Irrigation could increase the area under cultivation in following ways.

1) It helps to bring new land under cultivation; (which are otherwise fallow or barren).

2) It makes cultivation possible in dry seasons thereby help to raise more than one crop from the same piece of land.

3) It helps farmers to adopt new technologies which provide opportunities to grow short duration crops, and thereby makes multiple cropping possible.

However, it should be mentioned that expansion of gross cropped area (GCA) is not necessarily caused by irrigation alone. There are other factors also which cause growth in gross cropped area e.g. population pressure. Prof. V.K.R.V. Rao observed this fact in his Panse Memorial Lecture at the 27th Annual Conference at the Indian Society of Agricultural Statistics. He said "contrary to popular impression, it is not only irrigated area that is capable of having more than one crop. India has large area under double cropping, that

is not irrigated but only rainfed and that is, in fact, substantially larger than irrigated area under double cropping."[1]

But there are limitations in raising more than one crop in unirrigated land on a large scale. Double cropping is possible only in areas endowed with suitable climatic conditions and assured rainfall. Except in kharif season, rainfall in most parts of India is highly uncertain and the risk in growing a second crop, at least in rabi or summer season, must be very high. Irrigation eliminates such risk and can make double or multiple cropping possible.

According to T. Satpathy, an impact of irrigation through which it increases the gross sown acreage is called its "area effect". This phenomenon consists of two components. First increase in net sown area which becomes possible on account of irrigation facilitating reclamation of waste land and extending cultivation to hitherto uncultivated land. Second increase in total cropped area that arises out of irrigation encouraging intensive cultivation of currently cultivated land, that is the index of cropping intensity. Both these components through positive interaction lead to absolute increase in gross cropped area and thereby cause "area effect".[2] He referred to Ghosh's

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1 S. P. Pal. Contribution of Irrigation to Agricultural Production and Productivity, NCAER, February 1985, p.35.

2 T. Satpathy. Irrigation and Economic Development, Orissa, 1984, p. 36.

study in this context according to which "acreage effect" operated in Punjab and in regions served by Rajasthan canals where the cultivated areas increased significantly on account of reclamation of waste land and progressive decline in fallow land consequent upon the availability of irrigation water.

Author studied the irrigation and economic development in the State of Orissa. According to him the first component of area effect is not much effective in Orissa in which irrigation facilitates reclamation of waste land and extends cultivation hitherto uncultivated area. For example, in 1967-68 irrigated area in Orissa was 587 thousand hectares, and the total cultivated area was 6687 thousand hectares. But in 1980-81 while irrigated area went upto 1197 thousand hectares i.e. by about 104 per cent, the cultivated area went upto 6771 thousand hectares i.e. merely by 1.4 per cent.[3] This has been largely because land reclamation has not been undertaken in extensive scale in the state.

However, the second important component of "area effect" that is increase in gross cropped area resulting from higher crop intensity is evident. Gross cropped area in Orissa increased from 6761 thousand hectares in 1970-71 to 8746 thousand hectares in 1980-81. Cropping intensity

3 Statistical Abstract of Orissa, 1977, p. 59 and Orissa Agricultural Statistics 1980-81, p. 3.

has been increased from 120.71 to 142.68 during the same period.[4] This increase in cropping intensity is mainly due to the summer irrigation facilities in the state during the period.

Thus above analysis leads to the conclusion that irrigation has facilitated the double/multiple cropping and helped to expand area under cultivation or gross cropped area.

Dharam Narayan and Shyamal Roy are of the view that in India expansion of cultivated area, which made an important contribution to the growth of agricultural output in the 1950s has declined over the years.[5] Table 3.1 shows that the growth of net sown area slowed from 1.0 per cent per annum (compound) in the 1950s to 0.4 per cent in the 1960s and to only 0.12 per cent in the five year period ending in 1975-76. The progress of cropping intensity via the spread of multiple cropping proceeded at a slow pace. The index of multiple cropping or cropping intensity is defined as gross cropped area as a percentage of net sown area. It grew by a meagre 0.26 per cent per annum between 1950-51 and 1975-76. The annual increase was about the same in the 1950s and the 1970s (0.36 and 0.38 per cent respectively),

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4 Orissa Agricultural Statistics 1980-81, p. 19.

5 Dharam Narayan and Shyamal Roy, Impact of Irrigation and Labour Availability on Multiple Cropping - A Case Study of India, IFPRI, November 1980, Research Report 20, p. 9.

Table 3.1 : Growth Rates of Area, Cropping Intensity and Productivity

Period	Net sown area	Gross cropped area	Index of cropping intensity	Index of productivity
1950-51 - 1960-61	1.16	1.52	0.36	
1960-61 - 1970-71	0.40	0.62	0.22	
1971-72 - 1975-76	0.12	0.50	0.38	
1950-51 - 1975-76			0.26	
1950-51 - 1964-65				1.64
1964-65 - 1975-76				2.33

Source : Dharam Narayan and Shyamal Roy. Impact of Irrigation and Labour Availability on Multiple Cropping - A Case Study of India, IFPRI, November 1980, p.9.

while it was significantly lower in the 1960s (0.22 per cent). Without improvement in the growth rate of cropping intensity, the rate of expansion of gross cropped area, now mostly reflecting the spread of multiple cropping, dropped to 0.5 per cent per annum in the 1970s from a level of 1.5 per cent per annum in the 1950s. The growth of productivity per unit of gross cropped area did improve, especially after the introduction of the high-yield varieties of seeds, but

the degree of improvement was not sizable enough to accelerate the growth of agricultural output by more than enough to make up for the slow down in the expansion of area.

According to the authors growth in net sown area is almost petered out, therefore if annual increase of 4.0 per cent in agricultural production is to be achieved multiple cropping should be resorted to. This multiple cropping is made possible by irrigation. Though on unirrigated farming multiple cropping or double cropping could be practised but it has certain limitations. Authors further point out that irrigation has not only quantitative aspect but also a qualitative dimension. Unless the source of irrigation is capable of ensuring water supply in the post-monsoon period, it would be of little help in raising a dry season crop. Thus in increasing the multiple cropping and thereby gross sown area, along with the availability of irrigation facilities they stress on quality of irrigation.

V. M. Jakhade and T. R. Sundaram also visualise the effect of irrigation, the expansion of gross cropped area and net sown area.[6] They explain it in their essay 'Role of Agriculture in the Indian National Economy' with the help of Table 3.2.

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6 M. L.Dantwala and Others. Indian Agricultural Development Since Independence, Indian Society of Agricultural Economics 1986 - A Collection of Essays, p. 46.

Table 3.2 : Gross Cropped Area, Irrigated Area and Index of Cropping Intensity

(Million hectares)

Particulars	1950-51	1960-61	1970-71	1975-76	1980-81
Net sown area	118.74	133.20	140.86	141.57	140.27
Area sown more than once	13.15 (10.00)	19.57 (12.8)	24.93 (15.00)	29.72 (17.4)	33.05 (19.1)
Gross cropped area	131.89 (100.00)	152.77 (100.00)	165.79 (100.00)	171.30 (100.00)	173.32 (100.00)
Gross irrigated area	22.60	27.98	38.50	43.36	49.58
Index of intensity of cropping*	93.7	98.3	100.9	103.1	104.4

* Base : Triennium ending 1969-70 = 100

Source : Dantwala and Others (1986). Article 2, Jakhade & Sundaram, Table 13, p. 46.

According to authors net sown area has steadily increased from 118.7 million hectares in 1950-51 to 140 million hectares in 1980-81. Although depending on the rainfall and climatic conditions, there are fluctuations in areas sown from year to year; it is estimated that net sown area in the country increased by about seven per cent during

the five years ending 1955-56, by about three per cent between 1955-56 and 1960-61 and by about 2.2 per cent during the next five years ending 1965-66.[7] During the period between 1970-71 and 1978-79 it fluctuated between 138 million hectares and 143 million hectares.

The extension in net sown area during the planning era has been possible because of land reclamation operations, reduction in fallow lands and appreciable decline in culturable waste, as a result of virgin lands coming under cultivation on account of new irrigation projects, adoption of soil conservation measures, etc. Since the rainfall in India is highly seasonal and unpredictable and thus a substantial proportion of rain-water is drained away to the sea through rivers. In many areas because of soil structure, retentivity of soil is poor and the percolation is not adequate to enlarge the underground water resources. Therefore, taking more than one crop on the same piece of land in the same agricultural year depends mainly on the availability of irrigation water through canals, wells etc. Furthermore more intensive land use would be possible if short duration maturing varieties of crops become available. Table 3.2 shows that during the period 1950-51 to 1980-81 there was an increase of about 20 million hectares in the area cropped more than once. The index of intensity

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7 Ibid., pp. 200-201.

of cropping which was 93.7 in 1950-51 increased to 100.9 in 1970-71; it ranged from 102 to 104.7 between 1975-76 and 1979-80. However, the gross cropped area did not increase significantly from 1950-51 to 1980-81 i.e. from 131.89 to 173.32 nearabout 42 million hectare or 31 per cent during the thirty year period. Though the gross cropped area did not increase significantly from 1950-51 to 1980-81 area sown more than once increased by two and half times during the same period. As author already indicated the seasonal and unpredictable nature of monsoon in India, one can come to the conclusion that increase in gross irrigated area from 22.60 million hectares to 49.58 million hectares i.e. more than double increase in gross irrigated area would have contributed to the expansion of gross cropped area along with increase in short duration maturing varieties, mostly requiring assured irrigation water.

S. K. Tewari studied the cropping intensity, irrigation and farm size in the plains of Uttar Pradesh for forty seven districts.[8] Data on cropping intensity, percentage gross cropped area irrigated, and percentage area under small, medium and large size farms were derived from the publication entitled "Agricultural Census in Uttar Pradesh, 1970-71", published by Board of Revenue, U.P.Lucknow. The correlation of

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8 S. K. Tewari. Cropping Intensity, Irrigation and Farm Size in the Plains of U.P. Agricultural Situation in India, December 1982, p. 583.

cropping intensity with percentage gross cropped area irrigated, percentage area under small farms and medium farms was found to be positive and significant whereas with percentage area under large farms, it was found to be negative and significant. He also projected cropping intensity at different levels of percentage gross cropped area irrigated, Ceteris Paribus for U.P. plains which is given in Table 3.3.

Table 3.3 : Projected Cropping Intensity at Different Levels of Percentage Gross Cropped Area Irrigated for U.P. Plains

Gross cropped area irrigated (percentage)	Cropping intensity
40	134.5
50	139.1
60	143.7
70	148.3
80	152.9
90	157.5
100	162.1

Source : Agricultural Situation in India, December 1982-83, p. 584.

He thus concludes that irrigation has a positive and significant impact upon cropping intensity in U.P. plains.

Small size farms contribute positively in attaining the higher level of cropping intensity in U.P. plains.

Dhawan questions the simplistic assumption of the role of irrigation that has given rise to an expectation of one to one correspondence between incremental gross cropped area and expansion in irrigated acreage. That is, if an addition of 'x' hectares is reproduced in irrigation facility during a given time span, a naive expectation of 'x' hectares addition to gross cropped area is raised.[9]

But he explains that the realisation of one to one correspondence between irrigation and cropping intensity can occur under very particular situation such as

(1) irrigation facility is created for the dry season only when rainfed farming also continues in a tract and

(2) though irrigation is for the main crop season only, say for irrigated paddy during kharif season, yet it incidentally promotes the cultivation of an unirrigated. pulse crop during the ensuing rabi season on the residual moisture of the heavily irrigated paddy field.

But sometimes farmers may find it more remunerative to grow such long duration crops (sugarcane, bananas, cotton, chillies, ginger etc.) instead of two or three consecutive crops of one season duration once their access to water

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9 B. D. Dhawan. Questionable Conception and Simplistic Views about Irrigated Agriculture in India, Indian Journal of Agricultural Economics, Jan-March 1985, pp. 1-13.

changes for the better. If this perception of farmer behaviour is correct, it is futile to expect one to one correspondence between irrigation and intensity of cropping even in apparently favourable situation.

Therefore according to B. D. Dhawan, given the vast diversity of agro-climatic conditions, on the one hand and the great variety of irrigation means, on the other, it is totally unwarranted to visualise uniform relationship or correspondence between irrigation availability and intensity of cropping for the country as a whole.

He further says that the expected increment in the intensity of cropping consequent upon one percentage point rise in irrigation availability (measured by percentage of gross irrigated area to net cropped area) may be reackoned as follows.

	Percentage points
1) North India and Western India (Rajasthan & Gujarat)	0.66
2) East India and Maharashtra	0.33
3) South India	0.25
4) All India	0.48

Source : Indian Journal of Agricultural Economics, January-March 1985, p. 5.

Thus, for the country as a whole it is fair to expect that one percentage point rise in irrigation availability may be accompanied by almost half a percentage point rise in the intensity of cropping. Hence there is no ground for considering one to one correspondence between irrigation and cropping intensity. So this misconception must be removed. However, one can conclude from the above analysis that though cropping intensity does not increase in the same proportion as in the increase in irrigation availability, it does affect to some extent or partly on cropping intensity and thereby giving rise to multiple cropping or gross cropped area.

S. K. Basu and S. B. Mukerjee in their study - A Study of the Benefits of Damodar Canal (1959-60) also support the view that irrigation leads to the expansion of double cropped area.

There are two types of canals in the Damodar Command Area : (1) canals included in the Old Damodar and Eden Canal systems which have been in operation for a minimum period of 25 years. (2) new canals excavated in recent years by the Damodar Valley Corporation. The number of villages irrigated by the Old System is 537, and that irrigated by New System is 1610.

