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Rural Infrastructure ant Its Impact on Agricultural Growth in India: An Empirical Analysis

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Abstract

The present paper attempts to find the impact of the rural infrastructural facilities on agricultural growth in India. It analyzes the trends in rural infrastructure variables and value of output from agriculture sector over the study period 1990-19 to 2017-18. Compound annual growth rates (CAGR) have been worked out to find the changes in area, production and yield of agriculture output. To investigate the relationship between infrastructure variables and value of agricultural output the regression analysis has been used. In present study the rural infrastructure includes irrigation facilities, fertilizer consumption, primary agricultural credit societies, electric supply, agricultural markets, and road network in rural areas. Study finds that there is significant impact of irrigation, fertilizer consumption, credit, regulated agricultural markets and road infrastructure on agricultural output. The impact of electric pump, tractors and village electrification has not found statistically significant. It implies that infrastructure facility like roads, irrigation and electricity have a more direct effect on agriculture growth than personal infrastructure like electrical pumps and tractors. This finding validates the conclusion regarding positive and significant relationship between rural infrastructure and agriculture growth in India.

Keywords: Rural Infrastructure, Agriculture Growth, Irrigation Intensity, CAGR

Introduction

Many agricultural shifts and transitions have taken place in India in the last fifty years. The factors that underlie these changes in different periods are different. In the 1950's and 1960's structural reforms such as land consolidation, changes in tenancy laws, creation of irrigation and other infrastructure facilities played a crucial role in the growth of productivity. In the seventies, green revolution was key driver of agriculture growth and the spread of technology in agriculture played significant role in the 1980s. In the 1960s and 1970s, the public investment was increased for creation of infrastructure in rural areas which improved the growth performance of agriculture sector. However, in 1980s public investment in agriculture witnessed decline but the revenue expenditure on input subsidies increased considerably. This declining trend in public investment on agriculture and rising trend in input subsidies continued further.

The infrastructure facilities of a developing country such as India are typically poor and insufficient, especially in rural areas. In several states, even minimal infrastructure facilities such as public roads, irrigation and electricity are not available to rural people. There is an urgent need of accelerating the process of creation of infrastructure in rural areas if the country wants to achieve balanced and stable growth.

Agriculture sector cannot grow without some basic infrastructural facilities in the form of agricultural credit, irrigation, power, transport and marketing network etc. In the absence of adequate provision, the agricultural productivity is low in India compared to other countries. In the country, the yield per hectare of different crops and amount of agricultural production among different states can largely be compared to the degree of application of agricultural inputs despite differences in land productivity and rainfall. The poor rural infrastructure constraints the access of the farmers to market and compels them to sale their produce at lower prices. The construction of rural roads becomes inevitable to market the agriculture produce at the profitable and competitive prices. According to the World Development Report (1994) “Rural infrastructure leads to agricultural expansion by increasing yields, farmers’ access to markets and availability of institutional finance. The kind of infrastructure put in place also determines whether growth does all that it can to reduce poverty. Most of the poor are in rural areas, and the growth of farm productivity and non-farm rural employment is linked closely to infrastructure provision. It is estimated that 15 per cent of the crop produce is lost between the farm gate and the consumer because of

poor roads and inappropriate storage facilities alone, adversely influencing the income of farmers."

Economic reforms and trade liberalization were supposed to change the scenario in agriculture sector through expansion of market opportunities for primary goods exports and private investment. However, it was realized that basic infrastructure facilities like marketing, electric supply, and irrigation system did not expanded to meet the needs of agriculture sector. Agricultural growth slowed from 4.69% in 1991 to 2.6% in 1997-1998 and then to 1.1% in 2002-2003. Since 2002 was a drought year, the rate of growth recovered in the subsequent years but never exceeded 3%. This poor performance of agriculture sector limited the ability of industrial sector to grow and generate the employment opportunities. The present study deals with rural infrastructure in particular and its impact on agricultural growth during the 1990-91 to 2017-18 period.

Review of Literature

Zhang and Fan (2004) applied a causality test to examine the relationship between infrastructure and technology applying panel data approach. The study found that there was a strong linkage between infrastructure development and productivity in the long run. For the short run, it was not observed. To estimate the degree and amount of productivity impact of infrastructure, the researchers formed different models. After controlling for autocorrelation and accounting for possible endogeneity problems, they found that the magnitude of relationship decreases slightly.

Narayanmoorthy and Hanjra (2006) examined the linkages between rural infrastructure development and agricultural growth, using cross-sectional data. The study found that the districts having value of agricultural output above the average were having better infrastructure facilities. There was low productivity in those districts where the infrastructure base was poor. The income from the sale of agriculture produce was found significantly impacted by agriculture market and road connectivity. In addition to this difference in rural infrastructure facility among districts led to increase in inequalities in terms of income and agriculture productivities. Infrastructure facilities have been found to play a catalytic role in the production process. While several schemes for infrastructure investments in various regions of the country were introduced under the different Five Year Plans, all regions were not equally developed. A first step in the direction of balanced regional development is identification of backward rural areas to remove the infrastructure disparities among the different regions. And the backward areas need to be focused in order to implement corrective steps.

