

**GROWTH PATTERN OF IRRIGATION AND EFFECT OF IRRIGATION ON
MULTI-CROPPING IN RAJASTHAN**

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ABSTRACT

The Study was organized to find out about the change in patterns of irrigation sources as well as crop wise gross irrigation with their growth and instability. Irrigation as determinant used to find out impact of irrigation on multiple cropping. Period of study was 1968-69 to 2010-11 source of data used were secondary and analytical tool were used as three years average, semi log model, regression model and instability index. It was found that Wells were on first position as a source of irrigation followed by canals in TE 1970-71 and reached to third relative important source in TE 2010-11. Area irrigation by Tanks decreasing continuously and Irrigation by Tube Well were becoming popular. Food grains were having larger share and among them cereals having highest recipient of irrigation though cereals were losing relative share over the period of time and oilseed specially Rape & Mustard were gainer in area irrigated. In Crop wise Annual Combined Growth Rate of Irrigation maize and barley were the largest loser with and highest growth rate in drug & narcotics followed by Rice. Foodgrain crops and Cereals were showing very slow growth in this study period. Instability was highest in Groundnut, castor seed and Sesamum. To see the effect on multiple cropping two variables chosen, Irrigation Ratio (GIA to NSA) and Rainfall both have significant effect on multiple cropping among them irrigation ratio has as 68.5 percent effect which was higher than rainfall and significant statistically.

1. INTRODUCTION

Rajasthan as a state having largest geographical area of India with having 10.41 percent comprising nine agro- climatic zones with having huge regional diversity. Agriculture sector was found crucial in Rajasthan as agriculture contributing 22.09 percent in 2011-12 in State Domestic Product at Constant (2004-05) Prices (Economic review of Rajasthan 2011-12), rural population was 75.10 percent in the state and around 74.2 percent out of total workers are either cultivator or agricultural labours (Some facts about Rajasthan 2012). Even having such an important sector have natural constraint in growth and severely affected by short of rainfall. Except some pockets drought and famine were treated as normal in Rajasthan as per table 5 given in appendix it can be said that during depicted 19 years only two lucky years first one is 2003-04 where number of affected districts were only 3 and in 2010-11 number of affected districts were 2. Incidence of famine was less than half districts was found in 1992-93, 2007-08 and 2008-09 where number of affected districts were 12. There were five years where almost entire state was under effect of famine these years were 1995-96 having 29 affected districts in 1991-92 this number was 30 in 2000-01 and in 2004-05 total 31 districts were affected and in 2002-03 highest 32 districts out of 33 were affected. In such a situation there was a need for assured supplies of water which can be only through irrigation system. Irrigation mean the

process of providing water to crops through artificial means such as wells, tube wells, tank, canals, tanks or ponds. Apart from it though irrigation moisture of soil can be maintained during cropping period to ensure proper growth of crop along with it area under the crop can be increasing by using more land or using same land more than once. After the spread of green revolution need of dependable and assured water supply became more strong due to heavy cost of input used.

ORGANIZATION OF STUDY: The paper is mainly divided into seven parts. The first part comprises with introduction about the subject matter, second part like review of literature, in the third part methodology and objectives comprising with sub parts like data source, research gap, statistical tools to be used, hypothesis and objectives of the study will be discussed, in fourth part results and its discussion and in fifth part summary and conclusion will be discussed and sixth part will consist references and in seventh part appendix was used in the paper.

2. REVIEW OF LITERATURE

Moorthi T.V. and Mellor W.J. (1972) after a study on Cropping Pattern Yields and Income under Different Sources of Irrigation with Special Reference to IADP, Aligarh District, Uttar Pradesh, concluded that farmers having private tube-wells can manage timely availability in adequate quantity of irrigation in this way they were found better off than others which resulted in higher cropping intensity, yield, higher crop income and cultivation of high yielding crops in such farms.

Bagi.F.S (1981) analyzed in the study economic contribution of irrigation in crop production with the help of primary survey with 119 individuals. Value of irrigation was used as a variable with other value and non value variables and it was argued as stated that "irrigation improves the technical and allocation efficiency of crop production." It was concluded that except labour all inputs were underutilized and output per hectare was much higher in case of irrigated land.

Mahendradev, S. (1987) studied about growth and instability and irrigation was pointed out as a major factor determine growth and variability in crop production. Percentage of net sown area irrigated at the all India level was found increased by around 60 per cent during the period between 1960-61 to 1983-84. Level of irrigation was lowest 10.7 per cent in Maharashtra and highest 85.7 per cent in Punjab in 1983-84.

B. D. Dhawan (1988) examines the productivity of land under irrigation, different types of irrigation and the effect of irrigation on the stability of agricultural production as well as income gains from irrigation with land size holding. It was found that in four states of Maharashtra, Tamil Nadu, Punjab and Uttar Pradesh, is that benefits from irrigation were proportionately to every household and benefits need not rise with the size of a farm holding because of equality in fertilizer and other equipment use. Maharashtra and UP surveys did not have that much of equality in input use like fertilizer machine so benefits from each unit of irrigated area was found positively associated with farm size. It was argued that land redistribution and public irrigation have equalization effect and strongly favorable to small farmers.

