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Rural Poverty and Irrigation Performance in India: A District-level Study

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ABSTRACT

The main objective of the study is to analyze the impact of irrigation on rural poverty across districts in India. The secondary data from different sources have been culled using descriptive cum regression analysis. The statistically significant inverse and strong relationship between irrigation and rural poverty has been pointed out not only from descriptive analysis but also regressions which is expected in this study. The important finding of the study is that irrigation infrastructure is more pronounced as lag variable in determining rural poverty than as normal variable.

Keywords: Irrigation, Agricultural growth, Livelihood, Rural poverty alleviation, Livelihood.

There is a positive impact of irrigation on agriculture growth which has been accepted by various studies in the context of Asian agriculture (Mellor, 1985, 1996, 2002; Lipton, *et. al.,* 2002; Deb Roy and Shah, 2003). The significance of irrigation with regard to agriculture development has very well documented by both micro and macro level study in India too (Gadgil, 1948; Dhawan, 1988; Rath and Mitra, 1989). Since the levels of poverty were somewhat higher in the rural areas relative to those in urban, agriculture is the central driver for alleviating poverty in rural areas (Asian Development Bank, 2002). There are some studies resulting inverse relationship between agricultural growth and the incidence of rural poverty (Ahluwalia, 1978; Sundaram and Tendulkar, 1988; Ghosh, 1996 and 1998; Datt and Revallion, 1996; Bhattarai and Narayanamoorthy, 2003). In fact, there is a positive impact of agricultural growth on rural poverty reduction, and the irrigation is the main factor that determines the growth of agriculture.

Irrigation resources have played a major role historically in poverty alleviation by ensuring agricultural development, expanding livelihood opportunities, increasing the use of yield increasing inputs cropping intensity and productivity

of the crops, providing additional employment opportunities both on and off the farm and pushing up the wage rates for agricultural laborers (Dhawan, 1991; Ray, 1992; Narayanamoorthy, 2001; Hussain and Hanjra, 2004; Hussain et al, 2006; Ghosh et al, 2011, 2012). Thus, an empirical evidence suggests that irrigation has reduced rural poverty (Narayanamoorthy, 2001; Bhattarai and Narayanamoorthy, 2003; Hussain and Hanjra 2004; Shah and Singh, 2004; Smith 2004; Lipton 2007; and Hussain 2007; Narayanamoorhty, 2007; Narayanamoorthy and Beero, 2014). By irrigation it has been possible to achieve increased crop productivity, food security, opportunities for higher and more stable incomes and employment and multiple cropping pattern and crop diversification. The enlarge production brings welfare to producers, better income to the farmers and farm labourers, and profits to overall population by providing more food at low prices (Narayanamoorthy, 2007). However, despite these achievements, there remain vast areas in established irrigation systems where productivity and incomes of farmers remain low and highly variable (Hussain and Hanjra, 2003). If irrigation has such vitality, why are such impacts not being replicated by districts level study in India? The missing contacts between irrigation and rural poverty have been focused in this study.

Among the existing studies, the most relevant studies are selected and reviewed. First of all, Rao (1978) attempted to link between irrigation, agriculture and rural development. In the finding he asserted that the irrigation has opened up two alternative lines of advance in rehabilitating and developing the villages. Again, Rao (1987), in another study, attributed that irrigation impacts on small farmers, marginal farmers and agricultural households. After examining temporal changes in absolute poverty among farm families in Haryana during the period 1969-70 to 1982-83, Paul (1990) identified that Poverty is inversely related to the level of irrigation in the region. In connection to the above study, Bhattarai *et al.,* (2002) explored that irrigation has increased crop production and farm income, decreased inequities in income distribution and reduced poverty. Palmer and Sen (2003) attempted to find out the relationship between irrigation and agriculture growth for 1962-1990 taking 281observation and demonstrated that the poverty, during 1962-90, was low due to high growth in the agriculture sector and it is evident that irrigation is more important for agricultural growth. Narayanamoorthy (2001) made an attempt to understand the role of irrigation on the reduction of the rural poverty, incidence of rural poverty and the changing scenario of rural poverty in India by taking cross section data of 14 major states from 1972-73 to 1993-94. He demonstrated that irrigation has been a crucial factor for agricultural growth as well as rural development. He further added that there is a inverse relationship between irrigation and incidence of rural poverty. After reviewing the trends in investments in irrigation and providing a framework for analyzing the positive and negative impacts of irrigation on poverty, Lipton *et al.,* (2003) reached to the conclusion that irrigation has a positive impact on the poor. Hussain and Hanjra

(2003) in their study found that irrigation enables households to improve crop productivity, grow high-valued crops, generate higher incomes and employment, earn a higher implicit wage rate for family labor and, more importantly, benefits the poor and landless through the enhanced availability of food, lower food prices, higher employment opportunities and income and other indirect effects and then reduces the incidence and severity of poverty. Similarly, Saleth *et al.,* (2003); Hussain (2004); Reddy (2004); Molden *et al.,* (2007) and Hussain (2007) expressed that there is a strong linkages between irrigation and rural poverty. Again Panahi *et al.,* (2009) analyzed the role of optimizing agricultural water resource management to livelihood poverty abolition in rural Iran and stated that as a vital agricultural resource, irrigation water is important for the productivity of a society and the livelihood of its members. In the other study, Narayanamoorthy and Hanjra (2010) used cross section data relating to seven time points from 1973-74 to 2004-05 by covering 29 districts of Tamil Nadu and showed that the incidence of rural poverty significantly less among districts having irrigation above the state average (DIASA) group of districts as compared districts having below the state average (DIBSA) group of districts suggesting that irrigation helps reducing rural poverty in Tamil Nadu. Again Ghosh, et al (2011, 2012) analyzed irrigation, agriculture and level of living in the districts of Orissa and identified through the regression analysis that irrigation has 71% variation in alleviating rural poverty. In the concluding remarks, irrigation source is very crucial for development of agriculture and then reduction of rural poverty.