The command area has been divided into two zones. Zone I is composed of the villages irrigated for more than

25 years from the old canal system. Zone II is composed of the villages which started getting canal water from the New Canal System two or three years back and which may have reaped some of the short-term benefits of irrigation but have not evidently reaped the long term benefits. The authors have also taken Zone III which consist of non-irrigated villages in order to compare the situation between irrigated and non-irrigated villages.

According to author there is a considerable difference between the average percentage of double cropped area in the irrigated zones than in the unirrigated zone, namely 10.5 per-cent and 12.6 per cent in Zone I and II and 3.9 per cent in Zone III.[10] This analysis leads to the conclusion that irrigation facilities lead to expansion of gross cropped area.

Divakar Jha is also of the opinion that irrigation results in expansion in gross cropped area by causing double cropping.[11] He has attempted to assess the entire direct and indirect benefits of irrigation derived from the Tribeni canal in the district of Champaran (Bihar). The result of this report have been based on an intensive survey of farm households.

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10 S. K. Basu and S. B. Mukherjee, Evaluation of Damodar Canals (1959-60) - A Study of the Benefits of Irrigation in the Damodar Region, pp. 16 & 140.

11 Divakar Jha. Evaluation of Benefits of Irrigation Tribeni Canal Report 1967, pp. 72 & 461.

The survey has revealed that there is a greater degree of land utilisation and more double cropping farming in the project area than in the control area. The net area sown to the total cultivated area was 99.42 per cent in the irrigated zone and 97.06 per cent in the non-irrigated zone in the year of enquiry. Double cropping is practised in 30.52 per cent of the area in the irrigated zone and 13.95 per cent in the non-irrigated zone. Fallow land is negligible in both the project and control areas. This difference in land utilisation between project and control areas reflect the effect of irrigation on gross cropped area or intensity of land utilisation.

However, the National Council of Applied Economic Research has reported that the Sarda Canal System, has not led to any increase either in the area under cultivation or in double cropping. It concluded that the introduction of Sarda Canal has not brought benefits by way of increasing the gross area under cultivation and the distribution of the sown area between kharif and rabi. The only change that has been brought about in the crop pattern is an increase in the area under sugarcane which occupied nearly 3 per cent of the net area cultivated in 1921-26 and now occupies about 5 per cent to 6 per cent of it. But the total area under cash crop including sugarcane has remained limited to 7 per cent of the net area cultivated which means that

sugarcane has largely replaced the other cash crops particularly poppy and indigo.[12] They also report no significant change whatsoever in average yield per acre or in the total area under irrigation. It is pointed out that, "the introduction of the Sarda Canal has given benefits in two respects.

1) it has increased the area under sugarcane from 3 per cent to 7 per cent of the net cultivated area;

2) it has made it possible to irrigated land by canals instead of by wells or tanks.

Singh and Misra conducted a separate study of cost benefit of Sarda Canal System. They observe that their findings closely confirm the findings by NCAER. They have studied the changes in the cultivated and irrigated area since the introduction of canal in the 14 districts irrigated by it and have analysed the changes separately for those districts where there is substantial canal irrigation and others where canal irrigation is limited to 6 per cent or less of the cultivated area. For conditions before the introduction of Sarda Canal they have taken the averages of the three years before its construction and have compared these with the averages of the cultivated area in the three years ending with 1956-57. For comparing the changes in

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12 Baljit Singh and Shridhar Misra, Benefit Cost Analysis of the Sarda Canal System, 1960, p. 57.

respect of irrigated area a five yearly average from 1921-26 has been taken as the base and compared with last two years.

The net cultivated area has registered an increase of nearly 12 per cent in all the 14 districts taken together during the last 30 years. But the increase has been greater i.e. 13.1 per cent in the five district with little canal irrigation than in other districts (11.1 per cent) where there has been substantial canal irrigation. The conclusion is inescapable that the introduction of Sarda Canal irrigation has not led to any increase in the net area cultivated.

The impact of canal irrigation on the double cropped area has also been negligible. The double cropped area has registered an increase of 13.6 per cent in all the 14 districts taken together. The increase in five districts with little canal irrigation is, however, very much higher amounting to 22.4 per cent than in the district with substantial canal irrigation where it is only 3.7 per cent. It is thus obvious that there has been no increase in the double cropped area due to irrigation provided by Sarda Canal.

The authors therefore conclude that the gross cultivated area has remained unaffected by the introduction of the Sarda Canal. According to authors Sarda Canal irrigates a region which is quite backward in relation to other parts of the state. The water is not fully being utilised because

of the small size of the market for irrigation water resulting from low farm incomes, lack of simultaneous development of social and economic overhead and absence of any improvement in farming and cropping practices. The Sarda Canal has failed to create its own demand. Therefore gross cropped area could not be increased in spite of the availability of irrigation facilities.

The above discussion of effect of irrigation on gross cropped area or acreage effect is generally related to surface irrigation (major/medium irrigation projects) which leads us to conclude that though irrigation is likely to expand area under cultivation, it does not necessarily result in increase in area under cultivation and gross cropped area.

Now let us examine the effect of minor sources of irrigation on the cropping pattern. Study conducted by H. Laxminarayan regarding the evaluation of investment on tube-wells and land development in Sangrur district in Punjab comes to the conclusion that irrigation leads to expansion in area cultivated and gross cropped area.[13]

Energisation of tube-wells has helped in reclaiming Kellar land and bringing more area under cultivation in the Sangrur district. As a result the total cultivated area

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13 H. Laxminarayan. Evaluation of Investment on Tube-wells and Land Development in Sangrur District of Punjab, Agricultural Economics Research Centre, Delhi, 1985, p. 22.

increased from 779 acres to 1,043 acres that is by 34 per cent. Uncultivated area as a percentage of cultivated area, declined from 49.8 per cent before introduction of irrigation to 7.7 per cent after introduction of irrigation. Table 3.4 indicates the growth in irrigated area, gross cropped area and cultivated area. Percentage irrigated area increased by 59.08 per cent, gross cropped area increased by 68.07 per cent and cultivated area increased by 34.01 per cent. Cropping intensity per household increased from 1.48 per cent before irrigation to 1.86 per cent after irrigation which suggest the effect of irrigation on gross cropped area.

W. B. Donde studied the benefits of irrigation in the drought/famine prone districts of Haryana : Bhiwani and Mohindergarh. Study relates to minor irrigation. He came to the conclusion that irrigation results in the expansion of gross cropped area. In the before and after situation the difference in the irrigated area is more by 13 acres than the difference in the unirrigated area.[14] This is indicated from Table 3.5.

After the irrigation facility was created it became possible for some to take on lease adjoining land which their facility could also irrigate. As a result of irrigation facilities, the reduction in the unirrigated area is

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14 W. B. Donde. Benefits of Irrigation-Agricultural Situation in India, August 1985-86, pp. 377-379.

Table 3.4: Irrigated Area, Gross Cropped Area Cultivated Area (Before and After Irrigation)

(Figures in acres)

Size of holding	Irrigated area		% increase in irrigated area	Gross cropped area		% increase in GCA	Cultivated area		% increase in cultivated area
	Before	After		Before	After		Before	After	
0.0- 5.00	23.00	28.75	25.00	48.00	57.50	19.79	27.00	28.75	6.48
5.01-10.00	110.50	135.00	22.17	178.00	262.50	47.47	124.00	136.00	9.68
10.01-20.00	342.50	509.00	48.61	653.00	948.50	45.25	408.50	515.00	26.07
20.01 and above	171.00	356.50	108.48	273.50	668.50	144.42	219.00	363.50	65.98
Total	647.00	1029.25	59.88	1152.50	1937.00	68.07	778.50	1043.25	34.01

Source : H. Laxminarayan. Collected from Evaluation of Investment on Tube-wells and Land Development in Sangrur District of Punjab, Table 11, p. 22.

Table 3.5 : Land Utilisation Before and After Irrigation

(Area in acres)

	One year before irrigation	In the survey year(after irrigation
Cultivated area	693	706
Net irrigated area	205	519
Gross irrigated area	396	1,002
Net unirrigated area	488	187
Gross unirrigated area cropped	488	187
Gross cropped area irrigated and unirrigated	884	1,189

Source : Agricultural Situation in India, August 1985-86, p. 377.

substantial. The area as it was mentioned is drought prone and if there are no rains or inadequate rains, the undulating land remained uncultivated. The cultivators and officials reported that the unirrigated area remained uncultivated in three years out of five years. So the productive years are only two in five years.

The relevant parts of Table 3.5 could then be restructured as given in Table 3.6.

Table 3.6 : Average Cropped Area in a Cycle of Five Years

	Before irrigation	After irrigation
Gross irrigated land in 5 years	396.5	1,002 x 5
Gross cultivated unirrigated land in 5 years	488.2	187 x 2
Total in 5 years	2,956	5,384
Average cropped area per year	591	1,077

Source : Agricultural Situation in India, August 1985, p. 377.

The picture changes from 884 acres cropped area in one year before irrigation to 591 acres cropped area before irrigation when three out of five are years of failure of rains. Since some part of the holding continues to be unirrigated even after the installation of irrigation facility, it also is cultivated only in two years out of five. The result is that the average gross cropped area after irrigation is 1,077 acres instead of 1,189 as before.

Gross cropped area after irrigation is 1.35 times or 135 per cent of gross cropped area before irrigation according to Table 3.5. And according to Table 3.6 it is 1.82 times or 182 per cent. Nothing really has changed

except that in the calculation of Table 3.6 average of gross cropped area in 5 years has been taken. And when this is done, unirrigated area is presumed to be productive in only two years as the drought or famine conditions rendered unirrigated area uncultivable in the three years. Table 3.5 is not faithful to reality while Table 3.6 comprehends the real change. Thus we can conclude that though here gross cropped (irrigated) area increases substantially there is no one to one correspondence between increase in irrigation facilities and gross cropped area.

Study report of the impact of three irrigation bunds in tehsil Narnaul (District Mahendragarh) of the Government of Haryana reveals the fact that irrigation results in increasing the double/multiple cropping and results in increase in gross cropped area.[15] Report states that in village Ropar Sarai area sown more than once increased from 227 acres in 1963-64 to 287 acres in 1968-69. In village Meghot Binja area sown more than once increased from 90 acres in 1963-64 to 244 acres in 1968-69. This is quite substantial change.

From the preceding discussion the conclusion that emerges is area effect of irrigation is less pronounced in

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15 Study Report of the Impact of Three Irrigation Bunds in Tehsil Narnaul, Dist. Mahendragarh, 1972, Government of Haryana, Publication No. 101, pp. 2 & 5.

case of surface irrigation (major and medium) but it is more pronounced in case of minor irrigation.

Ownership of sources of irrigation do play an important role in this context. Major and medium projects are publicly owned. Irrigation facilities developed as a result of construction of irrigation project varies from project to project. Provision of water from these projects depend upon the availability of water in the reservoir, water distribution policy of the government, cropping pattern of the concerned region, development of infrastructure in the command area etc. These sources are beyond the control of individual farmers.

But sources of minor irrigation like dug-wells, tube-wells (private) are generally privately owned. Area covered by these sources is smaller compared to surface irrigation, which serves large areas running into thousands of hectares. Therefore farmer can command the best use of water from minor sources as compared to major and medium sources. Therefore these sources are likely to result significantly in increase of area under cultivation and gross cropped area. This is not to say that surface irrigation does not result in expansion of land under cultivation and gross cropped area, but as said earlier, it only meant that its effect is less pronounced than minor irrigation.

After reviewing the literature regarding the area effect of irrigation an important component of production effect of irrigation, in the next chapter we will examine literature regarding the other important component i.e. yield effect of irrigation.

CHAPTER IV

YIELD EFFECT OF IRRIGATION

It is generally said that irrigation has positive effect on yield. Table 4.1 exhibits such positive yield trend as a result of increase in irrigation facilities.

However, with the advent of other yield raising technological inputs, viz. fertilizers and HYV seeds in recent years, the question has been raised regarding the relative importance of irrigation vis-a-vis other technological inputs. It has been found that areas naturally endowed with good rainfall and using fertilizer and HYV seeds sometimes yield more output even without artificial irrigation (this may be true of some kharif crops in eastern and north eastern India). Although such examples are exceptions rather than the rule, they do raise a question regarding the relative importance of various technological inputs in different agro-climatic conditions.[1]

However, the question of relative importance of these inputs has remained unanswered or at best has been partially answered, primarily because of lack of an appropriate methodology to evaluate the contribution of each input to

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1 S. P. Pal. Contribution of Irrigation to Agricultural Production and Productivity, NCAER, February 1985, p. 1.

Table 4.1 : Yield Effect of Irrigation

Year	Rice		Wheat		Coarse cereals		Total pulses		Nine oilseeds		Cotton		Sugarcane	
	Yield kg/ hect	% coverage under irrigation	Yield kg/ hect	% coverage under irrigation	Yield kg/ hect	% coverage under irrigation	Yield kg/ hect	% coverage under irrigation	Yield kg/ hect	% coverage under irrigation	Yield kg/ hect	% coverage under irrigation	Yield kg/ hect	% coverage under irrigation
1950-51	522	18.1	663	34.0	408	7.9	441	9.4	481	-	88	8.2	34,422	67.3
1955-56	605	18.5	708	32.0	449	8.0	476	8.4	474	2.4	88	10.0	32,779	67.2
1960-61	710	19.1	851	32.7	528	7.7	539	8.0	507	3.2	125	12.7	45,549	69.3
1964-65	757	20.2	913	36.8	514	7.3	520	9.2	561	3.4	122	15.5	46,838	71.5
1969-70	805	23.7	1,209	51.1	578	9.4	531	9.4	522	6.1	122	16.4	49,121	75.5
1975-76	944	26.5	1,410	61.8	694	9.9	533	7.9	527	7.9	138	23.5	50,903	78.0
1982-83	1,035	30.7	1,816	72.4	685	8.6	519	7.9	563	14.9	163	29.5	56,441	79.2

Source : Agricultural Statistics At A Glance. Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, April, 1986, pp. 9,11,13,21,27,36,40.

agriculture. Technological inputs to agriculture are complementary to each other in such a way that measuring their individual contribution is extremely difficult.