B. D. Dhawan and Harsharan Singh Datta (1992) find out impact of irrigation on multiple cropping of India agriculture using time series data from 1950-61 -1o 1987-88 at all India level. Linear multiple regression model was used taking cropping intensity as a dependent variable and irrigation intensity as one of the independent variable. Close relationship between irrigation development and the rise in intensity of cropping was found at significant level at the all-India level.

Sawant S D Achuthan C V (1995) analysed in the study about the crop output growth and the sources of output growth at region wise at the national level using the secondary data. Irrigation was analyzed as an associated factor required for adoption of new technology. It was found that share of southern and eastern region was 2.2 percent each in all India between 1970-71 to 1980-81 and became 16.0 percent in southern and 24 percent in eastern between 1980-81 to 1990-91. Share of western region was decreased from 18.3 percent to 6.4 percent and in north eastern region it decreased from 15.5 percent to 10.7 percent in the same period. It can be argued from data that irrigation facilities were developed faster in southern and eastern region than other are.

Rawal Vikasand, Swaminatha Madhura (1998) in a detailed study of with the objective to examines the record of agricultural growth over the last 50 years in West Bengal. An impressive development in irrigation was observed since since 1980s. It was found that West Bengal has outperformed India between 1976-77 and 1985-86 firstly in terms of total increase in net irrigated area in West Bengal during this period was of the order of 74 per cent as compared to about 20 per cent in India. Secondly area irrigated by tubewells increased by as much as 575 per cent in West Bengal as compared to about 60 per cent in India. Thirdly area irrigated by tanks and ponds increased in West Bengal-in contradistinction to the general deterioration of tank-irrigation in India.

Vakulabharanam Vamsi (2004) analyzed in the study about agriculture and irrigation in Telangana using kinked-exponential growth rates model. Study was divided in two separate periods - 1971-85 and 1985-2001 for area irrigated by sources. Area under tank irrigation decreased mostly in the first period. Area under canal irrigation decelerated in the later period. Area under well irrigation accelerated and found major source of growth using private capital, which has adverse impact on underground water levels and it was indicated one of the source of immiserisation of marginal and small peasants.

Narayanamoorthy, A. (2007) The objective of this section is to discover the role of groundwater irrigation in determining rural poverty across the India. It was found a significant inverse relationship between the incidence of rural poverty and groundwater irrigated area per thousand rural population.. Groundwater irrigated area was used as one of the explanatory variables along with other poverty-related variables in multiple regression analysis, it was turned out to a significant factor in determining rural poverty.

Kannan E (2011) using the proportion of gross area irrigated to gross cropped area and proportion of Net Irrigated Area to Net Cropped Area argued that all efforts of huge funded irrigation projects percent irrigation in any segment could not cross 20 percent area in Maharasta state till TE 2004-05.

Need for study RESEARCH GAP

It was observed that there was reasonable work has been done in irrigation at national level but also very limited. Since Rajasthan was known for THAR desert so irrigation in the state did not get much attention. Crop wise irrigation field was rarely chosen by any researchers. In this study effort was made to include every major crop and possible longest period so long term trend can be observed. In this way this wide horizon of the study with long period of time will make it significant addition in this area field.

3. OBJECTIVES AND METHODOLOGY

OBJECTIVES OF THE STUDY:

In such a scenario where agriculture has very supportive role in state's income and having several backward and forward linkages so it is an effort to observe the change in agricultural situation through these small steps

1. To find out pattern of gross of irrigated area from 1968-69 to 2010-11 in Rajasthan
2. To find out pattern of crop wise irrigation in Rajasthan from 1968-69 to 2010-11.
3. To find out growth and instability of irrigation of crop wise irrigation in Rajasthan from 1968-69 to 2010-11.
4. Impact of Irrigation on Multiple Cropping in Rajasthan from 1968-69 to 2010-11.

Hypothesis

Hypothesis to be tested in this study were as follows

1. There is positive growth of irrigated area.
2. There is positive and significant effect of irrigation on multiple cropping.

Data and data Source:

Data in the study used were secondary and published sources form Directorate of Economics and Statistics, Department of Planning, Rajasthan, Yojana Bhawan, Jaipur, Government of Rajasthan. Various issues of Agricultural Statistics Rajasthan, "50 Years of Agricultural Statistics of Rajasthan (1956-57 - 2005-06)", Some Facts about Rajasthan 2013.

Period and Coverage of study:

Period of study was from 1967-68 to 2010-11 using time series data of agricultural production. Coverage of the study was entire gross and net irrigated area with all given sources of irrigation and state level. For sources of irrigation five sources were chosen as Canals, Tanks, Tubewells, Wells and Other sources as given in the agricultural statistics. Selection of growth of gross and net irrigated area crop-wise was chosen and for that all major categories of crops was taken keeping in mind to give representation to every segment of agricultural production. For this cropping pattern of state for current year 2010-11 was used and all crops and categories

which having area under the crop at least half percent were shortlisted for study.