The existing studies show that irrigation and poverty are closely related both directly as well as indirectly. Most of the studies have shown that irrigation has increased the agricultural productivity while a few other studies have shown that increased agricultural productivity has led to poverty alleviation in many developed countries. There are also studies available regarding the role of irrigation, agriculture on income, employment opportunity and rural poverty alleviation. A few and most relevant studies, like Narayanamoorthy and Beero (2014), have analyzed the importance of irrigation on rural poverty after Narayanamoorthy (2001) studied irrigation development and rural poverty nexus across states in India using secondary data at macro level. However, there are absolutely no studies available on the issue of irrigation development and rural poverty across districts in India. Studies are also not available with regard to irrigation and poverty nexus from 1970 to till date covering districts of India. Studies are seldom available treating irrigation as explanatory variable in the district level study in India. Studies are available using irrigation area per thousand rural population (IATRP) variable as explanatory variable to study rural poverty but studies are not available using percentage of irrigated area to gross cropped area (GIAGCA) variables as explanatory variable. Therefore, keeping these in view, an attempt is made in this study to analyze and examine the relationship between irrigation and

rural poverty using district level secondary data across India. Based on the above mentioned gaps the following objectives have been formed.

I) To analyze the impact of irrigation on rural poverty across the districts in India.

II) To study the relationship between base level irrigation and rural poverty.

III) To identify as to which of the variable is greatly influencing the rural poverty

Materials and Methods

The study is entirely based on secondary data pertaining to four time points (1970-71, 1980-81, 1990-91 and 2000-01). For the purpose of the analysis, 178 districts have been selected from 13 states of India which are presented in Table 1. These districts are selected based on the similar variable available for all the districts for four points of time. These 178 districts have an average 28.10% of rural poverty and 17.65% of standard deviation. The data for this study has been estimated from different published sources. Since the percentage of rural poverty is the main variable for this study, the district-wise percentage of rural poverty (PRP) have been collected and calculated from Chaudhuri and Gupta (2009). The other data like percentage of irrigated area to gross cropped area (GIAGCA) and cropping intensity (CI) have been collected and computed from Bhalla and Singh

Table 1: Number of Districts Selected from 13 different States

States	No of Districts	AVG.	SD
Andhra Pradesh	15	9.80	7.99
Bihar	6	41.35	16.87
Gujarat	10	29.06	22.79
Haryana	6	8.50	5.09
Karnataka	13	26.71	15.65
Madhya Pradesh	28	43.00	14.97
Maharashtra	16	38.96	10.71
Odisha	9	48.70	19.92
Punjab	11	7.17	7.22
Rajasthan	19	21.15	11.15
Tamil Nadu	6	16.95	5.89
Uttar Pradesh	28	26.00	9.44
West Bengals	11	31.15	13.12
Total	178	28.10	17.65

Notes: AVG: Average; SD: Standard Deviation.

(2010; 2012); gross cropped area per thousand rural population (GCAPTRP) have been collected and computed Bhalla and Singh (2010; 2012) and Census of India, (GOI, 1971; 1981; 1991 and 2001). Data pertaining to availability of pucca road (ROAD) and percentage villages having electricity (ELE), rural literacy (LITE) have been harvested from the Census of India (GOI, 1971; 1981; 1991 and 2001). Data on average wages of skilled and unskilled rural male labourers are compiled and computed from Agricultural wages in India (AWI, 1971; 1981; 1991 and 2001).

Since poverty is the multidimensional concept, there are so many poverty determinants variables. However, due to non availability of variables only seven important poverty determinants variables (CI, ELE, GCAPTRP, GIAGCA,

Table 2: Description of Variables Used in the Study for Analysis

Variables	Description	Average				
		Unit	1970-71	1980-81	1990-91	2000-01
CI	Cropping intensity	%	119.69 (19.62)	127.33 (19.88)	133.90 (23.78)	141.55 (29.15)
ELEC	Percentage of village electrified	%	24.06 (24.56)	53.68 (28.27	80.07 (21.75)	47.71 (16.71)
GCAPTRP	Gross cropped area per thousand rural population	ha	487.31 (275.40)	468.26 (270.28)	435.70 (280.59)	406.08 (552.09)
GIAGCA	Percentage of irrigated area to gross cropped area	%	24.50 (21.87)	31.10 (24.09)	38.49 (25.84)	43.69 (25.38)
LITE	Percentage of rural literacy rate	%	21.13 (8.27)	27.55 (12.65)	41.78 (12.89)	56.36 (14.18)
ROAD	Percentage of villages having road facility	%	29.42 (13.75)	39.92 (24.08)	47.27 (24.85)	61.86 (23.59)
WAGE	Average wages of skilled and unskilled rural male labourers	Rs/ day	4.29 (1.80)	9.78 (3.98)	31.26 (11.27)	76.47 (29.64)

Notes: Figures in the brackets are Standard Deviation.