Understanding their relative importance has important policy implications and any misconception regarding the relative importance of these inputs may lead to mal-allocation of resources and lopsided development. Thus if HYV seeds and fertilizers are thought to be more important than irrigation, government policies would obviously be directed towards:

a) developing new seed varieties which are fertilizer responsive, and

b) giving incentives to farmers to use more fertilizers and the like.

These measures though important, are by themselves not sufficient for a sustained growth of agricultural production as they would lead to development mainly in areas where the agricultural infrastructure is developed enough to absorb such changes. The Indian experience suggests that though the HYV fertilizers package yielded quick gains in the late sixties, agricultural growth is not sustainable without the development of other complementary inputs mainly irrigation.[2]

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2 Ibid., p. 2.

B. D. Dhawan makes a distinction, between 'contribution of irrigation factor alone' and 'impact of irrigation'. Since the sole contribution of irrigation factor cannot be satisfactorily disentangled from the contributions of other factors that are inherently complementary with irrigation, quantification of irrigation impact in practice subsumes the contribution of these other factors. This distinction is of particular relevance in situations in which irrigation is viewed as an alternative instrument of agricultural growth, say to fertilizers or farm price support policy.[3]

It is often said that irrigation induces the use of other inputs and hence the entire increase in production in irrigated agriculture should not be attributed to irrigation alone. How could then one measure the contribution of irrigation to agricultural production? Should we say that increase in production in irrigated agriculture over the unirrigated agriculture without the use of other complementary inputs, is the net contribution of irrigation? Availability of irrigation changes the entire production process because of the inevitable complementarity of technological inputs in agriculture. Thus consideration of only the direct contribution of water to agricultural production is meaningless.[4]

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3 B. D. Dhawan. Irrigation Impact on Farm Economy, Economic and Political Weekly, September 1985, p. A-124.

4 S. P. Pal. op.cit., p. 2.

Since it is not very meaningful to assess the contribution of irrigation factor alone we are dealing here with the impact of irrigation as suggested by Dhawan.

Now let us examine how the effect of irrigation on production operates through the impact of irrigation on yield.

Impact of Irrigation on Yield

Irrigation is known to enhance productivity. However, the force of the impact of irrigation on yield varies across agro-climatic region, and depends to a considerable extent, on the farmers ability to use modern yield-raising inputs like fertilizers and HYV seeds. Differences in the quality of irrigation other things remaining the same may also lead to wide variations in the yield impact of irrigation across farms and agro-climatic zones.

As there are number of factors besides irrigation which can bring about yield variation measuring the impact of irrigation is a difficult task. Theoretically the net effect of irrigation on yield should be studied by comparing the yield differences between irrigated and unirrigated lands only after eliminating the sources of variation in yield both on account of technical and non-technical factors. However, the yield difference due to some technical factors cannot be isolated as their role is more often than not, complementary to irrigation. Moreover, under the field

conditions it is not possible to get observations which would enable one to test a hypothesis under the ceteris paribus clause, even if the observations are chosen from a fairly homogeneous group. Thus an accurate measurement of the contribution of irrigation to yield is possible only under a controlled experiment.[5]

The macro level information on yield under irrigated and unirrigated lands available from the secondary statistics could only qualitatively indicate that the contribution of irrigation to yield is positive but prevents one from drawing any quantitative conclusions as the associated relevant information on the quality of irrigation, the doses of yield-raising inputs etc. is not usually available.[6] However, macro-level data show significant yield differences between irrigated and unirrigated lands while micro-level data do not show such large differences for all crops and for all conditions.

It has been argued earlier that irrigation enhances the yield rate per hectare, as it enables the farm operator to switch over to improved technology, which is dependent on the use of chemical fertilizers and high yielding varieties of seeds. This change in character of cultivation under irrigation leads to greater productivity of crops

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5 Ibid., p. 7.

6 Ibid., pp. 7-8.

previously cultivated. Such improvement in the per hectare yield are technology induced and irrigation constitutes the major causative factor behind such yield rate enhancement. Studies on the relative contribution of various component elements in the growth of agricultural output by Kalhan and Johi, Minhas and Vaidyanathan, Prabha have established that increase in per hectare yield is attributable to the adoption of new agricultural technology emerging from rapid expansion of irrigation facilities.[7]

Dhawan has carried out an analysis of General Crop Estimated Survey (GCES) yield data for 1968-69 through 1978-79 to show the differences in yield of irrigated and unirrigated land at the macro level. He has estimated the average productivity through a method of standardisation of unit (i.e. by expressing all crops output in terms of food-grains equivalent of measurement).

Dhawan's estimate shows that except for the central Indian states and the states of Bihar, yield under irrigated lands are substantially higher than those under unirrigated lands. However, this aggregate picture may be misleading on two counts. First, the sampling design (of the GCES) and the method of aggregation may not be efficient enough to yield reliable estimates. Secondly, as the associated relevant information on the input use is not available along with

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7 T. Satpathy. Irrigation and Economic Development, 1984, pp. 47-48.

yield estimate it is not possible to draw any valid conclusions from this aggregate analysis. In fact, cropwise analysis in Dhawan's study shows that irrigated yields are not necessarily higher than unirrigated yields for all crops and for all agro-climatic zones.[8] Yield difference due to irrigation in Dhawan's estimate is evident from Table 4.2.

Study conducted by M. V. Nadkarni and others in Karnataka observes that the yields of irrigated crops have been more than double the yields of dryland crops. However, his analysis indicates that, in some cases the relationship between the farm size and the average yield is not inverse but positive. It implies that given irrigation facilities, yield differential depend on farm size.[9]

Baswan Sinha and Ramesh Bhatia observe yield differential before and after Auranga irrigation project. Yield of major crops under "Without Irrigation" have been estimated on the basis of average yield rates obtained during the four years 1975-76 through 1978-79 in Palamau district. He presents data for yield rates of paddy and wheat under following four conditions.[10]

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8 S. P. Pal. Op.cit., p. 8.

9 M. V. Nadkarni and Others. Impact of Irrigation (Canal, Well, Tank), 1979, Oct. 1979, pp. 35-37.

10 Baswan Sinha and Ramesh Bhatia. Economic Appraisal of Irrigation Projects in India, 1982, p. 57.

Table 4.2 : Yield Differences Due to Irrigation

Region/State	Yield quintal per hectare		Yield differential(in percentage)
	Irrigated	Unirrigated	
Indo-Gangetic plain	18.3	8.3	121
Peninsular South India	21.6	6.2	248
Western India	15.2	5.4	182
Central India	12.9	7.1	82
Punjab	23.6	10.6	123
Haryana	19.6	6.5	202
Uttar Pradesh	20.4	8.6	137
Bihar	10.9	8.0	36
Maharashtra	24.5	5.9	315
Karnataka	23.3	6.3	270
Andhra	18.6	6.1	205
Tamil Nadu	23.1	8.1	185
Gujarat	18.9	6.9	174
Rajasthan	13.6	4.5	202
Madhya Pradesh	12.9	7.1	82

Source : B. D. Dhawan. Productivity Impact of Irrigation in India, Institute of Economic Growth, (Mimeo) September 1983, Quoted by S. P. Pal, Table 1.1, p. 9.

Table 4.3 indicates the difference between irrigated and unirrigated yield. The four year average for unirrigated local paddy is 1,188 kg. per hectare whereas average for HYV unirrigated paddy is 1,636 kg. per hectare, and HYV irrigated paddy is 2,264 kg. per hectare.

Table 4.3 : Yield for Paddy and Wheat in Palamau District

(Quintals/hectares)

Year	Paddy			Wheat		
	Local unirrigated	HYV unirrigated	HYV irrigated	Local unirrigated	HYV unirrigated	HYV irrigated
1975-76	11.23	15.36	21.46	7.06	10.51	21.76
1976-77	8.95	18.85	25.36	5.27	3.84	11.88
1977-78	14.62	18.09	22.54	6.74	6.10	10.17
1978-79	12.73	13.15	21.18	N.A.	N.A.	N.A.
Average	11.88	16.36	22.64	6.35	6.81	14.60

Source : Baswan Sinha and Ramesh Bhatia. Economic Appraisal of Irrigation Project in India, Table 3.2.2, p.57.

In case of wheat four year average for local unirrigated wheat is 635 kg. per hectare, for HYV unirrigated 681 kg. per hectare and for HYV irrigated wheat 1,460 kg. per hectare. However, he emphasises the availability of water on a timely and assured basis to give higher yield rates.

Survey conducted by Mahatma Phule Krishi Vidyapeeth, Rahuri, Department of Agricultural Economics in Ghod Irrigation Project Area in Ahmednagar district observes the substantial yield difference between irrigated and unirrigated or rainfed agriculture. Irrigation makes it possible for the cultivator to change the technology in crop production. For instance intensive use of fertilizer is only possible when assured supply of irrigation water is available. To test the hypothesis the details of crop production of beneficiaries as well as non-beneficiaries were collected in the study.[11]

The per hectare yields of all the crops grown by the beneficiaries were substantially higher than those of the non-beneficiaries. Jowar which is a staple food crop of the area and which had the highest area in both the cases had registered one and half times more yield per hectare for beneficiaries as compared to non-beneficiaries. The yield of local bajra was more than double, while the yield of wheat was more than three times in case of beneficiaries. Gram recorded nearly double the yield per hectare for beneficiaries as compared to non-beneficiaries. The yields of hybrid bajra and mug were very much higher.

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11 T. K. T. Acharya, M. P. Dhongade, S. B. Jagtap. An Investigation into Existing and Expected Pattern of Crop Production and Farm Income in Ghod Irrigation Project Area in Ahmednagar Dist, Survey conducted by M.P.K.V., Agricultural Economics Department, August 1978, pp. 24-25.

Hardev Singh in his article Agriculture : Significant Strides, emphasises the importance of irrigation in raising the crop yields. According to him assured supply of water has been the primary factor in the rise of agricultural production. This is evident from the fact that major advances in yields have been recorded in the regions and crops where facilities for irrigation have been stepped up.[12]

Study on socio-economic benefits of minor irrigation projects to small and marginal farmers in Mysore district by Govindraju (K.V.) reveals the positive effect of irrigation on yield of crops.[13]

The yield per acre of ragi under the rainfed condition was 549 kg. per acre which is increased to 1,216 kgs. with irrigation. Introduction of irrigation caused the yield to be more than double. Table 4.4 shows the impact of irrigation on yield of different crops in Mysore district.

Per acre yield of groundnut increased by little less than double after irrigation. The yield of Mulberry another important crop has increased from 4,850 kgs. to 12,500 kgs. per acre with irrigation. Study also revealed that the introduction of irrigation made possible the use of associated inputs like improved seeds, chemical fertilizers etc.

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12 Eastern Economist, December 26, 1975.

13 K. V. Govindraju. Study on Socio-Economic Benefits of Minor Irrigation Project to Small and Marginal Farmers in Mysore District, March 1984, p. 19.

Table 4.4 : Yield (kgs) Per Acre by Selected Households

Crop	Before irrigation	After irrigation
Ragi	549	1,216
Groundnut	460	800
Chillies	500	750
Mulberry leaves	4,800	12,500

Source : Study on Socio-Economic Benefits of Minor Irrigation Project to Small and Marginal Farmers in Mysore District, Table 2.5, p. 19.

which was hardly seen before irrigation and are not independent of it.

Report on State Tube-wells (Punjab) by the Committee on Plan Projects minor irrigation team observes the advantage of irrigation in increasing production. Yield of rice in unirrigated land was 667 lbs. per acre which is increased to 932 lbs. after irrigation i.e. by 40 per cent. Yield of jowar which was 163 lbs. before irrigation is increased to 253 lbs. per acre i.e. by 55 per cent. Yield of bajra, wheat and barley are increased by 65, 81 and 87 per cent after the introduction of irrigation.[14]

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14 Report on State Tubewells (Punjab), 1962, p. 35.

The study taken up in Raninagar I and II Blocks of Murshidabad District (West Bengal) by the Bank of Baroda also reveals the positive impact of irrigation on crop output and yield. The findings of the study revealed that there had been increase in yield of three major crops, viz. paddy, wheat and jute. The average increase in different crops was to the tune of 1.0 to 2.2 quintals per acre. The highest aggregate increase was in wheat and more or less same increase was observed in case of jute and paddy. There were however certain sample farmers who got relatively less per acre yield in post development stage due to non-utilisation of HYV seeds, plant protection measures seed treatment etc. and also due to inability of giving timely irrigation on account of scarcity of diesel for running.[15] This also strengthens the argument that irrigation results in increase in yield.