All major crops were also taken to make picture more clear from foodgrain both cereals and pulses were taken from cereals Rice, Jowar, Bajra, Maize Wheat and Barley were selected. From pulses only gram was selected. From Oilseeds category Groundnut, Sesamum, Castor seed, Soyabean and Rape & mustard were taken. From Fodder crop category only Guarseed was the prominent crop and it was chosen. Rest crop categories were having less than 6 percent area under the crop so only categories were taken and their crops were ignored.

Tools and Techniques

In order to meet objectives of the study following tools and techniques were used

Three year average

Agriculture production in Rajasthan is highly unstable and uncertain, and it is frequently faced by famines and scarcity. To examine cropping pattern three years moving average was taken for area under the crop and production of the crop and term which was used by several researcher Triennium Ending [TE] as it was indicating end period of three years average of the desired variable such as area under the irrigation crop and production of the individual crop. Individual variable of any year may be abnormal then nearby and conclusion based on these can mislead.

Percentage change

Percentage Change in Y

$$(Y_{t+1} - Y_t) / Y_t \times 100$$

Y_{t+1} = Value of variable at next level

Y_t = Value of variable at present level

Proportion

Share of variable out of total has been used to demonstrate relative change

$$\text{Proportion} = (\text{Value of Variable} / \text{Total Value}) \times 100$$

Cropping Intensity

Cropping Intensity is simply a the ratio of gross cropped area to net cropped area and it denotes the intensification of use of land under cultivation. It is one of the measure to increase output using same land more than once.

$$\text{Cropping Intensity} = (\text{Total Cropped Area} / \text{Net Area Sown}) \times 100$$

Percent Irrigation

Irrigation Intensity is simply ratio of gross irrigated to net sown area in per cent which indicates the intense use of irrigation facility

Percent Irrigation = (Gross Irrigated Area/ Net Area Soan) x100

Annual Compound Growth rate

To compute annual growth rate with the date with a particular gap formula of compound growth rate was used

Compound Annual growth rate = [(Y_{present}/ Y_{initial})^{1/n} -1] x100

Y_{present} = Value of variable at present level

Y_{initial} = Value of variable at beginning

n = Number of years

Semi log models for Compound Growth rate

To obtained compound growth rate several researchers used semi log function as Kaushik K.K.(1993). In the study for computation of compound growth rates in Agriculture, K.P. Chandran (2005) suggested using natural log as good model depicted as under

$$\ln Y_t = \alpha + \beta t + \varepsilon$$

where

$$\alpha = \ln Y_0$$

$$\beta = \ln(1 + r)$$

ε = Error term

r = Compound rate of growth of Y

Y_t = Value of variable at present level

Y₀ = Value of variable at begning

t = time

Instability Index:

Instability Index has been used by several researchers which was also used by Chand R and Raju S.S. (2009). Same tool was used to find out instability in production of various crops.

Instability index = Standard deviation of Natural Logarithm (Y_{t+1}/Y_t) x100

Y_{t+1} = Value of variable at next level

Y_t = Value of variable at present level

Regression model

Impact of Irrigation on Multiple Cropping was calculated as B. D. Dhawan and Harsharan Singh Datta (1992) dependent variable was cropping intensity and independent variable used were rainfall and percentage irrigation to net shown are

$$Y = a + bX_1 + cX_2$$

Y = Ratio of gross to net sown area in percent

X₁ = Irrigation ratio of gross irrigated to net sown area in per cent

X₂ = Rainfall

4. RESULTS AND DISCUSSION

Gross irrigated area source wise in thousand hectare, percentage to gross irrigated area and annual growth rates from 1968-69 to 2010-11 was given table 1. Among all four sources Canals, Tanks, Tube-wells and Wells in TE 1970-71 main source of irrigation was Wells with 1355.33 thousand hectare and 54.82 percent out of gross irrigated area followed by Canals with 837.33 thousand hectare and 33.87 percent then Tanks 251.33 thousand hectare with 10.17 percent and Tube-wells with 9.33 thousand hectare 0.38 percent out of gross irrigated area.

Gross Area Irrigated (GAI) in TE 80-81 was highest in Wells 2118.46 thousand hectare 56.32 percent out of total, from Canals 1242.28 thousand hectare 33.03 percent from Tanks 199.97 thousand hectare with 5.32 percent and lowest in Tube-wells 163.82 thousand hectare 4.36 percent. Relative share of Wells in total 54.82 percent in TE 70-71 which became 56.32 percent in TE 80-81 and remained stagnant for two decades as 48.86 percent in TE 90-91 and 49.15 percent in TE 2000-01 after its relative share of Wells decreased so drastically to 28.74 percent till TE 2010-11. It can be said on basis of change in relative share in Tub-wells as 0.38 percent only in TE 70-71 which was 4.36 percent in TE 80-81 and 8.39 percent in TE 90-91 which was 15.95 percent TE 2000-01 finally it became 39.92 percent in TE 2010-11.