Source: Computed using Bhalla and Singh (2010, 2012), Census of India, Office of the register General and Census Commissioner, Ministry of Home Affairs, GOI, New Delhi (various years) and Agricultural Wages in India, GOI (various years).

LITE, ROAD and WAGE) are selected for the same periods (Table 2). We have considered the variable PRP as the dependent variable and other poverty determinant variables as independent variables to know which of the variable greatly influencing in reducing rural poverty. In order to represent the irrigation in the analysis, the percentage of irrigated area to gross cropped area (GIAGCA) has been used. Cropping intensity (CI), defined as the ratio of gross cropped area to net cropped area in percentage term, explains how intensively crops are cultivated in a year. Since agriculture directly impacts on rural poverty and agriculture is determined by the intensive of crop cultivation, CI has been included for analysis along with other variables (Narayanamoorhty and Hanjra, 2006).

Another important indicator that would positively and directly contribute to the agriculture development and indirectly influence the rural poverty is the total number of villages electrified (ELE). The road variable (Road) which is represented by the percentage of villages having road facility is indeed an indicator of the development of transport infrastructure and undisputedly is the most important element in alleviating rural poverty. GCAPTRP is indicated by coverage of gross cropped area per thousand rural populations which represents density of population in cropped area. It is well documented that if GCAPTRP increases then cropped area is more and population is less which represent more production and less population. RWAL has been considered as one of the important variables for studying the incidence of rural poverty by some earlier studies (for Ghosh, 1996).

Simple and multiple regressions have been used to study the nexus between irrigation development and rural poverty. In order to find out this relationship, keeping PRP as the dependent variable, four different types of simple linear regressions (OLS method) are computed; treating GIAGCA as an explanatory variable without any time lag and with 10, 20 and 30 years' time lag for all time points. The simple regression equations are as follows:

$$PRPt=\alpha+ b1\ GIAGCAt \quad (1)$$

$$PRPt=\alpha+ b1\ GIAGCAt - 10 \quad (2)$$

$$PRPt=\alpha+ b1\ GIAGCAt - 20 \quad (3)$$

$$PRPt=\alpha+ b1\ GIAGCAt - 30 \quad (4)$$

[Where, PRPt = % of rural poverty in time t; GIAGCA = irrigated area per thousand rural population in time t,/in time t - 10, t – 20 and in time t - 30; b1= regression parameter to be estimated and α = constant.]

Again in order to identify as to which of the variable is greatly influencing the rural poverty, A multiple regression analysis is carried out treating PRP as the dependent variable and other variables: CI, ELE, GCAPTRP, GIAGCA, LITE ROAD and WAGE as the independent variables. The regression model is as follows:

$$PRPt = \alpha + b1\ CIt + b2\ ELEt + b3\ GCAPTRPt + b4\ GIAGCAt + b5\ LITEt + b6\ ROADtt + b7\ WAGEt \quad (5)$$

$$PRPt = \alpha + b1\ CIt\text{-}10 + b2\ ELEt\text{-}10 + b3\ GCAPTRPt\text{-}10 + b4\ GIAGCAt\text{-}10 + b5\ LITEt\text{-}10 + b6\ ROADt\text{-}10 + b7\ WAGEt\text{-}10 \quad (6)$$

$$PRPt = \alpha + b1\ CIt\text{-}20 + b2\ ELEt\text{-}20 + b3\ GCAPTRPt\text{-}20 + b4\ GIAGCAt\text{-}20 + b5\ LITEt\text{-}20 + b6\ ROADt\text{-}20 + b7\ WAGEt\text{-}20 \quad (7)$$

$$PRPt = \alpha + b1\ CIt\text{-}30 + b2\ ELEt\text{-}30 + b3\ GCAPTRPt\text{-}30 + b4\ GIAGCAt\text{-}30 + b5\ LITEt\text{-}30 + b6\ ROADt\text{-}30 + b7WAGEt\text{-}30 \quad (8)$$

[Where, PRPt = percentage of rural poverty, CIt= cropping intensity, GCAPTRPt=gross cropped area to per thousand rural population, ELECt= percentage of villages electrified, GIAGCAt= percentage of irrigated area to cropped area, LITEt=,percentage of rural literacy rate, ROADt= percentage of villages having road facilities, and WAGEt= average wages of skilled and unskilled rural male labourers; b1= regression parameter to be estimated and α-- constant.]