H. Laxminarayan in his study Evaluation of Investment on Tubewells and Land Development in Sangrur District of Punjab observes substantial increase in crop yield due to irrigation. His study is concerned with only ARDC financed farms where the scheme was in operation for at least three years so that benefits of the scheme had matured. The yield per acre increased in all cases except mustard,

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15 Evaluation-cum-Impact Study of Minor Irrigation Project and Recovery of Advances under this Project - A Study taken up in Raninagar I and II Blocks of Murshidabad District, West Bengal, Evaluation Report No.3, April 1980, p. 11.

maize and cotton. The biggest increase in yield was in the case of paddy. Per acre yield in the case of paddy increased from 11.54 quintals before ARDC investment to 24.8 quintals after ARDC investment. In the case of wheat per acre yield increased from 9 to 12.49 quintals. The yield increases were reported in all size groups. Due to investment and consequent irrigation facilities application of fertilizer per acre increased from 11 kg. to 129 kg.[16]

Agricultural Economics Research Centre of University of Madras conducted a research study regarding benefits to small and marginal farmers through minor irrigation schemes in Tamil Nadu. Among the sample farmers, the sample beneficiaries had secured higher yields for irrigated crops in the first season (monsoon season) than the non-beneficiaries. In the case of paddy the yield per hectare was 3,920 kg. for the beneficiaries and 3,805 kg. for the non-beneficiaries. The yield of groundnut by the beneficiaries was 2,346 kg. per hectare, whereas non-beneficiaries got only 2,076 kg. per hectare. For cotton, yield secured by the beneficiaries was very much higher than that of the non-beneficiaries the figures being 2,455 kg. and 1,976 kg. respectively.[17]

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16 H. Laxminarayan. Evaluation of Investment on Tube-wells and Land Development in Sangrur District of Punjab, Agricultural Economic Research Centre, University of Delhi, 1985, pp. 37-42.

17 Benefits to Small and Marginal Farmers Through Minor Irrigation Schemes in Tamil Nadu, Agricultural Economics Research Centre, University of Madras, Research Study No. 79, 1984, p. 29.

Study also furnishes the yield of second season crops in the sample farms in 1981-82. The sample beneficiaries were able to raise irrigated crops in the second season with the help of irrigation. In the second season yield per acre of paddy in case of small farmer beneficiaries was 4,655 kg. per hectare and non-beneficiaries was 3,644 kg. per hectare. In case of groundnut, yield per hectare of small farmer beneficiaries was 764 kg. and small farmer non-beneficiaries was 1,768 kg. This leads to the conclusion that in the first season, though yield difference between irrigated and unirrigated land is positive, it is not substantial but in the second season it is substantial.

N. V. Sovani and Nilakantha Rath in their Report of an Inquiry into the Economic Benefits of the Hirakud Dam also observed the yield difference between irrigated and non-irrigated land. The difference between the yields of irrigated and non-irrigated paddy in the delta was found to be in the neighbourhood of six maunds. Yield of unirrigated wheat was found to be varying between three and six maunds per acre and of irrigated wheat between 8 and 12 maunds per acre. So average yield of 8 to 8 1/2 maunds per acre was expected with irrigation in the Sambalpur zone. The yield of groundnut after irrigation is introduced is estimated to be increased by about 3 maunds per acre over the 1955-56 average. The yields of pulses without irrigation come to about one and half maunds. With

irrigation it is estimated average of about three maunds per acre. Irrigated Sarad paddy per acre was reported to be 17.5 maunds; and of non-irrigated Sarad paddy about 11.5 maunds in the delta zone of Sambalpur district. The average per acre yield in Puri was also the same as non-irrigated Sarad paddy in Cuttack. Average increase of five maunds in the yield of Sarad paddy in the non-irrigated areas of the delta is expected once those lands are brought under irrigation. In case of Beali paddy, the yield under irrigation will increase by two maunds per acre.[18]

Sulabha Brahme in a research study on Irrigation Imperative for Agricultural Development in Maharashtra : Lessons from Drought 1972 also observes the substantial yield difference between irrigated and rainfed agriculture.[19] She emphasised the need for comprehensive and time bound plan for development and utilisation of surface and ground-water resources in the state.

According to her, in the scarcity zone, the land surface under cultivation is larger than the water resources

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18 N. V. Sovani and Nilakantha Rath. Economics of Multi-purpose River Dam - Report of an Inquiry into the Economic Benefits of Hirakud Dam, Gokhale Institute of Politics and Economics Publication 1960, pp. 133-164.

19 Sulabha Brahme. Irrigation Imperative for Agricultural Development in Maharashtra : Lessons from Drought (Research Project) 1972, Gokhale Institute of Politics and Economics Publication 1976, pp. 227-229.

available in the zone. A minimum of two feet water is needed for crop cultivation. This can be supplied through large storages in the heavy rainfall areas and development of a grid of canals so that the water supply in a given water basin could be augmented. In the case of failure of the rains, mainly the areas with canal irrigation will receive protection. Hence it is important to spread the water available over as large an area as possible resorting to lifting of canal water wherever necessary so that larger area could be brought under irrigation command. This will ensure large average yields and considerable reduction in the year to year fluctuations in the production in the drought prone areas. This difference in average yield of irrigated and unirrigated crops is indicated in Table 4.5.

Table 4.5 indicates that availability of irrigation facilities replaced the local bajra and jowar by hybrid varieties of them which results in more yield per acre or hectare. It also resulted in more than double increase in yield of pulses, groundnut and chillies.

V. V. Borkar and M. D. Padhye in their study of Socio-Economic Benefits of Purna River-Valley Project also observe the positive yield impact of irrigation. The most important aspect of their study was the comparison of agricultural productivity in the two groups of villages, Group I and Group II. Group II was more irrigated than the Group I. The yields per acre of different crops in the two regions

Table 4.5 : Average Yield of Irrigated and Unirrigated Crops

Crop	Average yield in quintals per hectare	
	Irrigated	Unirrigated
Bajra		
Local	-	3.01
Hybrid	7.0	-
Jowar		
Kharif	10.0	7.15
Rabi	17.0	4.35
Hybrid	30.0	-
Kharif pulses	11.6	4.26
Groundnut kharif	14.0	4.76
Chillies	16.0	6.73

Source : Sulabha Brahme. Irrigation Imperatives for Agricultural Development in Maharashtra : Lessons from Drought 1972, p. 229.

thus assume importance.[20] Data collected by them relate to two different years for the two groups. Thus the data in respect of Group I was collected in 1960-61 while that for Group II in 1962-63. The latter year was comparatively

20 V. V. Borkar and M. D. Padhye. Purna River Valley Project - A Study of Socio-Economic Benefits, p. 165. (year of publication not stated).

unfavourable in respect of rainfall, and the yields in that year were, therefore lower. An account of this important factor had to be taken before any comparison could be made. The author eliminated the differences in per acre yields in Group II which were revised upwards. Table 4.6 makes the difference in yield in the two groups clear.

Table 4.6 : Percentage Difference in Per Acre Yield

(In kg.)

Name of crop	Per acre yield in		Percentage difference-Group II over Group I
	Group I	Group II	
1. Kharif jowar	179.56	313.52	+74.6
2. Cotton	88.64	148.36	+67.4
3. Paddy	272.47	470.28	+72.6
4. Sugarcane	949.90	1,490.16	+56.9
5. Wheat	145.48	140.90	- 3.3
6. Rabi jowar	152.10	125.97	-20.7

Source : V. V. Borkar and M. D. Padhye. Purna River Valley Project, Table 9.12, p. 166.

Table 4.6 shows that in Group II villages the yield per acre in respect of kharif jowar, cotton sugarcane and paddy were higher. But yields for rabi crops i.e. wheat and rabi jowar are lower in Group II villages. This may be due to the influence of factors other than irrigation

such as the quality and suitability of land, use of manures, fertilizers and other socio-economic conditions. The percentage difference in the yields per acre in respect of six crops in Group II over those in Group I can be seen from the last column.

However, this conclusion does not seen tenable. Negative difference in per acre yield of wheat and rabi jowar may be due to the shortage of water consequent upon the more irrigation water being provided to the crops like sugarcane and cotton. Shortage of irrigation water to wheat and rabi jowar might have contributed to the negative yield difference in Group II villages over Group I villages.

It is clear from Table 4.6 that the percentage difference in the yields of four out of six crops are positive and substantial in Group II villages representing the most heavily irrigated ones in or near the Purna Project region. Much of this difference is attributable to the irrigation facilities.

D. R. Gadgil in his study of Economic Effects of Irrigation also observe the yield difference in irrigated and unirrigated area.[21] This yield difference is quite evident from Table 4.7.

Table 4.7 indicates that, in case of jowar irrigated land gives almost thrice the output than unirrigated land.

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21 D. R. Gadgil. Economic Effects of Irrigation, Gokhale Institute of Politics & Economics Publication No. 17, 1948, pp. 100-105.

Table 4.7 : Yields of Crops in India from Irrigated and Unirrigated Areas

(In maunds)

	Canal irrigated	Dry farmed
Jowar grain	8	3½
Wheat	7½	3
Groundnut	20	8
Gram	5	3
Bajri gram	6	2½
Cotton	3	1

Source : D. R. Gadgil. Economic Effects of Irrigation, Table 2.3, pp. 100-105.

In case of wheat and groundnut it is two and half times the more than unirrigated land. Yield of gram and bajri grain is almost the double, whereas cotton in irrigated area gives the three times more yield than in unirrigated areas.

This shows a vast difference in yields in the two cases. It would however be wrong to say that all these differences are due merely to the presence or absence of water. It was rightly observed by Chakravarty at the West Bengal Power and Water Resource development symposium that many amongst the educated people try to assess the benefits of irrigation by comparing yields in irrigated and non-irrigated areas. The real benefit from irrigation is in

its ability to present the manure in a suitable form for being taken in by the plant. For optimum growth, addition of manure is essential and irrigation being a sort of catalystic agent, it enables the plant to take the food in.[22]

P. C. Bansil in his book Agricultural Planning for 700 Million - A Perspective Study also of the view that irrigation has a positive impact on yield. On the basis of available data Table 4.8 has been drawn up which shows all India average irrigated and unirrigated yields for these

Table 4.8 : Irrigated and Unirrigated Yields Per Acre for Some Food Groups (1953-54)

(Lbs. per acre)

Crop	Irrigated area	Unirrigated area
Rice	1,034	692
Wheat	945	514
Barley	901	609
Jowar	952	391
Bajra	780	320
Maize	1,056	657
Gram	671	525

Source : Collected from P. C. Bansil. Agricultural Planning for 700 Million - A Perspective Study, 1971, Table 14.14, p. 316.

22 P. C. Bansil. Agricultural Planning for 700 Million - A Perspective Study.1971, p. 296.

major food crops.[23] In order to make these yield figures comparable with the total production some minor adjustment were made (both for irrigated and unirrigated yield).

Table 4.8 indicates the large differences in yields between irrigated and unirrigated area.

P. C. Bansil in his another book Agricultural Problems of India observes the same trend as above.[24] However, he gives a range from minimum to maximum yields obtained in the country for various crops. The statistics in Table 4.9 substantiate the general view that irrigation has a positive yield effect.

Yogindar K. Alagh in the Seventh Plan Perspective wrote about Agricultural Perspective of the Seventh Plan.[25] He also observes the difference in yield for irrigated and unirrigated land and gives some statistical information to support the views. (Table 4.10).

Table 4.10 clearly indicates the yield difference for irrigated and unirrigated land. HYV irrigated land gives more per acre yield than the other irrigated land. Irrigation facilitates the use of other inputs like fertilizers, seeds manures etc. which give rise to high yields.

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23 Ibid., p. 316.

24 P. C. Bansil. Agricultural Problems of India, 1981, pp. 80-81.

25 Yogindar K. Alagh. Agricultural Perspective of the Seventh Plan - Seventh Plan Perspective, 1985, p. 98.

Table 4.9 : Minimum and Maximum Irrigated and Unirrigated Yield of Principal Crops During 1975-76 (All-India)

Quintals/ha.

Crop	Irrigated yield		Unirrigated yield	
	Minimum	Maximum	Minimum	Maximum
Rice	6.5	25.6	5.3	16.9
Jowar	2.5	18.8	2.0	8.8
Bajra	7.7	17.5	3.0	7.1
Maize	6.2	27.7	6.2	22.0
Ragi	13.9	17.9	7.4	12.5
Wheat	9.8	24.3	3.9	14.9
Barley	7.1	17.6	6.2	17.0
Gram	2.8	10.4	4.6	7.8
Groundnut	7.4	15.2	6.1	13.0
Rapeseed & mustard	5.2	7.7	3.3	5.1
Sugarcane	328.0	930.0	211.8	380.2
Tobacco	8.6	18.1	3.9	7.9
Cotton	1.5	16.3	0.8	3.8

Source : P. C. Bansil. Agricultural Problems of India, Table 5.6, p. 81.

Table 4.10 : Yield Level of Principal Crops in 1984-85

Crop	Land category	Area (mill. hect.)	Yield (kg/ hect.)	Production (mill. tonnes)
Rice	HYV irrigated	19.89	2,231	44.37
	Other irrigated	0.80	1,293	1.03
	Unirrigated	20.58	863	17.76
	Total	41.27	1,524	63.16
Wheat	HYV irrigated	18.00	2,101	37.82
	Other irrigated	0.80	1,290	1.03
	Unirrigated	6.20	790	4.90
	Total	25.00	1,750	43.75
Other cereals	Irrigated	6.00	1,394	8.36
	Unirrigated	32.00	627	20.06
	Total	38.00	748	28.42
Cotton	Irrigated	4.10	310	74.76
	Unirrigated	4.36	75	19.24
	Total	8.46	1,189	94.00 (lakh bales)

Source : A Technical Note on the Sixth Plan of India, Planning Commission, Government of India, 1981, p. 98.

B. D. Dhawan in his article Irrigation Impact on Farm Economy observes the substantial yield difference between irrigated and unirrigated crop.[26] Author derived through properly designed sampling procedures estimates of yields of irrigated and unirrigated land for five major crops i.e. jowar, bajra, ragi, cotton and groundnut in the State of Tamil Nadu, the yield impact of irrigation is substantial (with the possible exception of groundnut crop) both in absolute and relative terms as can be ascertained from the data in Table 4.11 averaged over the six year period 1973-78.