Tanks were only one of major source of irrigation with 10.17 percent share TE 70-71 which loose to 5.32 percent in TE 80-81 and became 0.46 percent in TE 2010-11. In absolute area Tanks were having 251.33 thousand hectare area under irrigation in TE 1970-71 which became 36.46 thousand hectare TE 2010-11.

In absolute terms irrigation by Canals and Tube-wells has increased continuously, area under irrigation by Wells increased upto TE 2000-01 then shown shrink in it only Tanks as a source of irrigation were continuously losing importance. At the state level total area under the irrigation was increased from 2472.3 hectare in TE 1970-71 to 7847 hectare in TE 2010-11

In the percent terms Tubwell was main and continuous gainer in study period from 0.38 percent in TE 1970-71 to 39.92 percent in TE 2010-11 out of total. Annual growth rates of canals was 4.02 percent in TE 1970-71 to TE 80-81 it is continuously decreasing over the period of time but still remains positive as it only remains 0.68 percent in TE 2000-01 to TE 2010-11. Annual growth rates (AGR) of Tanks was -2.26 percent in TE 70-71 to TE 80-81 remains negative in entire period and its negativity increased over the period of time highest

negative growth was -6.98 percent in TE 90-91 to TE 2000-01. AGR of Tube Wells was highest in this group and 33.18 percent during TE 70-71 to TE 80-81 it was 8.69 percent during TE 80-81 to TE 1990-91 in TE 90-91 to TE 2000-01 it was 10.85 percent. AGR for Wells was have mixed AGR with wide variations as high 4.57 percent between TE 70-71 to TE 80-81 and -3.61 percent between TE 2000-01 to TE2010-11. AGR for other sources was high in 6.79 percent in TE 70-71 to TE 80-81 and it was decreasing but remains positive till 1990-91.

Table 1: SOURCE-WISE PATTERN AND ANNUAL GROWTH RATES OF GROSS IRRIGATED AREA FROM 1968-69 TO2010-11

Table 1: SOURCE-WISE PATTERN AND ANNUAL GROWTH OF GROSS IRRIGATED AREA from 1968-69 to 2010-11														
Year	Gross Area Irrigated (GAI) in thousand hectare					Percent Gross Area Irrigated (GAI) By Sources to total					Annual Growth Rates			
	TE 1970-71	TE 1980-81	TE 1990-91	TE 2000-01	TE 2010-11	TE 70-71	TE 80-81	TE 90-91	TE 2k-01	TE 2010-11	TE 70-71 to TE 80-81	TE 80-81 to TE 1990-91	TE 90-91 to TE 2000-01	TE2000-01 to TE2010-11
Canals	837.33	1242.3	1724.1	2190	2345	33.87	33.03	38.4	33.1	29.88	4.02	3.33	2.42	0.68
Tanks	251.33	199.97	152.48	73.94	36.5	10.17	5.32	3.39	1.12	0.46	-2.26	-2.67	-6.98	-6.83
Tube-wells	9.33	163.82	377.05	1057	3133	0.38	4.36	8.39	16	39.92	33.18	8.69	10.85	11.48
Wells	1355.3	2118.5	2195.3	3256	2256	54.82	56.32	48.9	49.2	28.74	4.57	0.36	4.02	-3.61
Other sources	19	36.64	43.94	48.85	77.7	0.77	0.97	0.98	0.74	0.99	6.79	1.83	1.06	4.75
Total	2472.3	3761.2	4492.8	6626	7847	100	100	100	100	100	4.28	1.79	3.96	1.71

Source: Compiled with the data collected from 50 Years of Agricultural Statistics of Rajasthan (1956-57 - 2005-06) and Agricultural Statistics Rajasthan various issues

Crop wise area under irrigation was analyzed on absolute as well as proportionate to total change. Absolute change was also important because demand of agricultural products is inelastic in nature crop might be cultivated on same or more than area but with rise in area under the crop with use of mechanics relatively the share might be losing. As per table 2 gross area irrigated under food crops was highest 1852.37 thousand hectare in TE 1970-71 in absolute terms it was kept increasing except TE 90-91 and became nearly doubled in TE 2010-11 as 3685.28 thousand hectare. Among the food crops two categories of crops were covered as cereals and pulses. Cereals were getting dominant part of irrigation than pulses as in TE 1970-71 total 1557.37 hectare was covered by cereals out of 1852.37 hectare out of total foodgrains and only 294.63 hectare was covered in pulses which revealed that around 84 percent area irrigated was under cereals. This situation was remains almost same till TE 2010-11 with even with rise in total area under the crop and area under the total irrigation. In TE 2010-11 total area under irrigation was 3685 hectare in foodcrops and cereals get 3139 hectare and pulses get 546.3 hectare. Area under the irrigation in Jowar and Barley was decreasing continuously.