Results and Discussion

To begin with, it is observed from Table 2 that on an average about 119% of cropping intensity during 1970-71 has increased to 141% in 2000-01 in each of the selected districts. The increased cropping intensity elaborate that the land intensity for cultivation has increased from 19970-71 to 2000-01. Wage rate increased from ₹ 4.29 to ₹ 76.47 for the same period. However, density of population to cropped area (GCAPTRP) decreased from 487.31 hectare to 406.08 hectare due to increased population and due cropped area 1970-71 to 2000-01. While the GIAGCA increased from 24.50% to 43.69% in 2000-01, villages having pucca road facility increased from 29.42% to around 61.86% during the same period. Similarly, the rural literacy rate (LITE) increased from 21.13% to 56.36% and coverage of rural electrification (ELEC) increased from 24.06% to 87.71% during this period. All these amply suggest that the poverty determinants variable have expanded considerably during 1970-71 to 2000-01. It is clear that there has been an appreciable improvement in the poverty determinants variables across the districts India. This increased electricity; literacy rate and wage rate and road connectivity show that there is a positive impact of these variables on rural poverty. But this information of irrigation and rural poverty nexus is not sufficient. Therefore, to be more cleared, the behavior of the rural poverty is analysied in the following section.

Incidence of poverty and Characteristics of Districts

A major objective of the study is to find out whether the irrigation has any relationship with the rural poverty. In order to study this, we have categorised the

districts into two as districts with above the average districts of 178 districts and districts with below the average districts of 178 districts during 2000-01. How the AA and BA districts rank in terms of poverty determinants parameters is evident from data presented in Table 3. As regards to the characteristics of the districts, a distinct difference in all the parameters between the AA and BA districts across all three time points is evident. Among the poverty determinants variables namely CI, ELEC, GCAPTRP, GIAGCA, LITE, ROAD and WAGE, the difference between AA and BA districts is more pronounced in GIAGCA. This suggests that districts having higher irrigation coverage have lower poverty rate.

Table 3. Districts' Characteristics based on Rural Population below Poverty Line (2004-05)

Classification	No. of districts	CI (%)	ELEC (%)	GCAPTRP (ha)	GIAGCA (%)	LITE (%)	ROAD (%)	WAGE (Rs/day)
AA Districts	76	135.80 (24.60)	83.57 (18.55)	503.34 (783.16)	34.30 (21.87)	56.94 (13.21)	49.36 (20.93)	64.34 (19.88)
BA Districts	102	145.84 (31.56)	90.79 (14.55)	333.61 (257.46)	50.69 (25.66)	55.93 (14.92)	71.18 (21.08)	85.52 (32.44)
All Average	178	141.55 (29.15)	87.71 (16.71)	406.08 (552.09)	43.69 (25.38)	56.36 (14.18)	61.86 (23.59)	76.47 (29.64)

Note: Figures in the brackets are Standard Deviation.

Source: Computed using Bhalla and Singh (2010, 2012), Census of India, Office of the register General and Census Commissioner, Ministry of Home Affairs, GOI, New Delhi (various years), Agricultural Wages in India, GOI (various years) and Chaudhuri and Gupta (2009).

As it is shown in the above Table 3 the relationship between poverty determinants variables and rural poverty, it also shown independent relationship between irrigation and poverty by dividing 178 districts into three parts namely districts with sever poverty (DSP), districts with medium poverty (DMP) and districts with lower poverty (DLP). It comes out from this analysis that the rural poverty is severing in districts where GIAGCA is low as compared to districts with medium poverty for all four point-times. Districts with lower poverty have better GIAGCA than district with medium poverty during the same period of time (see Table 4).

Table 4. Classification of districts based on poverty and their GIAGCA and IAPTRP

Classification	No. of Districts	GIAGCA				IAPTRP			
		2000-01	1990-91	1980-81	1970-71	2000-01	1990-91	1980-81	1970-71
Districts with Sever Poverty ($\bar{X}$+SD)	34	8.01	12.30	18.83	27.52	34.32	52.65	76.04	115.20
Districts with Medium Poverty ($\bar{X}$+SD) to ($\bar{X}$-SD)	114	22.56	29.63	37.48	46.32	91.33	129.12	152.27	181.64
Districts with Lower Poverty ($\bar{X}$-SD)	30	50.55	58.00	64.58	52.04	232.18	287.48	312.67	190.79

Source: Computed using Bhalla and Singh (2010, 2012), Census of India (various years) and Chaudhuri and Gupta (2009).

Irrigation relatively higher among the districts whose average GIAGCA is below the average GIAGCA of 178 districts than in case of districts whose GIAGCA is above the average GIAGCA (see Table 3). It shows that irrigation has many impacts on rural poverty reduction.

Similar to studying the relationship between the GIAGCA on rural poverty, we have also made an attempt to find out whether the irrigation area per thousand rural populations (IAPTRP) has any association with the rural poverty for this time period in 178 districts. It is cleared from the Table 4 that districts with lower poverty have more IAPTRP than districts with medium poverty and sever poverty for four time-points. This shows that there is an inverse relationship between irrigation and rural poverty. Hence, on the whole, one may not be able to judge decisively whether these variables play better than other factors from this descriptive analysis. Therefore, to make comprehensible of the link between irrigation and poverty, the independent relationship between poverty and other poverty determinants variables has been estimated by using simple and multiple regression analysis in the following section.

Irrigation and poverty nexus

As was pointed out earlier, each of the variables that have been taken up for study would in one way or the other influence the rural poverty reduction. In order to find out the relationship between PRP and other poverty determinants variables multiple regressions has been used keeping PRP as dependent variable and other variables as independent variable for the year 2000-01. The regression analyze also made to identify and understand how the base level variables influencing rural

poverty. Therefore, four types of multiple regressions have been used treating PRP as dependent variable and other variables as independent variables with time 10, 20 and 30 years lag which is presented in Table 5.