Table 4.11 : Differential Yield in Irrigated and Rainfed Agriculture

(kg/ha)

Crop	Rainfed yield	Irrigated yield	Yield difference	
			Absolute	Relative
Jowar	695	1,771	1,076	155
Bajra	702	1,777	1,075	153
Ragi	946	1,846	900	99
Cotton	291	1,552	1,261	433
Groundnut	902	1,611	709	79

Source : B. D. Dhawan. Irrigation Impact on Farm Economy Economic and Political Weekly, Review of Agriculture, September 28,1985, Table 1, p.A-125.

26 B. D. Dhawan. Irrigation Impact on Farm Economy, Review of Agriculture, Economic and Political Weekly, September 28, 1985.

Table 4.11 indicates that irrigated jowar, bajra gives the more than double the yield of unirrigated land. Irrigated ragi gives double the yield than unirrigated ragi. In case of cotton yield difference is much more substantial in Tamil Nadu. Groundnut yield increase is comparatively lower than other crops but still it is almost double the unirrigated land. The comparatively lower step up in groundnut yield is inter alia linked with the fact that irrigated groundnut in Tamil Nadu is mainly a summer-season crop in contrast to rainfed groundnut being a crop mostly of the wet season. Because of this seasonal difference the output augmenting role of irrigation is understated if viewed in terms of excess of irrigated over unirrigated yield of groundnut.

J. S. Kanwar in his article from 'Protective to Productive Irrigation' emphasises the role of water management in increasing agricultural production and crop yield per hectare. Several factors determine the production obtained from a high yielding variety. In fact, cultivation of these varieties require an entirely new agronomic technology. The difference between local and high yielding varieties is not so much in their water requirement as in the technique of water management. The fact is that though in the absence of a balanced use of fertilizer, irrigation does not give very different results as between local and high yielding

varieties. Controlled irrigation with balanced fertilizer application gives the full potential of high yielding varieties, many times higher than that of local varieties.[27]

The author observes that the new concept of irrigation is that irrigation is for the climate and the soil and not for the crop. Much saving of water and many times higher yields can be obtained by controlled and timely irrigations. Water management for the high yielding varieties has transformed irrigation from being protective to being productive.

Vidya Sagar in his study attempts to measure the contribution of the three technological factors, viz. high yielding varieties of seed, fertilizers and irrigation in the growth of agricultural productivity in Rajasthan during 1961-74. His analysis contradicts the popular hypothesis that the new varieties are, by and large, responsible for the green revolution in India. Even in the case of wheat, which has registered nearly 40 per cent yield increase, high yielding varieties contribute a mere 26 per cent the yield growth while the share of other two factors is 74 per cent.

Overall, the share of the new varieties of seed is 15 per cent. The share of fertilizers and irrigation is 30

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27 J. S. Kanwar. From Protective to Productive Irrigation, Review of Agriculture, Economic and Political Weekly, March 29, 1969, pp. A21-A23.

per cent and 18 per cent respectively. Of the growth of overall agricultural productivity 33 per cent is unexplained in the study.[28]

B. V. Krishna Murti in his article Investment Pattern for Fourth Plan also observes the difference in yield in rainfed and irrigated agriculture. According to him transformation of traditionally rainfed areas into irrigated conditions of agriculture brings out significant increases in yield. The difference in yields of the same crop under irrigated and unirrigated conditions even in good rainfall regions (and broadly identical agricultural practices) can be seen in the following figures for Punjab.[29] (Table 4.12).

Divakar Jha also believes in positive yield impact of irrigation. He made the expost assessment of the benefit of irrigation of Tribeni canal. He compared agricultural input and output in two areas similar in all respect except the availability of irrigation from Tribeni canal in the one and absence of it in the other called project and control areas respectively.

A large number of crops are grown in control and

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28 Vidya Sagar. Contribution of Individual Technological Factors in Agricultural Growth - A Case Study of Rajasthan, Review of Agriculture,Economic and Political Weekly, June 24, 1978, p. A23.

29 B. V. Krishna Murti. Investment Pattern for Fourth Plan, Economic and Political Weekly, March 1, 1969, P. 439.

Table 4.12 : Wheat Yield Per Acre

(In maunds)

Year 1955-56	Irrigated area	Unirrigated area
Amritsar	10.17	5.77
Ferozpur	10.56	6.33

Source : B. V. Krishna Murti. Investment Pattern for Fourth Plan, Economic and Political Weekly, March 1, 1969, p. 439.

project villages, out of which author has taken two important crops namely sugarcane and wheat.

The yield per acre of sugarcane is 2 1/4 times more in the project area as compared to control area. This is because of availability of irrigational facilities. The aggregate input per acre in the project area is Rs. 251 as against Rs. 202 in the control area. Thus there is an extra investment of Rs. 50 in the project area which does not seem to be very significant.

In project area less wheat is cultivated as compared to control area. But output per acre is 1.73 times more in the project area as compared to control areas.[30]

We can thus conclude that the project villages produce

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30 Divakar Jha. Evaluation of Benefits of Irrigation, Tribeni Canal Report, 1967, pp. 235-238.

a much larger output per acre of all crops than the control villages.

Singh and Misra in their study benefit cost analysis of Sarda Canal System observe the yield difference between irrigated and unirrigated areas i.e. project areas and control areas. The following observation is based on their study.

Gross farm output per acre is on the whole 8.6 per cent higher in the canal irrigated villages than outside. In case of large sized holdings i.e. 10 acres or more the increase has been of the order of 10 to 30 per cent depending on the size of holding. This study suggests that irrigation helps to increase per hectare or per acre yield in project areas as compared to control areas or unirrigated areas. Study also suggests that though the input cost is greater in case of project area than control areas still the net output is greater or per hectare/acre yield is greater in irrigated or project area.[31]

Irrigation and Stability in Productivity

The various studies discussed above suggest the positive impact of irrigation on yield per acre/hectare. But irrigation not only is expected to raise the yield, but it is also expected to stabilise the yield.

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31 Baljit Singh and Shridhar Misra. Benefit Cost Analysis of Sarda Canal System, 1960, p. 58.

During the era of planned economic development food-grain production has registered an average growth rate of about 2.7 per cent per annum which is slightly higher than the growth rate of human food consumption. Growth of food production has been accompanied by a more than proportional increase in the variation in production. Mehra (IFPRI 1981) and Hazella (IFPRI 1982) compared the two periods viz. 1954-55 through 1964-65 (Period I) and 1967-68 through 1977-78 (Period II) and found that co-efficient of variation increased from 4 per cent in Period I to 6 per cent in Period II. According to Mehra this increased instability in food production can be attributed to the widespread adoption of fertilizer/HYV package during the second period known as New Technology period which is very sensitive to weather changes and disease.[32] Table 4.13 indicates the co-efficient of variation in yield rates of a few selected crops for the two periods.

Table 4.13 indicates that except for wheat the co-efficient of variation in cereals in general have increased in Period II over Period I. Mehra has attributed this increased variation in the use of new technology. But wheat shows a reduced co-efficient of variation (CV) in spite of use of high HYV fertilizer package than any other crop. Therefore we cannot attribute increased co-efficient of

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32 S. P. Pal. Op.cit., pp. 26-28.

Table 4.13 : Co-efficient of Variation in Yield by Crops - All India

Crop	Period I 1954-55 to 1964-65	Period II 1967-68 to 1977-78	In percentage change
Rice	5.26	5.85	11.2
Jowar	8.92	11.77	32.0
Bajra	7.91	23.62	198.6
Maize	6.37	10.87	70.6
Wheat	8.31	5.41	-35.0
Cereals	3.70	4.46	20.4

Source : S. P. Pal. Contribution of Irrigation to Agricultural Production and Productivity, Table 2.1, p. 27.

variation necessarily to modern technology which is emerged in Period II. S. P. Pal has attempted to recompute the co-efficient of variation in yields of different crops by using the indices of yields at all India level. The results are presented in Table 4.14.

The comparison between Table 4.13 and 4.14 shows that the co-efficient of variation differ significantly. In Table 4.14 rice along with wheat shows a reduced C.V. for Period II. For all the cereals together there is no change in C.V. in Table 4.14 while Table 4.13 shows a 20 per cent increase in C.V. in Period II over Period I. On the whole,

Table 4.14 : Co-efficient of Variations of Yields Crop-wise - All India

(In percentage)

Crop	Period I 1954-55 to 1964-65	Period II 1967-68 to 1976-77	Change
Rice	7.77	5.25	-32.40
Jowar	9.24	13.03	+41.02
Bajra	10.50	23.44	+123.24
Maize	4.92	11.00	+123.58
Wheat	9.21	8.74	-5.10
Cereals	6.39	6.34	Neg.
Foodgrains	5.74	5.20	-9.4

Source : S. P. Pal. Table 2.2, p. 28.

the hypothesis that C.V. for cereals increased in Period II over Period I, as proposed by Mehra (1981) and Hazell (1982) needs to be investigated in detail for any firm conclusion to be drawn in this period.

However, the similarity between Tables 4.13 and 4.14 in the C.V.s of rice, wheat and foodgrains to increased irrigation facilities and assured rainfall particularly in rice growing regions. Indian agricultural production being dependent on the vagaries of monsoon fluctuates from year to year. Availability of irrigation water brings

down this intertemporal fluctuations. Therefore the reduced variance in yield in Period II must be attributed to the growth in irrigation in the country. Thus it is clear from the above that irrigation not only raises the yield but also helps to stabilise agricultural production and productivity.

B. D. Dhawan in his article Irrigation Impact on Farm Economy also supports the view that irrigation stabilises the yield or productivity. He studied the sample field data for four states of Maharashtra, Tamil Nadu, Punjab and Uttar Pradesh in order to assess the impact of irrigation. According to him fluctuations in crop output under dry farming are well known. For all the crops taken together, the value of the detrended co-efficient of variation for the rainfed segment of Bihar, Madhya Pradesh and Punjab states falls in the range 7 to 10 per cent as compared to 16 per cent in Andhra Pradesh, 19 per cent in Haryana and 33 per cent in Gujarat State - for Tamil Nadu the magnitude of this co-efficient is rather low, namely 11 per cent but is not so low for the crop group of foodgrains viz. 19 per cent. This interstate differences in output instability under rainfed condition are due to differences in natural factors like soil, climate topography etc.

His study reveals that available evidence on the beneficial impact of irrigation on the output, crop yield and crop area is far from unvarying across states. His

study further reveals that at least in four out of seven states, namely, Punjab, Haryana, Gujarat and Andhra Pradesh, the irrigated farming turns out to be less unstable than rainfed farming. Exceptions are Bihar and Madhya Pradesh, where rainfed farming is more stable than irrigated farming. However, this is due to two reasons. (1) These are high rainfall areas with much less uncertainty of precipitation than observed in other states and (2) Secondly these states experience favourable weather conditions during the period to which the output instability analysis relates. This gives rise to very low output instability in the rainfed farming. This however, does not contradict our hypothesis that irrigation does result in stability of yield, production and productivity.[33]

After reviewing the literature regarding the yield impact of irrigation we can come to the conclusion that irrigation has positive effect on yield rate though there are many other complementary factors which influence the yield rate per hectare because of irrigation.

Now in the next chapter we propose to examine the effect of irrigation on production through change in crop-mix. In other words change in cropping pattern brought about by irrigation.

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33 B. D. Dhawan. Irrigation Impact on Farm Economy, Review of Agriculture, Economic and Political Weekly, September 1985, p. A127.

CHAPTER V

CROPPING PATTERN EFFECT OF IRRIGATION

Cropping pattern can be defined as the proportion of area under different crops at a point of time. A change in the cropping pattern implies a change in the proportion of area under different crops.[1] The present cropping patterns of different regions are more or less traditional but are based on several years experience in farming after considering the suitability of crops to be grown in relation to the agro-climatic conditions in the region. It has been however, observed that the rigidity in the traditional cropping pattern is slowly breaking down partly with the onset of the green revolution and under Indian conditions more because of irrigation which plays an important role in this context.

However, in the overall Indian context it is quite clear that though crop-mix changes due to availability of irrigation it does not necessarily lead to complete alteration in the cropping pattern. It does not necessarily change the cropping pattern largely from food crops to cash crops but mainly it changes within the food crops itself, from inferior varieties of cereals to superior varieties. On the

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1 Ruddar Datta, K.P.M.Sundaram. Indian Economy, 1980, p. 363.

whole irrigation does bring about change in crop mix. However, apart from irrigation there are many other sociological institutional and economic factors affecting cropping pattern. But we assume here that all other factors are complementary to irrigation and many times they emerge because of availability of irrigation. In what follows, we examine the studies dealing with impact of irrigation on changes in cropping pattern.

To begin with examination of all India data on area under different crops and changes in those in different periods from early fifties to early eighties presented in Indian Agricultural Statistics and different statistical abstract shows that gross sown area under food crops was 1,01,096 thousand hectares in 1950-51 which increased to 1,27,001 thousand hectares in 1964-65. Area under food crops to total sown area in the country accounted for 80.38 per cent in 1950-51 whereas in 1964-65 it accounted for 79.75 per cent. Area under non-food crops registered increase from 18.80 per cent to 20.14 per cent during the same period indicating marginal change in favour of cash crops. Gross irrigated area increased by 36 per cent during the period.[2]

In 1965-66 green revolution brought about fundamental

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2 Indian Agricultural Statistics 1960-61, pp. 8-13; 1966-67 & 1967-68, Vol.I, pp. 5-10; 1973-74 and 1974-75, pp. 6-11; 1974-75 to 1978-79, pp. 8-11; Agricultural Statistics at a Glance April 1986, p. 29; Economic Survey 1985-86, p. 119.

change in foodgrain production. It gave a big push to the production of wheat to begin with and subsequently to the production of paddy largely due to its success in North Western India. Area under high yielding varieties of wheat increased from 7.86 million hectares in 1971-72 to 17.86 million hectares in 1982-83. During 1965-66 to 1974-75 area under foodgrains increased from 1,14,926 thousand hectares to 1,28,538 thousand hectares. Thus it increased from 79.52 per cent to 79.57 per cent of the gross cropped area in the country indicating a slight increase. Area under non-food crops declined slightly from 20.47 per cent in 1965-66 to 20.40 per cent in 1974-75.