Table 2: CROP-WISE ABSOLUTE AND RELATIVE IRRIGATED AREA WITH AGR from 1968-69 to 2010-11

CROP-WISE IRRIGATED AREA AND SHARE IN TOTAL IRRIGATED AREA WITH ANNUAL GROWTH RATE FROM 1968-69 to 2010-11														
Crops	Gross Area Irrigated (GAI) in thousand hectare					Percent Gross Area Irrigated out of Total Irrigated Area					Annual Growth Rates			
	TE 70-71	TE 80-81	TE 90-91	TE 2000-01	TE 2010-11	TE 70-71	TE 80-81	TE 90-91	TE 2000-01	TE 2010-11	TE 70-71 to TE 80-81	TE 80-81 to TE 90-91	TE 90-91 to TE 2000-01	TE 2000-01 to TE 2010-11
Foodgrain crops	1852.37	2613.79	2288.88	3442.57	3685.28	74.92	69.49	50.95	51.96	46.97	3.50	-1.32	4.17	0.68
Cereals	1557.73	2225.25	1991.37	3055.93	3139.01	63.01	59.16	44.32	46.12	40.00	3.63	-1.10	4.38	0.27
Kharif cereals	284.20	387.46	217.58	354.74	329.18	11.50	10.30	4.84	5.35	4.20	3.15	-5.61	5.01	-0.75
Rice	37.93	76.83	40.00	104.57	86.66	1.53	2.04	0.89	1.58	1.10	7.31	-6.32	10.09	-1.86
Jowar	12.40	8.93	5.78	2.95	2.60	0.50	0.24	0.13	0.04	0.03	-3.23	-4.26	-6.50	-1.25
Bajra	76.40	109.26	116.29	179.39	228.78	3.09	2.91	2.59	2.71	2.92	3.64	0.63	4.43	2.46
Maize	157.47	192.19	55.41	67.68	11.14	6.37	5.11	1.23	1.02	0.14	2.01	-11.69	2.02	-16.51
Rabi Cereals	1273.53	1837.80	1773.79	2701.19	2809.82	51.51	48.86	39.48	40.77	35.81	3.74	-0.35	4.30	0.40
Wheat	872.83	1523.19	1579.83	2512.33	2548.38	35.30	40.50	35.16	37.92	32.48	5.73	0.37	4.75	0.14
Barley	400.70	312.79	193.51	188.74	260.51	16.21	8.32	4.31	2.85	3.32	-2.45	-4.69	-0.25	3.28
Pulses	294.63	388.54	297.52	386.63	546.27	11.92	10.33	6.62	5.84	6.96	2.81	-2.63	2.65	3.52
Kharif pulses	5.70	6.66	6.77	13.11	55.96	0.23	0.18	0.15	0.20	0.71	1.57	0.16	6.83	15.62
Other kharif pulses	5.43	5.00	6.40	11.59	54.22	0.22	0.13	0.14	0.17	0.69	-0.82	2.50	6.12	16.68
Rabi Pulses	288.93	381.88	290.75	373.52	490.31	11.69	10.15	6.47	5.64	6.25	2.83	-2.69	2.54	2.76
Gram	281.57	365.95	270.33	342.14	460.92	11.39	9.73	6.02	5.16	5.87	2.66	-2.98	2.38	3.02
Oilseeds	58.47	258.31	1193.72	1692.50	2462.33	2.36	6.87	26.57	25.54	31.38	16.02	16.54	3.55	3.82
Kharif Oilseeds	9.70	19.91	91.84	176.94	392.30	0.39	0.53	2.04	2.67	5.00	7.46	16.52	6.78	8.29
Ground nut	7.60	16.90	44.01	99.19	250.67	0.31	0.45	0.98	1.50	3.19	8.32	10.04	8.47	9.71
Sesamum	2.10	1.95	1.64	4.29	10.72	0.08	0.05	0.04	0.06	0.14	-0.74	-1.72	10.09	9.59
Castor seed	N A	1.06	6.95	44.48	118.82	N A	0.03	0.15	0.67	1.51		20.69	20.40	10.32
Soyabean	N A	0.00	39.24	28.98	12.09	N A	0.00	0.87	0.44	0.15			-2.99	-8.37
Rabi oilseeds	48.77	238.40	1101.88	1515.56	2070.03	1.97	6.34	24.53	22.87	26.38	17.20	16.54	3.24	3.17
Rape & Mustard	46.07	219.56	1084.22	1504.94	2058.01	1.86	5.84	24.13	22.71	26.23	16.90	17.32	3.33	3.18
Taramira	N A	12.02	13.54	6.13	9.55	N A	0.32	0.30	0.09	0.12		1.20	-7.62	4.53
Fibres	169.97	337.59	371.94	566.17	334.64	6.87	8.98	8.28	8.55	4.26	7.10	0.97	4.29	-5.12
Cotton	169.97	336.92	371.73	566.13	334.63	6.87	8.96	8.27	8.54	4.26	7.08	0.99	4.30	-5.12
Condiments & spices	0.00	195.01	244.08	375.99	579.66	0.00	5.18	5.43	5.67	7.39		2.27	4.42	4.42
Coriander	N A	30.02	81.79	131.06	218.93	N A	0.80	1.82	1.98	2.79		10.54	4.83	5.26
Cumin seed	N A	86.43	79.68	161.65	232.86	N A	2.30	1.77	2.44	2.97		-0.81	7.33	3.72
Fruits	0.00	38.22	51.64	75.05	124.41	0.00	1.02	1.15	1.13	1.59		3.06	3.81	5.18
Drug & narcotics	0.00	20.37	57.50	95.36	209.25	0.00	0.54	1.28	1.44	2.67		10.93	5.19	8.18
Fodder crops	0.00	251.13	252.06	339.33	413.60	0.00	6.68	5.61	5.12	5.27		0.04	3.02	2.00
Guar seed	N A	83.95	91.15	132.31	255.86	N A	2.23	2.03	2.00	3.26		0.83	3.80	6.82
Other	N A	167.18	160.92	207.02	157.74	N A	4.44	3.58	3.12	2.01		-0.38	2.55	4.28