It is understood from the regression result that the R2 which is estimated to be 0.405 which implies that about 40% of the variations in rural poverty can be explained by the variables included in the regression analysis in 1970-71 (with 30 years' time lag). Similarly, 45% in 1980-81 (with 20 years' time lag), 40% in 1990-91(with 10 years' time lag) and 44% in 2000-01 (without time lag) of the variation are explained on rural poverty. It is found that the variation of rural poverty is high with 20 years' time lag which is in the year 1980-81. This is because of more emphasis was given for irrigation development during Fifth Five Year Plan. The results showed that all the variables have determined rural poverty variation in 2000-01 which is expected in this study. It is pointed out that the strength of relation between irrigation rural poverty higher as lagged variable than normal variable. Except irrigation variables, no other poverty determinant variables show expected and significant result as lag variable for all the time lag. Irrigation is increasingly and significantly influencing the rural poverty in both as lag variable as well as normal variable. The coefficient of irrigation, which is represented by GIAGCA, is negatively and significantly associated to PRP in determining rural poverty. It means, as the irrigation increases, there is a decrease in rural poverty. One percentage of increase in irrigation reduces 41% of rural poverty in 1970-71 (with 30 years' time lag). Likewise, irrigation reduces 37 per cent, 30% and 24% of rural poverty during 1980-81 (with 20 years' time lag), 1990-91(with 10 years' time lag) and 2000-01(without time lag) respectively. The second most important variable in reducing rural poverty is wage rate. Due to increased wage rate, income of the rural people increases, consumption increases and then living standard of the people increases and thus reduce rural poverty. The regression result showed that wage rate has reduced 40 per cent, 29 per cent, 08% and 11% of rural poverty in 1970, 1980, 1990 and 2000 respectively.

The regression coefficient of road suggest that for one square kilometer increase in road facility would lead to reduce of nearly 08 per cent, 03 per cent, 22% and 28% of rural poverty, while in case of ELEC the rural poverty reduce 07 per cent, 15 per cent, 03% and 19% of poverty during the same period. Recalling the previous discussions, road infrastructure can be expected to positively affect agriculture. The estimated coefficient of electricity variable (ELE) is negatively associated but is statistically insignificant in determining the PRP. Electricity infrastructure undoubtedly enters the production directly as intermediate input. More specifically, it is a part and parcel of irrigation activity, wherein improvement in access to electricity brings about substantial improvements in irrigation facilities.

Table 5: Factors Determine Rural Poverty-178 Districts

Independent Variables	1970-71	1980-81	1990-91	2000-01
CI	0.065ns (0.042)	0.147b (0.074)	0.068ns (0.061)	0.016ns (0.042)
ELEC	-0.076ns (0.077)	-0.155b (0.066)	-0.037 ns (0.066)	-0.191a (0.077)
GCAPTRP	-0.002ns (0.002)	0.007d (0.004)	0.001ns (0.004)	0.003d (0.002)
GIAGCA	-0.416a (0.047)	-0.377a (0.074)	-0.309a (0.005)	-0.240a (0.047)
LITE	-0.123ns (0.082)	-0.011ns (0.095)	-0.028ns (0.093)	0.145b (0.082)
ROAD	-0.087a (0.051)	-0.030ns (0.087)	-0.220ns (0.072)	-0.285a (0.051)
WAGE	-0.400ns (0.038)	-0.292ns (0.352)	0.080ns (0.139)	-0.119a (0.038)
CONSTANT	40.435a (8.446)	30.680a (9.230)	42.538a (9.159)	70.454a (8.122)
R2	0.405	0.454	0.405	0.445
Adjusted R2	0.381	0.432	0.381	0.422
D-W	1.684	1.722	1.653	1.860
F	16.551	20.208	16.558	19.495
N	178	178	178	178

Note: a, b, c and d are significant level at 1, 5, 10 and 20% respectively, figures in the brackets are Standard Error, and ns: not significant.

Source: Computed using Bhalla and Singh (2010, 2012), Census of India, Office of the register General and Census Commissioner, Ministry of Home Affairs, GOI, New Delhi (various years), Agricultural Wages in India, GOI (various years) and Chaudhuri and Gupta (2009).

This result goes in tune with the large body of literature which does concede to the fact that irrigation influences agriculture output significantly and reduce rural poverty. On the whole, the regression analysis suggests that along with irrigation other poverty determinants variables are also important in reducing the rural poverty without time lag.

In one hand, development of irrigation cannot make a significant impact instantaneously on rural poverty in any given region. Irrigation benefit flows on certain pathways to finally make an impact on the poor people, which normally take time. Irrigation availability initially changes the land-use pattern, including

its intensity; increases the adoption of technological inputs and then brings changes in cropping patterns from low-value to high-value crops; improves the cropping intensity; and then increases the production and productivity of crops. These changes increase not only the demand for labor but also the wage rate for agricultural laborers, among whom the incidence of poverty is very high in rural areas. The increased production of foodgrains owning to irrigation development also helps the rural poor to afford the mat a cheaper rate, which ultimately helps them to cross poverty barriers. This entire process cannot take place instantaneously after the introduction of irrigation in any region. On the other hand, it is observed that among the entire input variable, irrigation plays very crucial role, in multiple regression, to reduce rural poverty during without time lag and much more with time lag for four time points. Therefore, it is necessary to use irrigation as a lagged variable in the regression analysis to capture its real impact on rural poverty. Keeping this in view, we have estimated regressions separately, treating irrigation with without lag (PRPt= α +b1GIAGCA), with 10-year time lag (PRPt= α + b1 GIAGCAt – 10), 20 years' time lag (PRPt= α+b1 GIAGCAt – 20) and also 30 years' time lag (PRPt= α+b1 GIAGCAt – 30).