During 1975-76 to 1982-83 net irrigated area increased by 5 per cent. Area under food crops declined from 1,28,538 thousand hectares to 1,25,100 thousand hectares during the period. To that extent the area under non-food crops increased. Gross cropped area to total cropped area increased from 25.32 per cent in 1975-76 to 30.13 per cent in 1982-83.[3] Thus we find mixed trend here.

The overall picture presented above shows that there is very marginal change in cropping pattern from food crops to non-food crops as a whole, even during the period depicting large scale increase in irrigation. The cropping pattern

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3 H. Laxminarayan., Performance of Indian Agriculture and the Rural Sector in the Post-Green Revolution Period, June 1986, pp. 1-8.

change is mainly confined within the broad groups of food-grains from inferior cereals to superior cereals and from inferior variety to superior variety.

Now let us examine the various studies concerning the effect of irrigation on cropping pattern. However, it should be mentioned at the outset, that all changes in cropping pattern cannot be said to be entirely irrigation induced. Some shifts in crop pattern, do take place on account of economic and institutional factors, such as urbanisation, changes in food habits of the people, land tenurial condition, input requirements of crops, relative price movement of agricultural products and state policy on subsidies. But it is often seen that irrigation is the most important factor that contributes to such changes in the crop pattern and makes possible the production of more remunerative crops.[4]

Krishna Bharadwaj in her study based on farm management surveys also agrees that irrigation contributes to raising the productivity of land by making possible production of lucrative crops. For example, an irrigated holdings in Punjab, only 50 per cent of the cropped area was devoted to food crops with 25 per cent under fodder and 20 per cent under cotton. On unirrigated holdings on the other hand, when gram was the main crop with 73.94 per cent of cropped area going to food crops. In Madras where the

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4 T. Satpathy. Irrigation and Economic Development, 1984, p. 40.

quality of irrigation is poor, multiple cropping is not widely prevalent on all holdings. But the irrigated holdings concentrate on paddy, a relatively more valuable crop. While the unirrigated holdings mainly produce dry grains like cumbu and cholam.[5]

The study undertaken by the Agricultural Economics Research Centre, University of Madras regarding the benefits to small and marginal farmers through minor irrigation schemes in Tamil Nadu clearly brings out the fact that provision of irrigation water through wells in South Arcot district has certainly brought about considerable change in crop mix.

Well irrigation has brought about significant changes in the crop pattern of the small farmer beneficiaries. Introduction of well irrigation had not made any marked change in the area under paddy. One observation that could be made, was that, growing of paddy under rainfed conditions has been discontinued. A very important impact of well irrigation was the allocation of larger areas to commercial crops by the farmers. Area under sugarcane had gone upto 13.27 from 1.22 hectares. Groundnut area, which was only 14.28 hectares previously, had become 27.35 hectares. The significance of well irrigation was clearly shown by the fact the farmers were having an area of 20.37 hectares under irrigated groundnut in the second season. Previously, they were not able to

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5 Krishna Bharadwaj. Production Conditions in Indian Agriculture - A Study Based on Farm Management Surveys, 1974, p. 48.

grow irrigated groundnut in the second season. Similarly, cotton which was previously raised under rainfed conditions only, in an area of 1.65 hectares, was cultivated in 1981-82 in 7.51 hectares and that too under irrigated conditions.

As in the case of small farmers beneficiaries, the marginal farmer beneficiaries were able to allocate larger areas to commercial crops. Sugarcane, not grown prior to well irrigation accounted for 5.58 hectares in 1981-82. Area under irrigated cotton had increased to 5.49 hectares from 0.35 hectares. Similarly, area of irrigated groundnut registered an increase of 10.20 hectares. The farmers were in a position to grow groundnut and cotton under irrigated condition in the second season also.[6] The study shows the changes in crop mix effected by the farmers with the help of well irrigation which also made possible growing of some crop in fair weather season.

Baswan Sinha and Ramesh Bhatia in their book Economic Appraisal of Irrigation Projects in India also project the change in cropping pattern.[7]

Before irrigation was provided through Auranga Irrigation Project, paddy, wheat, barley, maize, pulses and oil-

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6 Benefits to Small and Marginal Farmers through Minor Irrigation Schemes in Tamil Nadu, Agricultural Economic Research Centre, University of Madras, 1984, Research Study No. 79, pp. 17-25.

7 Baswan Sinha and Ramesh Bhatia. Economic Appraisal of Irrigation Projects in India, 1982, p. 56.

seeds were grown in the project area under rainfed conditions. However, since his analysis is concerned with the estimation of cost and benefit of Auranga irrigation project he gives the account of expected change in cropping pattern and not the actual change in cropping pattern. According to him, after irrigation is introduced, the area under wheat and paddy is expected to increase and some area is likely to be devoted to cultivation of winter and summer vegetables, as well as sugarcane.

The crop pattern before and after irrigation is given in Table 5.51.

Table 5.1 indicates that though cash crops like vegetables and sugarcane get introduced, the major change because of the introduction of irrigation is very large increase in area under paddy and wheat. Decrease in area under pulses and oilseeds will be replaced by crops like paddy and maize.

A survey conducted by the Mahatma Phule Agricultural University, Rahuri regarding the existing and expected pattern of crop production and farm income in Ghod irrigation project area in Ahmednagar district reveals the fact that irrigation induces change in cropping pattern, but it still remained dominated very much by foodgrains.

In order to find out the change in the cropping pattern, information about area under different crops before commencement of the project i.e. 1963-64 and the area under different

Table 5.1 : Crop Pattern : Before and After Irrigation

Name of crop	Before irrigation		After irrigation	
	Area in hectares	Area in percent of CCA	Area in hectares	Area in percent of CCA
Paddy	30,300	42.0	51,000	70.0
Maize	7,500	10.4	-	-
Wheat & barley	7,500	10.4	19,600	27.0
Pulses and oilseeds	7,500	10.4	-	-
Vegetables(W)	-	-	2,200	3.0
Vegetables(S)	-	-	2,200	3.0
Sugarcane	-	-	1,500	2.0
Total	52,800	73.2	76,500	105.0

Source : Economic Appraisal of Irrigation Project in India, Table 3.2.1, p. 56.

crops after commencement of the project i.e. 1969-70, was collected from the records of the selected villages. The information is summarised in Table 5.2.

It can be seen from Table 5.2 that gross sown area of all villages put together, increased by about 800 hectares i.e. by 4.30 per cent after commencement of the project. The increase is partly due to increase in area under different crops sown more than once.

Table 5.2 : Cropping Pattern of Selected Villages

Crop	Before commencement of the project 1963-64		After commencement of the project 1969-70	
	Area in hect-areas	Percen-tage to total	Area in hect-areas	Percen-tage to total
Jowar	148.82	80.18	12,360.62	63.85
Wheat	292.35	1.58	664.60	3.43
Bajra	814.85	4.39	1,009.86	5.22
Gram	217.39	1.17	436.95	2.26
Total pulses	522.99	3.00	1,005.13	5.19
Sunflower	962.10	5.18	1,566.64	8.09
Groundnut	29.10	0.15	347.37	1.79
Cotton	415.36	2.24	465.24	2.40
Sugarcane	58.27	0.31	1,111.48	5.75
Others	335.79	1.80	391.63	2.02
Gross cropped area	18,561.44	100.00	19,359.52	100.00

Source : An Investigation into Existing and Expected Pattern of Crop Production and Farm Income in Ghod Irrigation Project Area, Table 5.1, p. 14.

The highest proportion of area before as well as after commencement of the project remained under jowar though there was substantial reduction in the area under jowar, the percentage came down from 80.18 to 63.85 per cent after commencement of the project. As against this there was an increase in the area in case of wheat, groundnut and sugarcane.[8] This shows that area under cash crops like sugarcane is increasing. However, it may be pointed out here that the change in cropping pattern after commencement of the project was not spectacular.

T. Satpathy's study also observes the change in cropping pattern largely from inferior variety to superior variety of cereals as a result of introduction of irrigation. According to him for an assessment of changes in the pattern of crops raised in Orissa, the crop season is usually divided into two such as, kharif (June to December) and rabi (January to May).

The traditional crop pattern in kharif season in this state was mainly limited to paddy. Paddy is the single most important crop in the kharif season, with both autumn as well as winter varieties still constituting as much as 70.81 per cent of the total kharif area. Irrigation induced crop pattern shift is confined to paddy cultivation in kharif season. However, local variety kharif paddy has been

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8 T. K. T. Acharya, M. P. Dhongade, S. B. Jagtap. An Investigation into Existing and Expected Pattern of Crop Production and Farm Income in Ghod Irrigation Project Area, M.P.K.V. Rahuri, August 1978, pp. 13-17.

replaced by higher yielding variety paddy. This represents a beneficial effect of irrigation.

Table 5.3 gives figures with regard to the growth of net area irrigated, and areas under high yielding variety paddy during 1971-72 to 1980-81.

Table 5.3 shows that high yielding paddy area which formed only 11.59 per cent of kharif irrigated area in 1971-72 has increased to 87.05 per cent in 1980-81. This growth of high yielding variety paddy represents the improved crop pattern caused by increased irrigation facilities.

In the non-kharif season as the irrigation facilities expand, more remunerative crops are being raised. Almost entire area covered under paddy, wheat and potato is irrigated.

Table 5.4 indicates the growth of area under summer paddy, summer high yielding variety wheat and summer vegetables during the period 1971-72 to 1980-81.

Table 5.4 indicates that during the period irrigated area in summer season increased from 237 thousand hectares in 1971-72 to 487 thousand hectares in 1980-81, that is by 105.49 per cent. Paddy acreage during the same period increased from 163 thousand hectares to only 172 thousand hectares. This poor increase in summer paddy is mainly due to the uncertainty in water supply in canals, irregular water delivery, frequent closures of canals in summer. Any

Table 5.3 : Growth of Net Area Irrigated and Area under High Yielding Variety Paddy in Kharif Season (June to December (1971-72 to 1980-81)

('000' hect.)

Year	Kharif irrigated area	High yielding variety paddy area	High yielding variety paddy area as percentage of kharif irrigated area
1971-72	785	91	11.59
1972-73	820	151	18.41
1973-74	891	225	25.25
1974-75	1,017	201	19.76
1975-76	1,015	324	31.92
1976-77	1,049	402	38.92
1977-78	1,071	471	43.98
1978-79	1,133	710	62.67
1979-80	1,159	807	69.63
1980-81	1,197	1,042	87.05
Mean	1,013.70	375.78	40.86
S.D.	140.77	248.75	24.90

Source : Orissa Agricultural Statistics, Directorate of Agricultural and Food Production, Government of Orissa, 1980-81, pp. 59-60.

Table 5.4 : Growth of Area under Summer Paddy, Summer High Yielding Variety Wheat and Summer Vegetables

('000' hect.)

Year	Summer irrigated area	Summer paddy		Area total summer paddy	Summer wheat	Summer vegetables
		Local	HYV			
1971-72	237	57	106	163	21	189
1972-73	235	32	150	182	34	177
1973-74	232	34	134	164	46	176
1974-75	168	44	112	156	52	182
1975-76	364	21	159	180	54	214
1976-77	314	17	155	172	60	181
1977-78	357	12	176	188	60	248
1978-79	440	8	167	175	63	273
1979-80	464	7	135	142	50	258
1980-81	487	7	165	172	67	307
Mean	329.80	23.90	145.90	169.40	50.70	220.50
S.D.	110.74	17.28	22.75	13.59	14.09	47.55

Source : Orissa Agricultural Statistics 1980-81, Directorate of Agriculture and Food Production, Government of Orissa, p. 7.

way what is more significant in this connection is that, along with the expansion of irrigation local normal paddy is being substituted by high yielding variety of paddy in summer. Columns 3 & 4 of the table illustrate this point of gradual decline in normal paddy and its replacement by high yielding varieties of paddy.

In case of high yielding variety wheat, it is observed that along with growth of irrigation the area has steadily increased from 21 thousand hectares in 1971-72 to 67 thousand hectares in 1981-82. Summer vegetables also show an increasing trend so far as the area under it is concerned with the increased irrigation facilities.[9]

The changes in the crop pattern as evidenced from the macro-analysis in the state, are also discernible from certain micro studies undertaken in different areas in Orissa. A few illustration support the conclusions arrived at earlier.