Source: Compiled with the data collected from 50 Years of Agricultural Statistics of Rajasthan (1956-57 - 2005-06) and Agricultural Statistics

Proportion in total area was showing a different picture except slight variation in TE 90-91 share in total was declined from 74.92 thousand hectare in TE 70-71 to 46.97 thousand hectare in TE 2010-11. Annual Growth Rate (AGR) was -1.32 in TE 80-81 to TE 90-91 and remains positive in all time frames during study. Cereals were found key components among food grains with majority of share in TE 70-71 as 63.01 percent out of total irrigated area and found followed same trend as food grains. Rabi Cereals were with 51.51 out of total irrigated area occupy largest place in TE 70-71 and specially wheat. All the food crops including all crops of cereals were losing share in terms of total irrigated area except wheat till TE 2000-01 then after its share was also decreasing. Highest loser was Maize which was continuously losing area under irrigation from 157.47 thousand hectare in TE 70-71 to 11.14 thousand hectare in TE 2010-11. Area irrigation under Pulses was rise in absolute terms from 294.63 thousand hectare in TE 70-71 to 546.27 thousand hectare to TE 2010-11 but percent share out of total was decreasing continuously from 11.92 percent in TE 70-71 to 5.54 percent TE 2000-01 after it in TE 2010-11 increased little bit and became to 6.96 percent. Most of irrigation received by Rabi Pulses and among them Gram was found only big share holder of area irrigated.

Area under the oil seeds and among them Rape & Mustard dramatically in the study period. Area irrigated in Rape & Mustard increase from 46.07 thousand hectare in TE 70-71 to 2058.01 thousand hectare in TE 2010-11. Percentage share was just 1.86 percent out of total in TE 70-71 to 26.23 percent in TE 2010-11. AGR of Rape & Mustard 16.9 percent in TE 70-71 to TE 80-81 and 17.32 percent TE 80-81 to TE 90-91 which was significantly high.

Crop wise Annual Combined Growth Rate of Irrigation was given in table 3 maize was with largest loser with -3.65 percent followed by barley -1.93 percent. Highest growth rate was statistically shown in drug & narcotics followed by Rice but it can be seen from table 2 that both the categories were having very less representation in absolute terms. Foodgrain crops and Cereals were showing stagnation in growth in this study period. Bajara was one of the the main food crops in Rajasthan specially in arid part this crop also getting irrigation and growth of irrigation was highest in food crops as 3.63 percent followed by wheat with 2.46 percent growth. Growth rate in irrigation in pulses grew with 1.04 percent but growth of irrigation in kharif pulses was 5.76 percent. Growth of irrigation in oilseed crops was found 9.49 percent and in this category Groundnut with 11.21 percent and Rape & Mustard was grown at 9.60 percent rate. Cotton was one of single largest fibers crop with 1.91 percent growth in irrigated area. Total cropped area irrigated was having significant higher compound growth rate as 3 percent which was statistically significant also so the first hypothesis was found correct. Instability was found highest in Groundnut 288.34 followed by castor seed 160.31, Sesamum 158.54, Jowar 155.22 Kharif oilseeds 107.23 and lowest in Foodgrain crops 1.33 total Cereals and 1.36 in Rabi cereals 1.36 in Wheat 1.56. It can be seen that crops with high market value or have higher use either for human or livestock like wheat, Barley, Rabi pulse, oilseeds, cotton, fodder crops and rice were used in assured irrigated areas so the instability was low as compared to other crops.