Table 6: Impact of Irrigation (GIAGCA) on Rural Poverty: Linear Regression Results

PRP = a+b1 GIAGCA	Results arrived using the data of 178 districts				
	Constant	Slope	R^2	Adjusted R^2	N
PRP = f(GIAGCA)	39.570[a] (2.450)	-0.262[a] (0.049)	0.143	0.138	178
PRP = f(GIAGCAt-10)	42.75[a] (1.980)	-0.381[a] (0.043)	0.310	0.307	178
PRP = f(GIAGCAt-20)	41.740[a] (1.738)	-0.438[a] (0.044)	0.358	0.355	178
PRP = f(GIAGCAt-30)	40.090[a] (1.586)	-0.489[a] (0.048)	0.368	0.364	178

Note: Note: a, b, c and d are significant level at 1, 5, 10 and 20% respectively, figures in the brackets are Standard Error, and t, t-10, t-20 and t-30 are time lag.

Source: Computed using Bhalla and Singh (2010, 2012) and Chaudhuri and Gupta (2009).

The results show that the strength of impact of irrigation on reducing the rural poverty is much better when compared to the regression results computed treating irrigation without any time lag (see Tables 6). However, the strength of regression coefficients and the R2 has been increasing over time even when irrigation is used as a lagged variable in the regression analysis. This shows that the irrigation is

very important in reducing rural poverty today in India. Therefore, one cannot completely discard the relevance of irrigation in reducing rural poverty because even today when irrigation availability reduces due to monsoon failures or other reasons, the production of food grains and other agricultural commodities declines sharply, which results in increased food inflation, causing deep distress especially for the rural poor (Narayanamoorthy, 2001). It is also clearly shown in the Figure 5.1 that PRP reduces as irrigation increases in a fluctuating manner over the period.

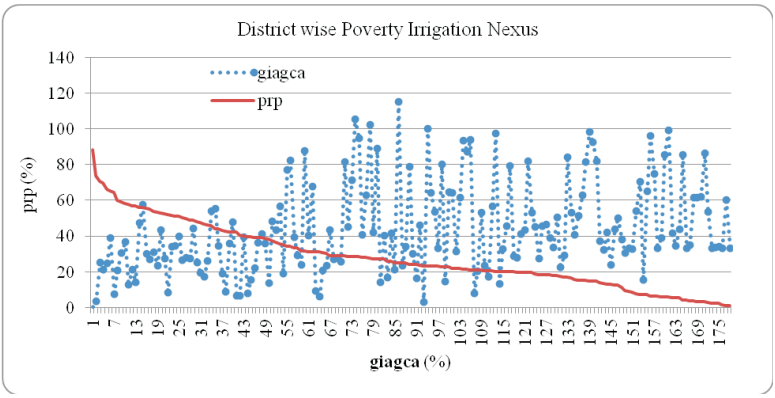

Fig. 1. District wise Poverty Irrigation Nexus

The reduced strength of regression coefficients of irrigation over time can be attributed to a few important factors. First, like the rural non-agricultural income (earnings) which is confirmed by various studies (Vaidyanathan, 1994b; Nayyar, 1996; Hussain, 2006; Binswanger-Mkhize, 2013)? This possibly could have dampened the relationship between irrigation and rural poverty. Second, looking from another angle, various anti-poverty programs implemented in the late 1970s might have been another factor in reducing rural. On the whole, one can say from the above information that the decline of a relationship between rural poverty and irrigation is possibly more due to significant increase of rural non-agricultural income than due to agricultural income during the last two decades.

Conclusion

The main objective of the study is to analysis the impact of irrigation on rural poverty across districts of India. For this study, 178 districts from 13 states of India have been taken. Both descriptive and regressions analysis have been used for the study. Simple and multiple regressions have been used considering PRP as dependent variable and other selected poverty determinant variables as independent variables with time lag and without time lag for analyzing. The descriptive analysis results that the PRP is relatively high for those districts whose percentage of gross irrigated area to gross cropped area (GIAGCA) is below the

average of 178 districts than those whose GIAGCA is higher than the average. The PRP is also found to be relatively high for those districts where the irrigation area per thousand rural populations (IAPTRP) is below the average of 178 districts. This indicated that there an inverse relationship between irrigation rural poverty.

The important findings from the both simple and multiple regressions analysis are that base level irrigation impacts in alleviating rural poor better than the without base level irrigation. It is understood that irrigation infrastructure will not results on reducing rural poverty immediately but it will take some time to influence the rural poverty reduction. We came to conclude that among the selected poverty determinants variables, irrigation is predominantly impacting on rural poverty which is expected in this study. The results demonstrate not only in descriptive analysis but also in regressions that irrigation is one of the most important factors in reducing/influencing rural poverty.