The report on Dhenei Medium Irrigation Project Survey undertaken by Bureau of Statistics and Economics Orissa, found out that, while in unirrigated villages there is a greater dependence on kharif crop and kharif cultivation is restricted mainly to paddy, in irrigated villages there is diversification of cropping pattern with more crops raised, and larger acreage cropped particularly in the second crop season or

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9 T. Satpathy. Irrigation and Economic Development, 1984, pp. 44-45.

rabi season.[10]

Ansari, in a micro-study in Delta Irrigation Project area found out that in rabi season, there are significant differences in cropping pattern between irrigated and unirrigated villages. On the other hand, high yielding varieties of paddy are grown in irrigated villages, on about 60 per cent of net sown area.[11]

Similar findings are also available from different studies undertaken by the World Bank, Bureau of Statistics and Economics, Orissa State Evaluation Organisation.[12]

Study undertaken by Agricultural Economics Research Centre, University of Delhi regarding the Evaluation of Investment on Tubewells and Land Development in Sangrur District of Punjab also indicates the change in cropping pattern towards market oriented crops as a result of introduction of tubewell irrigation. Survey indicates that significant change in cropping pattern, has been the increase in area under kharif crops. It increased from 527 acres to 995 acres, that is by 89 per cent. The area under rabi crops

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10 Report on Dhenei Medium Irrigation Project Survey, Bureau of Statistics and Economics, Government of Orissa, Bhubaneshwar, 1973, p. 29.

11 Nasim Ansari. Report on the Evaluation of Mahanadi Delta Irrigation, Planning and Co-ordination Department, Government of Orissa, 1974, Mimeo. p. 19.

12 Draft Report of the World Bank Committee on Food Production in Orissa, Directorate of Agriculture and Food Production, Government of Orissa, 1976, p. 20.

increased from 626 acres to 942 acres, that is by 69 per cent. Wheat is the most important rabi crop accounting for 41.8 per cent increased to 42.1 per cent after irrigation. Paddy, the important kharif crop, area under it increased from 5.94 to 31.56 per cent after irrigation. Thus while wheat showed a marginal increase, cultivation of paddy increased substantially.[13] Thus it is seen that in Punjab even the well irrigation leads to growing paddy which may be considered as a crop grown entirely for market.

S. P. Pal is of the view that irrigation can contribute to total agricultural production by influencing the farmers land allocation decision towards the high valued and high yielding crops. He has presented the cropping pattern data in irrigated and unirrigated lands for three states of India, viz. Andhra Pradesh, Gujarat and Uttar Pradesh.

The results are presented in Tables 5.5, 5.6 and 5.7. It is evident from Table 5.5 that there is no perceptible change in crop mix with the increase in level of irrigation from 1952-53 to 1977-78. Paddy dominates with around 80 per cent of irrigated area. Inferior cereals and pulses show decrease in irrigated area while there is some increase under oilseeds and sugarcane.

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13 H. Laxminarayan. Evaluation of Investment on Tube-wells and Land Development in Sangrur, District of Punjab, Agricultural Economic Research Centre, University of Delhi, 1985, p. 31.

Table 5.5 : Cropping Pattern Percentage in Irrigated and Unirrigated Areas - Andhra Pradesh

Period	Rice	Jowar	Bajra	Maize	Ragi	Pulse	Cotton	Sugar-cane	Oil-seeds	Tobacco	Other crops	Gross irrigated area as a percentage of gross cropped area (level of irrigation)
1952-53												
Total area	18.6	23.8	5.8	1.6	2.8	11.1	2.9	0.5	16.3	1.4	15.2	
Irrigated area	78.2	1.4	2.7	0.9	6.5	0.5	Neg.	2.3	1.4	0.9	5.2	22.4
Unirrigated area	1.4	30.2	6.7	1.7	1.7	14.2	3.7	Neg.	20.6	1.5	18.3	
1964-65												
Total area	27.1	19.6	4.7	1.6	2.7	11.0	2.9	1.1	13.3	1.3	14.7	
Irrigated area	82.0	0.3	1.3	1.3	3.3	0.2	0.1	3.7	2.5	0.4	4.9	30.2
Unirrigated area	3.4	27.9	6.1	1.8	2.4	15.6	4.1	Neg.	17.9	1.7	19.1	
1977-78												
Total area	29.2	18.4	4.5	2.4	2.6	10.3	3.3	1.6	10.9	2.3	14.5	
Irrigated area	78.9	0.6	1.4	1.2	2.8	Neg.	0.9	4.4	4.1	0.6	5.1	34.9
Unirrigated area	2.5	28.0	6.2	3.1	2.5	15.9	4.6	Neg.	14.6	3.2	19.4	

Source : S. P. Pal. Contribution of Irrigation to Agricultural Production and Productivity, Table 4.1, p. 44.

Table 5.6 : Cropping Pattern Percentage in Irrigated and Unirrigated Areas - Gujarat

Period	Rice	Jowar	Bajra	Maize	Ragi	Wheat	Oil-seeds	Cotton	Sugar-cane	Tobacco	Pulse	Other crops	Gross irrigated area as a percentage of gross cropped area (level of irrigation)
1960-61													
Total area	5.5	13.5	14.7	2.3	0.8	3.7	22.5	18.5	0.3	0.9	5.2	12.1	
Irrigated area	9.0	4.4	5.2	1.2	-	29.7	5.4	14.3	3.5	2.1	1.0	24.2	7.5
Unirrigated area	5.2	14.2	15.5	2.4	0.9	1.5	23.9	18.8	-	0.9	5.6	11.1	
1971-72													
Total area	4.9	10.5	11.3	2.5	0.4	5.0	21.4	21.0	0.4	0.8	4.5	17.3	
Irrigated area	10.7	1.8	4.5	0.3	-	24.7	0.5	28.4	2.8	2.9	0.7	22.7	14.6
Unirrigated area	3.9	11.9	12.4	2.9	0.4	1.7	24.1	19.8	-	0.5	5.2	17.2	
1977-78													
Total area	4.7	10.0	13.2	2.6	0.5	6.6	22.0	17.7	0.6	0.8	4.4	16.9	
Irrigated area	7.3	1.9	8.8	0.2	-	27.8	6.2	21.9	3.4	2.8	0.4	19.3	17.5
Unirrigated area	4.1	11.6	14.2	3.2	0.6	2.1	25.4	16.8	-	0.4	5.2	16.4	

Source : S. P. Pal. Contribution of Irrigation to Agricultural Production and Productivity, NCAER, February 1985, Table 4.2, p. 45.

Table 5.7 : Cropping Pattern Percentage in Irrigated and Unirrigated Areas - Uttar Pradesh

Period	Rice	Jowar	Bajra	Maize	Ragi	Wheat	Oil-seeds	Cotton	Sugar-cane	Pulse	Other crops	Gross irrigated area as a percentage of gross cropped area (level of irrigation)
1952-53												
Total area	19.3	4.7	5.2	4.2	0.9	16.7	1.8	0.2	5.1	20.9	21.0	
Irrigated area	8.2	0.3	Neg.	0.7	0.2	31.3	-	0.4	13.3	20.2	25.4	26.1
Unirrigated area	23.2	6.3	7.1	5.4	1.2	11.4	2.5	0.1	2.2	21.1	19.5	
1971-72												
Total area	20.6	2.7	4.1	6.4	1.2	26.3	3.2	0.2	5.5	15.3	14.5	
Irrigated area	8.4	0.1	Neg.	1.6	Neg.	50.5	1.1	0.6	10.4	11.6	15.8	34.9
Unirrigated area	27.0	4.1	6.3	9.0	1.8	13.3	4.3	0.1	2.9	17.3	13.9	
1977-78												
Total area	20.8	2.9	4.2	5.1	0.7	29.0	4.0	0.1	7.0	12.8	13.4	
Irrigated area	10.9	Neg.	Neg.	1.5	Neg.	53.6	1.9	0.2	12.7	7.3	12.0	42.9
Unirrigated area	28.3	5.3	7.3	7.9	1.3	10.5	5.6	Neg.	2.8	17.0	14.3	

Source : S. P. Pal. Contribution of Irrigation to Agricultural Production and Productivity, NCAER, Table 4.3, p. 46.

Table 5.6 indicates that there is no discernible change except in the case of cotton from 1960-61 to 1971-72 in Gujarat.

Table 5.7 shows the considerable increase in area under wheat but no change under cotton, sugarcane, and oilseeds. Moreover, area under pulses declined considerably while area under oilseeds increased marginally. Thus in Uttar Pradesh, except wheat there is no noteworthy change in cropping pattern during 1952-53 to 1977-78.

Study conducted by the Bank of India Monitoring and Evaluation Division regarding impact of minor irrigation on small and marginal farmers in Hazaribagh District (Bihar) indicates that well irrigation induces change in cropping pattern with some preference for market oriented crops.

In the post-borrowing period, 80.48 per cent of the beneficiaries cropped area was accounted for by foodgrains as against about 90.20 per cent in the pre-borrowing period. This reflects increased preference of the sample beneficiaries for cash crops following improvement in the provision of irrigation. Share of area under rice had sharply declined from 62.39 per cent in the pre-borrowing period to 39.73 per cent in post-borrowing period, the share of wheat almost tripled from 5.14 per cent to 15.85 per cent over the same period.

In case of cash crops, the share of sugarcane and vegetables increased from less than one per cent in the pre-

borrowing period to 3.69 per cent and 4.69 per cent respectively in the post-borrowing period. The share of potato increased from 1.39 per cent to 5.96 per cent during the same period.[14] This reflects the growing preference of the borrowers towards market oriented crops like wheat, sugarcane, potato and vegetables.

M. V. Nadkarni and others in their study Impact of Irrigation in Karnataka also observe the substantial change in cropping pattern consequent upon the introduction of irrigation. They studied three types of sample villages, wet, perennial and DCW (Dry-cum-wet) villages.

Before the introduction of canal irrigation, jowar, bajra, navane and cotton were the important major crops, which accounted for 98.05 per cent of their total dry area in DCW villages. After the introduction of irrigation farmers in DCW villages started wheat cultivation which accounted for 13.89 per cent of their total cropped area. The area under bajra increased from about 2 per cent to 21.38 per cent. However, the area under cotton decreased from 29.05 per cent before irrigation to 5.57 per cent after irrigation. Maize was a new addition to the crops cultivated in the DCW villages, constituted 2.62 per cent of the cropped area. Pulses were grown in about 4 per cent of the total cropped area in DCW villages.

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14 Impact of Minor Irrigation on Small and Marginal Farmers in Hazaribagh District (Bihar), Bank of India, Monitoring and Evaluation Division, pp. 33-35.

In the wet and perennial villages, jowar, navane and cotton were cultivated in about 75.38 per cent and 93.10 per cent of their respective total cropped area. Bajra was cultivated in about 12.71 per cent and 6.37 per cent of the cropped area in the wet and perennial villages respectively.

In wet villages, after the introduction of irrigation paddy was the most important irrigated crop which was cultivated in 31.38 per cent of their total cropped area. A major change in cropping pattern is found in respect of jowar. The area cultivated under jowar before irrigation was about 30 per cent of GCA, it declined to about 18 per cent of GCA in the wet villages. Introduction of irrigation in the wet villages show a significant decline in the proportion of area under jowar, navane, cotton and groundnut, but there was a relatively small decline in the area under bajra.

In perennial villages introduction of paddy and sugarcane crops considerably affected the cropping pattern-prevailed before the introduction of canal irrigation. The proportion of gross cropped area covered under paddy and sugarcane were 34.60 per cent and 7.62 per cent respectively in the villages. The area under jowar and navane declined to 22.80 per cent and 6.09 per cent of the GCA. The area under cotton went down from 26.90 per cent to 17.85 per cent. Other remarkable shift was in respect of maize and groundnut which covered 1.08 per cent and 6.45 per cent of the total cropped area. There was no land under the cultivation of

these two crops before the introduction of irrigation. Thus, in the perennial villages cultivation of superior crops like paddy and commercial crops like sugarcane and groundnut has considerably replaced the cultivation of inferior crops like jowar and navane.

Because of the three different characteristics of canal irrigation, the pattern of HYV cropping varies from one category of villages to another. In the DCW villages, wheat, bajra, cotton and maize are the major irrigated crops, and so the farmers have sown their HYV seeds. Bengal gram is not a major irrigated crop, but the cultivation of HYV Bengal gram is significant from the point of view of new practice. The farmers in the wet villages having paddy, bajra and cotton as major irrigated crops are reported to have used their HYV seed in their farm cultivation. In the perennial villages also, farmers have used the HYV seeds.[15]

Thus above analysis bears out that irrigation availability leads to change in cropping pattern either towards cash crops or superior varieties of the same crop depending upon the quality of irrigation and market orientation of the crops.

Sulabha Brahme states that the crop pattern varies considerably between different areas of the Maharashtra State according to the agro-climatic factors. The share of cereals

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15 M. V. Nadkarni and Other. Impact of Irrigation (Canal,Well and Tank), pp. 27-31.

and pulses in the total irrigated crops, declined from about 46 per cent in 1951 to 33 per cent in 1971, while that of sugarcane and horticultural crops, increased from 47 per cent to about 60 per cent in the same period. The additional water resources created, are mainly being utilised for voracious water consuming crops notably sugarcane.

She also examined the irrigation water made available at taluka level in the last two decades for the three scarcity zone districts viz. Ahmednagar, Sholapur and Pune. It is observed that in areas where the source of increase in the irrigation is mainly through wells which have relatively dependable water supply as these are located in the canal command areas, the major increase is in the cultivation of sugarcane. There is little or almost no increase in the irrigated area under foodgrains. In case the increase in irrigation is due to the extension of canal irrigation because of restriction on cropping pattern in canal command areas, increase in the area under sugarcane as well as the area under foodgrain is noted.

For the above three districts together the irrigated area increased from 3.1 lakh hectares to 4.3 lakh hectares between 1950-51 and 1969-70. The area under foodgrains increased from 2.0 lakh to 2.5 lakh hectares and that under sugarcane from 0.32 lakh hectares to 0.84 lakh hectares.[16]

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16 Sulabha Brahme. Irrigation Imperative for Agricultural Development in Maharashtra - Lessons from Drought 1972, Gokhale Institute of Politics and Economics, Pune, 1976, pp. 8 and 76.