Table 3: Crop wise Annual Combined Growth Rate and Instability of Irrigation from 1968-69 to 2010-11

S. No	Crop	AGR in percent	t vale	Instability Index
1	Foodgrain crops	0.13	12.00	1.33
2	Cereals	0.13	12.09	1.36
3	kharif cereals	0.58	1.70	10.89
4	Rice	780.88	2.11	6.44
5	Jowar	0.98	-2.97	155.22
6	Bajra	3.63	5.11	13.20
7	Maize	-3.65	-3.01	45.26
8	Rabi cereals	1.75	12.79	1.37
9	Wheat	2.46	14.68	1.56
10	barley	-1.93	-6.72	2.86
11	Pulses	1.24	5.55	3.09
12	Kharif pulses	5.69	9.67	26.45
13	Other kharif pulses	5.76	9.07	30.95
14	rabi pulses	1.06	4.96	3.07
15	Gram	0.90	3.94	3.21
16	Oilseeds	9.49	17.76	4.87
17	Kharif oilseeds	12.23	13.35	107.23
18	Groundnut	11.21	12.58	288.34
19	Sesamum	6.59	6.76	158.54
20	Rabi oilseeds	9.38	16.47	5.40
21	Rape & mustard	9.60	16.60	5.68
22	fibres	1.90	5.68	3.04
23	Cotton	1.91	5.69	3.04
24	Castorseed	0.06	0.09	160.31
25	Taramira	4.24	12.83	20.74
26	Condiments & spices	4.24	12.83	4.14
27	Coriander	6.11	12.06	10.36
28	Cuminseed	5.43	8.32	10.26
29	Fruits	4.15	38.15	3.44
30	Drug & narcotics	833.37	14.05	7.60
31	Fodder crops	1.47	4.72	3.63
32	Guarseed	2.47	2.33	19.19
33	Other	0.41	2.20	2.22
34	Total cropped area irrigated	3.00	28.23	1.00

Source: Compiled with the data collected from 50 Years of Agricultural Statistics of Rajasthan (1956-57 - 2005-06) and Agricultural Statistics Rajasthan various issues

As given in table 4 chosen two variables can explain around 83 percent of effect and it is reflected by higher F value that total model was found significant. Both the independent variables have significant effect on multiple cropping as irrigation ratio has higher and strong significant effect as it can have 68.5 percent effect on multiple cropping. Second factor rainfall was found positive and significant effect but it was less effective than irrigation ratio. In this way second and hypothesis was found correct.

Table 4: Effectiveness of Irrigation in multiple cropping

R Square	.830		F Value	97.987
	B	Std. Error	t value	Significance level.
(Constant)	90.316	2.777	32.525	.000
Irrigation Ratio (GIA to NSA)	.685	.049	13.918	.000
Rainfall	.125	.035	3.538	.001
Source: Compiled with the data collected from 50 Years of Agricultural Statistics of Rajasthan (1956-57 - 2005-06) and Agricultural Statistics Rajasthan various issues				

5. CONCLUSION

Wells were found the major source of irrigation followed by canals in TE 1970-71 and was replaced by tubewells and canal and reached to third position as relatively in TE 2010-11. Area irrigation by Tanks were shrinking continuously and Tube Well were becoming popular. Food grains were having larger receiver of irrigation and cereals were major segment in foodgrains in absolute terms. Relatively foodgrains were losing their position from 74.92 out of total in TE 1970-71 to 46.97 percent in TE 2010-11 same trend was seen in cereals. Jowar, Bajara Maize and even Wheat was not found same relative share in irrigation and same was true for majority of pulses. Oilseeds were getting more and more area under the crop as it can be seen in both levels at absolute level as well as share in total irrigation. On the basis of these facts emerged from these data it can be said that in Rajasthan Cereals were relatively losing share over the period as new area introduced to agricultural use was mainly goes towards oilseeds and specially with Rape & Mustard. In Crop wise Annual Combined Growth Rate of Irrigation maize and barley were the largest loser with and highest growth rate in drug & narcotics followed by Rice. Foodgrain crops and Cereals were showing very slow growth in this study period. Instability was highest in Groundnut, castor seed and Sesamum. Two variables chosen, Irrigation Ratio (GIA to NSA) and Rainfall which can explain around 83 percent of effect in multiple cropping and it was both the independent variables have significant as irrigation ratio has as 68.5 percent effect which was higher and strong significant than rainfall.

6. REFERENCES

- Moorthi T.V. and Mellor W.J. (1972), "Cropping Pattern Yields and Income under Different Sources of Irrigation with Special Reference to IADP, Aligarh District, Uttar Pradesh", Indian Journal of Agricultural Economics, Vol. 27(4), pp.117-125.
- Bagi.F.S (1981), "Economic of Irrigation in Crop Production in Haryana", Indian Journal of Agriculture Economic, Vol-35, No-3 1981, July Sep, pp-15-23.

Mahendradev, S. 1987. "Growth and Instability in Food grains Production: An Inter-State Analysis." *Economic and Political Weekly* 22 (39): A82-A92.