Next to the irrigation, agriculture wage rate is playing major role in influencing rural poverty. Other poverty determinant variable like cropping intensity (CI) shows inverse relationship but not significant factor. Percentage of village electrified (ELEC) shows significant and positive association in reducing rural poverty. Gross cropped area per thousand rural populations (GCAPTRP) is decreasing over the time but significantly influencing rural poverty. Percentage of rural literacy (LITE) is not significant. Road is associated with inversely but not significant as is expected for the time periods. On the whole the all these selected poverty determinants variables are influencing in rural poverty alleviating. Among the all, irrigation is more importantly and predominantly influencing rural poverty. However, we cannot say that irrigation infrastructure is the only one which reduces rural poverty, there are many other variables like, government progammes in poverty alleviation and employment generation, NOGs, institutions, etc. are also responsible for reducing poverty.

References

Agricultural Wages in India, (various years). Government of India, New Delhi.

Ahluwalia, M. S., (1978). Rural Poverty and Agricultural Performance in India. Journal of Developing Studies, **14**(2): 298-323.

Asian Development Bank, (2002). Poverty in Pakistan: Issues, Causes and Institutional Responses. Pakistan Resident Mission, Islamabad.

Bhalla, G.S., Singh, G., (2010). Growth of Indian Agriculture, Final Report on Planning Commission Project. (Ed.). Centre for Study of Regional Development, Jawaharlal Nehru University, New Delhi.

Bhalla, G.S., Singh, G., (2012). Economic Liberalization and Indian Agriculture: A District-level Study. (Ed.). Sage Publications India Private Limited, New Delhi.

Bhattarai, M., Sakthivadivel, R., Hussain, I., (2002). Irrigation Impacts on Income Inequality and Poverty Alleviation: Policy Issues and Options for Improved Management

of Irrigation Systems.Working Paper 39. International Water Management Institute (IWMI), Colombo, Sri Lanka.

Bhattarai, B., Narayanamoorthy, A., (2003). Impact of Irrigation on Rural Poverty in India: An Aggregate Panel-Data Analysis. *Water Policy*, **5**(5-6): 443-458.

Binswanger, H.P.M., (2013). The Stunted Structural Transformation of the Indian Economy: Agriculture, Manufacturing and the Rural Non-Farm Sector. *Economic and Political Weekly*, **58**(26-27): 5-13.

Census of India (various years). Indian Planning Experience, A Statistical Profile, Planning Commission, Government of India (www.planningcommission.nic.in).

Chaudhuri, S., Gupta, N., (2009). Levels of Living and Poverty Patterns: A District-Wise Analysis for India. *Economic and Political Weekly*, **44**(9): 94-110.

Datt, G., Ravallion, M., (1996). Why have some Indians States Done Better than Others at Reducing Rural Poverty? Policy Research Working Paper No. 1594, Policy Research Department, Poverty and Human Resources Division, The World Bank, Washington, D.C., U.S.A.

Deb, R. A., Shah, T., (2003). Socio-ecology of Groundwater Irrigation in India. In: Intensive use of Groundwater: Challenges and Opportunities, Swets and Zetlinger, eds., Netherlands, 307-336.

Dhawan, B.D., (1988). Irrigation III India's Agricultural Development: Productivity, Stability, Equity. (Ed.). Sage Publications India Pvt. Ltd., New Delhi.

Dhawan, B.D., (1991). Role of Irrigation in Raising Intensity of Cropping. *Journal of Indian School of Political Economy*, **3**(4): 632-671.

Gadgil, D. R., (1948). Economic Effects of Irrigation: Report of a Survey of the Direct and Indirect Benefits of the Godavari and Pravara Canals. Publication No. 17, Gokhale Institute of Politics and Economics, Poona, Maharashtra.

Ghosh, S., Panda, D.K., Nanda, P., Kumar, A., (2011). Links between Irrigation, Agriculture and Level of Living. *Indian Research Journal of Extension Education,* **11**(3): 32-36.

Ghosh, S., Verma, H.C., Panda, D.K., Nanda, P., Kumar, A., (2012). Irrigation, Agriculture, Livelihood and Poverty Linkages in Odisha. *Agricultural Economics Research Review*, **25**(1): 99-105.

Ghosh, M., (1996). Agricultural Development and Rural Poverty in India. *Indian Journal of Agricultural Economics,* **51**(3): 374-380.

Ghosh, M., (1998). Agricultural Development, Agrarian Structure and Rural Poverty in West Bengal. *Economic and Political Weekly*, **33**(47-48): 2987-2995.

Hussain, I., (2004). Assessing Impacts of Irrigation on Poverty: Approaches, Methods, Case Studies and Lessons, Paper Presented at the Workshop, International Water Management Institute (IWMI), Colombo, Sri Lanka.

Hussain, I., Hanjra, M. A., (2003). Does irrigation water matter for rural poverty alleviation? Evidence from South and South-East Asia. *Water Policy*, **5**(5): 429-442.

Hussain. I., Hanjra, M. A., (2004). Irrigation and Poverty Alleviation: Review of the Empirical Evidence. *Irrigation and Drainage*, **53**(1): 1-15.

Hussain, M., Hussain, Z, and Ashfaq, M, (2006). Impact of Small Scale Irrigation Schemes

on Poverty Alleviation, in Marginal Areas of Punjab, Pakistan. *International Research Journal of Finance and Economics*. ISSN 1450-2887, No. 6.