Thus above analysis indicates that irrigation results in the change in cropping pattern generally in favour of cash crop like sugarcane. This is because superior cereals like paddy, wheat are not suitable for these tracts. But of late there has been increase in area under hot-weather groundnut which is irrigated.

R. P. Singh also observes the change in cropping pattern from inferior variety to superior variety of cereals in Bihar. He studies the changes in production in the Kosi area and in non-Kosi area. He found that in case of local paddy, average area planted decreased from 2.90 hectares in 1970 to 2.20 hectares in 1978 i.e. it decreased by 19 per cent. At the same time, average area planted of HYV paddy increased from 0.72 hectare to 1.14 hectares i.e. it increased by 58 per cent. In case of wheat average area planted increased from 0.78 hectare in 1970 to 0.95 hectare in 1978, thus showing an increase of 22 per cent. He thus concludes that trends in cropping pattern of two main crops - viz. paddy and wheat - showed a weaker trend prior to introduction of HYV. Indeed, the difference made by the Kosi project was more evident after HYV made production profitable.[17] This indicates that availability of canal irrigation encouraged the introduction of HYV and thus brought about change in cropping pattern.

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17 R. P. Singh. Effect of Irrigation on Production and Input Use - A Case Study of Kosi Irrigation Project, Economic and Political Weekly, Review of Agriculture, June 1983, pp. A-64 - A-70.

However, according to B. D. Dhawan that crop pattern would become more market oriented in the wake of irrigation is understandable because not all the additional output due to irrigation is likely to be obsorbed in self-consumption. Given the pressure for production for the market, it is questionable to presume that the cropping pattern would shift in favour of non-food or non-grain crops, once irrigation is introduced. While irrigation is often a necessity for raising a few non-grain crops such as sugarcane and vegetables, many a non-grain crops from the family of oilseeds and fibre crops are raised in many parts of India, without the aid of irrigation. Thus according to him it is not a very well placed conception that irrigation encourages the production of non-foodgrains at the expense of foodgrains. He agrees that advent of HYV seeds for cereal crops has tilted the scales in favour of cereal crops to the extent irrigation is a must for the cultivation of these new varieties.[18]

T. V. Moorti and John W. Mellor also observe the effect of irrigation on cropping pattern. According to them until very recently irrigation programmes were considered as protective rather than productive for intensification of crop production. But the evolution of high yielding varieties which require huge quantity of water, has changed the

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18 B. D. Dhawan. Questionable Conceptions and Simplistic Views about Irrigated Agriculture of India, Indian Journal of Agricultural Economics, Jan-March 1985, p. 9.

vicissitudes of irrigation policies. However, according to them though irrigation results in change in cropping pattern in favour of high yielding varieties, ownership of sources of irrigation may reflect the cropping pattern. Greater availability and reliability of water supply from the private tube-wells reflect on the crops grown. They grow more of high yielding varieties which primarily depend on irrigation. Crops, which require water in summer like vegetables,American cotton are sown only on farms irrigated by the private tube-wells. The state tube-well farms, on the other hand, have to devote more area under arhar and wheat mixture (with desi variety) because of the uncertainty of water.[19]

Study report of the Government of Haryana of the impact of three irrigation bunds in tahsil Narnaul (1972) also reveals that irrigation leads to change in cropping pattern. The study was undertaken in 1970 and cover the period from 1963-64 to 1968-69.

The land in tahsil is heterogeneous, consisting of valleys, hillocks and uneven land. It receives hardly 20 inches of rainfall and is usually confined to the months of July to August. This tract is away from any perennial river. Due to absence of these facilities agriculture is in a precarious condition in this tahsil. The only possibility of

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19 T. V. Moorti and John W. Mellor, A Comparative Study of Costs and Benefits of Irrigation from State and Private Tubewells in U.P., Indian Journal of Agricultural Economics, Jan-March 1973, pp. 181-189.

providing irrigation facility is through minor irrigation works. Several bunds were, therefore constructed in Narnaul tahsil. Out of these, the following three bunds were selected for detailed study.

1) Ropar Sarai
2) Mosnoota
3) Mehgot Binja

Before the bunds were constructed i.e. before 1968-69, 91 per cent of total cropped area was under food crops and most of the area was occupied by low value food crops, like bajra, barley and gram. These crops were preferred since they ensured some return even in adverse climatic conditions. The high value crops like rice, sugarcane and cotton were not sown at all in the village. The only cash crop worth mentioning was oilseeds. Change in cropping pattern is evident from Table 5.8.

Table 5.8 indicates that the area under jowar, gram and oilseeds had decreased and area under bajra, wheat and barley had increased in 1968-69 as compared to 1963-64. Fodder which was not previously grown was taken up during 1968-69. Thus introduction of irrigation has led to change in crop mix (wheat, barley etc.) but not to shift away from foodgrains.[20]

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20 Study Report of the Impact of Three Irrigation Bunds in Tahsil Narnaul, District Mahendragarh, Government of Haryana, p. 3.

Table 5.8 : Change in Cropping Pattern

(Acres)

Crop	1963-64		1968-69		Increase/Decrease	
	Area	% to total	Area	% to total	Area	Percentage
Jowar	12	2	7	1	-5	-42
Bajra	405	55	450	55	45	11
Wheat	16	2	35	4	19	119
Barley	29	4	144	18	115	397
Other cereals	-	-	-	-	-	-
Gram	172	24	101	12	-71	-41
Other pulses	-	-	8	1	8	-
Vegetables	3	1	10	1	7	233
Oilseeds	94	13	43	5	-51	-54
Fodder	-	-	18	2	18	-
Total	731	100	816	100	85	12

Source : Study Report of the Impact of Irrigation Bunds in Tahsil Narnaul, 1972, Table 3, p. 3.

However, table does not indicate a very noteworthy change, possibly because quality of irrigation is poor.

Divakar Jha also observes the change in cropping pattern towards more concentration of foodgrains as a result of irrigation. He has made expost assessment of the benefits of irrigation of Tribeni canal. His report is based on an intensive survey of farm households in Champaran district of Bihar irrigated by Tribeni canal.

The author has classified the crop pattern in two major groups, 'food crops' and 'cash crops'. The enquiry has revealed that in the project area 92.15 per cent of the total cropped area is utilised for food crops, and 7.85 per cent for cash crops. Among the food crops, paddy is the most important crop grown in this area in as much as 72.84 per cent of the total cropped area is cultivated for growing paddy, 7.27 per cent for wheat, 17.74 per cent for pulses and 2.25 per cent for other miscellaneous crops as stated above. Among the cash crops sugarcane is the only crop cultivated in this area, 7.77 per cent of the cropped area is utilised for sugarcane.

In the control area 76.82 per cent of land is utilised for food crops as against 92.15 per cent in the project area. Rice cultivation occupy 66.68 per cent of area in the control area. Sugarcane occupies 22.89 per cent of total cultivated area in the non-irrigated zone as against only 7.77 per cent in the irrigated zone (project area). This may feel contradictory that more sugarcane is grown in unirrigated zone.

There is a reason behind it. Distinction between paddy as a food crop and sugarcane as a cash crop has been very much reduced in recent years (p.461). Due to the scarcity of rice production it has assumed the character of cash crop with a high price and easy marketability. A sugarcane is a crop of full year, but farmers can grow summer and winter paddy as well as pulses in the same field. For these reasons, rice is cultivated in nearly 9/10ths of the area in the irrigated zone. Land utilisation for wheat cultivation is greater in the control area (18.35 per cent) as against only 7.27 per cent in the irrigated area. In the irrigated area, 17.74 per cent of land is cultivated for several types of pulse crops, which is only 5.88 per cent in the control area.

Thus it is apparent that irrigation has contributed in no small measure to the concentration of paddy and pulses in the irrigated area but diminished the production of wheat, sugarcane and miscellaneous crops comparatively to the crop pattern of the control area.[21]

From the preceding discussion it is clear that though crop mix changes due to availability of irrigation it does not necessarily lead to complete alteration in the cropping pattern. Some of the important studies reviewed in this chapter also suggest that although in general there is no departure from the food crops dominant cropping pattern to

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21 Divakar Jha. Evaluation of Benefits of Irrigation Tribeni Canal Report, 1967, pp. 77-84.

non-food crops prominent cropping pattern due to the introduction of irrigation, there is considerable shift to the high yielding varieties and to superior high value cereals crop from the traditional varieties and inferior cereals. This has certainly contributed significantly to increase in production which may be attributed to irrigation.

However, it should be mentioned here that the concept of cash crop depends upon the market orientation of a crop in a given region and its suitability for cultivation in that region, like sugarcane in Maharashtra, paddy in Andhra Pradesh, Tamil Nadu, Karnataka, wheat and paddy in Punjab, Haryana, U.P. etc. However, even in Maharashtra though well irrigation sources show a change in crop mix from cereals to sugarcane, the surface irrigation sources show no such perceptible change because of restriction on growing sugarcane on canal irrigation.

Lastly, inception of irrigation does not seem to have favourably affected the area under pulses and oilseeds in any region.

CHAPTER VI

SUMMARY AND CONCLUSIONS

In this study attempt has been made to review the quantitative and qualitative changes brought about by irrigation on agricultural production. Irrigation can contribute to agricultural production in three ways. It raises yield per unit area by inducing the use of other complementary inputs like fertilizer, pesticides, HYV seeds etc. It leads to an expansion of gross cropped area by making double and multiple cropping possible. It may also contribute to production by enabling farmers to allocate their lands to high yielding, high value and water responsive crop.

Measuring the contribution of irrigation is a controversial issue as irrigation by itself may not contribute very significantly to production. Irrigation induces the use of other inputs (fertilizers, HYV seeds etc.) which in turn raise productivity. The use of these yield raising inputs is however possible even in unirrigated land, but their yield response may not be significant. We may therefore consider that but for irrigation the use of fertilizer etc. and fertilizer responsive varieties introduced in the post-irrigation period would not have come about, hence the contribution of irrigation in production increases is very significant.

However, the effect of irrigation on agricultural production depends on the quality of irrigation i.e. whether the irrigation is productive or protective in nature. If use of irrigation is made only to supplement the water requirement of rainfed crop during monsoon season then its effect may be significant mainly in slowing down fluctuations in production. But if this irrigation water in addition is used to raise the rabi or summer crop, then it would contribute significantly to production increases.

After reviewing the literature regarding the effect of irrigation on production, some of the major conclusions that emerge are as under.

1) Irrigation results in expansion of gross cropped area through double/multiple cropping. Main studies reviewed show that there are limitations in raising more than one crop in unirrigated land on large scale. Double cropping is possible only in areas endowed with suitable climatic conditions and assured rainfall. Except in kharif season, rainfall in most part of India is highly uncertain and the risk in growing a second crop, at least in rabi or summer season, must be very high. Irrigation eliminates such risk and can make double or multiple cropping possible. Also area effect of irrigation operates through positive interaction of two components i.e. increase in net sown area and increase in cropping intensity. Irrigation facilitates reclamation of waste land and extends

cultivation to hitherto uncultivated area. Increase in cropping intensity is mainly due to the summer irrigation facilities. However, it should be remembered that this again depends on quality of irrigation i.e. whether it is used as productive or protective measure. And irrigation will result in increase in gross cropped area only when it is used as a productive measure and not to supplement the rainfed crop during monsoon.

2) However, effect of irrigation on area expansion in case of minor irrigation is more significant than major and medium (surface) irrigation. Since area covered by minor sources is smaller compared to surface irrigation, and quality of minor irrigation is best known to farmers than major,medium irrigation, farmers can command the best use of water from minor sources than major and medium sources. Therefore minor sources are likely to result significantly in increase of area under cultivation and gross cropped area.

3) Irrigation has a positive effect on yield per hectare. It increases the productivity of land per unit of area. Studies reviewed indicate the positive correlation between availability of irrigation facilities and yield per hectare. Dhawan's study shows that except for the Central Indian states and the State of Bihar, yield under irrigated land are substantially higher than those under unirrigated lands. Other studies also observe the yield difference

before and after irrigation project, and reveal the positive effect of irrigation on yield. Again yield differences would vary from region to region. A region endowed with good rainfall, the yield difference between irrigated and rainfed crops may not be very significant. Further, a shift from indigenous variety to HYV and from inferior cereals to superior cereals in the post-irrigation period would also bring about a significant difference between the yield of irrigated and rainfed crops. However, many other studies reviewed indicate the positive association between irrigation and yield per hectare.

4) Irrigation raises yield per unit of area by inducing the use of other complementary inputs like fertilizers, pesticides, HYV seeds etc. The use of these yield raising inputs is however possible in unirrigated land but their yield response may not be significant.

5) Though irrigation results in change in cropping pattern or crop-mix, it does not necessarily change the crop pattern from food crops to non-food or cash crops. A glance at the statistics in different studies reveal the fact that there is very marginal change in cropping pattern from food crops to non-food crops as a whole, even during the period depicting large scale increase in irrigation. Some of the important studies reviewed also come to the conclusion that there is no break through in cropping pattern as a result of introduction of irrigation.

6) Change in cropping pattern is mainly confined within broad groups of foodgrains and non-foodgrains, from inferior variety to superior variety; studies reviewed reveal the same trend. Therefore we can say that there is no departure from food crops dominant cropping pattern to non-food crops prominent cropping pattern due to introduction of irrigation, but there is a considerable shift to high yielding varieties and superior high valued crops from the traditional and inferior varieties.

7) However, irrigation results in initiating the interaction of these three important component i.e. area effect, yield effect and cropping pattern effect and thereby results in increase in agricultural production. It is also observed that both extension of irrigation facilities and quality of irrigation contribute to agricultural production.

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