B. D. Dhawan (1988) *Indian Irrigation: An Assessment*, *Economic and Political Weekly*, Vol. 23, No. 19 May 7, pp. 965-967+969-971

B. D. Dhawan and Harsharan Singh Datta (1992), *Impact of Irrigation on Multiple Cropping*, *Economic and Political Weekly*, Vol. 27, No. 13 (Mar. 28), pp. A15-A18

Sawant S D Achuthan C V (1995) *Agricultural Growth across Crops and Regions Emerging Trends and Patterns*, *Economic and Political Weekly*, Vol. 30, No. 12 (Mar. 25, 1995), pp. A2-A13

Rawal Vikasand, Swaminatha Madhura (1998) *Changing Trajectories: Agricultural Growth in West Bengal, 1950 to 1996*, *Economic and Political Weekly*, Vol. 33, No. 40 (Oct. 3-9, 1998), pp. 2595-2602

Vakulabharanam Vamsi (2004) *Agricultural Growth and Irrigation in Telangana A Review of Evidence*, *Economic and Political Weekly*, Vol. 39, No. 13 (Mar. 27 - Apr. 2,), pp. 1421-1426

Narayanamoorthy, A. (2007) *Does Groundwater Irrigation Reduce Rural Poverty? Evidence from Indian States*. *Irrigation and Drainage*, 56: 349–362,

Kannan E (2011), *Determinants of stagnation in Productivity of important crops*": Research Report: XI/ADRTC/127, *Agricultural Development and Rural Transformation Centre Institute for Social and Economic Change Bangalore- 560 072*, page no 19

Government of Rajasthan. *Agricultural Statistics Rajasthan*, various issues, Directorate of Economics and Statistics, Department of Planning, Rajasthan, Yojana Bhawan, Jaipur

Government of Rajasthan. (2008) *50 Years of Agricultural Statistics of Rajasthan (1956-57 - 2005-06)* Directorate of Economics and Statistics, Department of Planning, Rajasthan, Yojana Bhawan, Jaipur

Government of Rajasthan. (2012). *Some Facts about Rajasthan 2012*. Directorate of Economics and Statistics, Department of Planning, Rajasthan, Jaipur.

Government of Rajasthan. (2012). *Economic review of Rajasthan 2011-12*, Directorate of Economics and Statistics, Department of Planning, Rajasthan, Jaipur.

7. APPENDIX

Table 5: Effectiveness of Drought and Famine in Rajasthan from 1991-92 to 2010-11

S No	Year	No of affected Districts	No of affected Villages	Affected Population in Lakhs

1	1991-92	30	30041	289
2	1992-93	12	4376	34.66
3	1993-94	25	22586	246.81
4	1995-96	29	25478	273.82
5	1996-97	21	5905	55.29
6	1997-98	24	4633	14.91
7	1998-99	20	20069	215.07
8	1999-2K	26	23406	261.79
9	2000-01	31	30583	330.41
10	2001-02	18	7964	69.7
11	2002-03	32	40990	447.8
12	2003-04	3	649	5.82
13	2004-05	31	19814	227.65
14	2005-06	22	15778	198.44
15	2006-07	22	10529	136.37
16	2007-08	12	4309	56.12
17	2008-09	12	7402	100.12
18	2009-10	27	33464	429.13
19	2010-11	2	1249	13.67
Source: Economic review of Rajasthan 2011-12				

Table 6: Position of Rajasthan in India in 2011

S.No.	Indicator	Rajasthan	India
1.	Geographical Area (lakh Sq. Km.)	3.42	32.87
2.	Population (in crores)	6.85	121.06
3.	Rural Population (as percentage of total population)	75.11	68.89
4.	Literacy Rate (in percentage)	66.1	73.02
5.	Decadal Growth Rate (2001-11)	21.3	17.7
6.	Density (per sq.km.)	200	382
7.	Total Reporting Area (in lakh hectare)	342.7	3059.0
8.	Total Forest Area (in lakh hectare)	27.43	22.84
9.	Gross Irrigated Area to Gross Cropped Area (in percent)	36.33	44.91
10.	Net Sown Area to Total Reporting Area (in percent)	52.63	46.28

11.	Net Irrigated Area to Net Area Sown (in percent)	39.49	44.92
12.	Average Size of Operational Holdings (hectare)	3.07	1.16
13.	Cropping Intensity (in percent)	142.98	140.54
14.	Consumption of Fertilizer per hectare of Cropped Area (kg/hectare)	62.35	

Source: Some Facts about Rajasthan 2012 and Basic Statistics of Rajasthan 2012

Table 7 Output of effectiveness of variables on cropping intensity (Result of SPSS)

Variables Entered/Removed ^a						
Model	Variables Entered	Variables Removed	Method			
1	RAIN FALL, GIAbYNSA ^b		Enter			
a. Dependent Variable: Cropping intensity						
b. All requested variables entered.						
Model Summary						
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate		
1	.911 ^a	.830	.822	3.2332		
a. Predictors: (Constant), RAIN FALL, GIAbYNSA						
ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2048.687	2	1024.344	97.987	.000 ^b
	Residual	418.156	40	10.454		
	Total	2466.843	42			
a. Dependent Variable: Cropping intensity						
b. Predictors: (Constant), RAIN FALL, GIAbYNSA						
Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	90.316	2.777		32.525	.000
	GIAbYNSA	.685	.049	.916	13.918	.000
	RAIN FALL	.125	.035	.233	3.538	.001
a. Dependent Variable: Cropping intensity						