Hussain, I., (2007). Direct and Indirect Benefits and Potential Disbenefits of Irrigation: Evidence and Lessons. *Irrigation and Drainage,* **56**(2-3): 179-194.

Lipton, M., Litchfield, J., Faurès, J. M., (2003). The Effects of Irrigation on Poverty: A Framework for Analysis. *Water Policy*, **5**(5): 413-427.

Lipton, M., (2007). Farm Water and Rural Poverty Reduction in Developing Asia. Irrigation and Drainage, **56**(2): 127-146.

Mellor, J.W., (1985). Determinants of Rural Poverty: the Dynamics of Production, Technology, and Price. In: Agricultural Change and Rural Poverty: Variation on a Theme, Dharm Narain, eds., The Johns Hopkins University Press, Baltimore, MD. pp. 21-40.

Mellor, J.W., (2002). Irrigation agriculture and poverty reduction: general relationships and specific needs, in Managing Water for Poor: Workshop Proceedings, eds., International Water Management Institute, Colombo, Sri Lanka. pp. 53-69.

Molden , D., Burton, M., Bos, M.G., (2007). Performance Assessment, Irrigation Service Delivery and Poverty Reduction: Benefits of Improved System Management. Irrigation and Drainage, **56**(2-3): 307-320.

Narayanamoorthy, A. and Beero, S.K., (2014). Is Irrigation Development Still Relevant in Reducing Rural Poverty in India? An Analysis of Macro-Level Data. In: The Water, Energy and Food Security, M. Dinesh Kumar; Nitin Bassi; A. Narayanamoorthy and M.V.K. Sivamohan, Eds., Routledge Publication, Earthscan Studies in Natural Resource Management, London and New York, pp. 73-96.

Narayanamoorthy, A., (2001). Irrigation and Rural Poverty Nexus: A State-wise Analysis. *Indian Journal of Agricultural Economics*, **56**(1): 40-56.

Narayanamoorthy, A., Hanjra, M.A., (2006). Rural Infrastructure and Agriculture Output Linkages: A Study of 256 Indian Districts. *Indian Journal of Agricultural Economics*, **61**(3): 444-459.

Narayanamoorthy, A., (2007). Does Groundwater Irrigation Reduce Rural Poverty? Evidence from Indian States. *Irrigation and Drainage*, **56**(2-3): 349-362.

Narayanamoorthy, A., Hanjra, M. A., (2010). What Contributes to Disparity in Rural-Urban Poverty in Tamil Nadu?: A District Level Analysis. *Indian Journal of Agricultural Economics*, **65**(2): 228-244.

Nayar, R., (1996). New Initiatives for Poverty Alleviations in Rural India. In: Economic Reforms and Poverty Alleviation in India, C.H. Hanumantha Rao and H. Linnemann, Eds., Sage Publications, New Delhi, pp. 171-198.

Parthasarathy, G., (1995). Public Intervention and Rural Poverty: Case of Non-Sustainable Reduction in Andhra Pradesh. *Economic and Political Weekly*, **30**(41-42): 2573-2586.

Palmer, R. J., Sen, K., (2003). What has Luck Got to do with it? A Regional Analysis of Poverty and Agricultural Growth in Rural India. *The Journal of development Studies*, **40**(1): 31.

Panahi, F., Malekmohammadim, I., Chizari, M., and Samani, J. M.V., (2009). The Role of Optimizing Agricultural Water Resource Management to livelihood Poverty abolition

in Rural Iran. *Australian Journal of Basic and Applied Sciences*, INSI net Publication, **3**(4): 3841-3849.

Paul, S., (1990). Green Revolution and Poverty Among Farm Families in Haryana 1969/70-1982. *Economic and Political Weekly*, **25**(39): A105-A110.

Rao, C. H. H., (1987). Poverty Alleviation Programmes and the Poor. *Economic and Political Weekly*, **22**(35): 1491.

Rao, V. M., (1978). Linking Irrigation with Development. Economic and Political Weekly, **13**(24): 993-997.

Rath, N., and Mitra, A.K., (1989). Economics of Irrigation in Water Scarce Region: A Study of Maharashtra. Anna Vijnana, **31**(1): 1-129.

Ray, S. K., (1992). Development of Irrigation and its Impact of Pattern on Land Use, Output Growth and Employment Generation. *Journal of Indian School of Political Economy*, **4**(4): 677-700.

Saleth, R. M., Namara, R. E., Samad, M., (2003). Dynamics of irrigation-poverty linkages in rural India: analytical framework and empirical analysis. *Water Policy*, **5**(5): 459-473.

Shah, T., Singh, O.P., (2004). Irrigation Development and Rural Poverty in Gujurat, India: A Disaggregated Analysis. *Water International*, **29**(2): 167-177.

Smith, L.E.D., (2004). Assessment of the Contribution of Irrigation to Poverty Reduction and Sustainable Livelihoods. *Water Resources Development*, **20**(2): 243-257.

Sundaram, K., Suresh D. T., (1988). Towards an Explanation of Interregional Variation in Poverty and Unemployment in Rural India. In: Rural Poverty in South Asia, T.N. Srinivasan and P. K. Bardhan, eds., Oxford University Press, Delhi, pp. 316-362.