Bhalla and Tyagi (2012) analyzed the impact of green revolution at district level. Their study analyzed the determinants of agricultural growth.

They found that new technology and varieties of seeds have been applied where there are proper facilities of irrigation. Infrastructurally backward areas were not experimented with new technology and technique of production. It was observed that the growth in agriculture sector has been adversely affected in post liberalization period. They suggested that the huge infrastructure investment is required in neglected areas to remove the inter-regional inequalities in agriculture development.

The present study deals with agricultural infrastructures in particular and its impact on agricultural development in two areas of India:

Objectives of Study

1. To analyze the trends and variation in agricultural output in India.
2. To analyze the growth of rural infrastructure in India.
3. To examine the impact of rural infrastructure on agricultural growth in India.

Hypothesis

H_0: There is no significant difference in trends in growth of agriculture output in India over the reference period.

H_0: There is no impact of rural infrastructure on agricultural growth in India.

Methodology and Data Source

The present study is an attempt to empirically examine the relationship between rural infrastructure and growth in agriculture sector in India during the period 1990-91 to 2017-18. To find the degree and nature of relationship between agriculture growth and rural infrastructure variables the correlation method has been used and for examining the impact of infrastructure on agricultural growth the ordinary least square regression method has been applied.

Agricultural productivity in value terms (per hectare) has been taken as an indicator of agricultural growth. The rural infrastructure facilities like irrigation, electricity, tractors, regulated markets for selling the crop, road connectivity, primary credit societies which are most useful for agriculture sector have been included in the study. These have been represented by the following indicators in the analysis:

Y= Agricultural productivity in value terms (per hectare)

X_1 = Irrigation intensity (gross irrigated area as percentage to net sown area).

X_2= Number of electric pumps/1000 hectare of GCA.

X_3 = Fertilizer consumption/1000 hectare of GCA.

X_4 = Tractors /1000 hectare of GCA.

X_5 = Number of primary agricultural credit societies/lakh of population.

X_6 = Percentage of village electrified.

X_7 = Road density (length of total roads per hundred square kilometer area).

X_8 = Number of regulated markets per thousand villages.

Coefficient of Variation (C.V.)

To measure the disparities in agricultural output and infrastructure variables the C.V. has been computed. It reflects the variability in indicators chosen for the analysis.

(Standard Deviation / Mean) * 100

Co-efficient of variation = σ/ x 100,

Where

σ = Standard deviation X =Arithmetic Mean

The compound annual growth rate has been computed by fitting the following equation in the time series data area, production and yield.

$Yt=Y_0 (1+r)\ t$ …….. (1)

Taking log $LnYt=LnY_0+tLn\ (1+r)$ ……. . (2)

$LnYt= a+bt$ …….. (3)

Where

$a=LnY_0$ and $b=Ln\ (1+r)$

Yt= area/ production/ yield Y_0= constant t= time period in years b= regression coefficient

Percentage compound growth rate = (Anti log b-1) × 100

Percentage change in yield is given by:

Percentage change in yield = (Current year yield −Previous year yield)/ Previous year yield ×100

The data has been compiled from the various issues of Handbook of Statistics of the Indian Economy (RBI), Agricultural Statistics at a Glance, Department of Agriculture and Co-operation, Ministry of Agriculture, Government of India, Rural Development Statistics, National Institute of Rural Development, Ministry of Rural Development, Government of India, Statistical Abstract of India, Central Statistics Organization, Government of

India, Ministry of Finance, Ministry of Statistics and Programme Implementation, Govt. of India.

Analysis and Discussion

The growth in agricultural production is very significant for the economic growth and development of a country. The value and volume of agriculture output has increased in 1990s. The table shows the trends in agriculture production. A cursory look at the table indicates there are many ups and downs in growth of agricultural output during the reference period. There are so many factors which together affect the agriculture production. There has been an increase in the use of improved seeds, chemical manures and implements. These necessitate the increased use of irrigation facilities. Better rotation of crops, double cropping, fighting plant diseases and pests are being adopted increasingly by the farmers.

A look at the table 1 makes clear that agriculture has increased considerably over the years but in terms of percentage, there have been wide fluctuations. During 1992-93 to 1999-2000 the rate of growth of agricultural production has been favourable. However, it was negative in 1995-96 and but registered remarkable growth in 1996-97. Despite these some positive changes in the value of agriculture output, the situation is not satisfactory.

Table 1. Trend in Agricultural Production

At Constant Prices (2011-12) (Rs Crore)

Year	Agricultural Output	Growth Rate (%)	Year	Agricultural Output	Growth Rate (%)
1990-91	682657	1.84	2004-05	905455	-0.57
1991-92	661396	-3.11	2005-06	961230	6.16
1992-93	700938	5.98	2006-07	988620	2.85
1993-94	719341	2.63	2007-08	1049922	6.20
1994-95	751618	4.49	2008-09	1032552	-1.65
1995-96	739557	-1.60	2009-10	1010845	-2.10
1996-97	814841	10.18	2010-11	1120135	10.81
1997-98	789420	-3.12	2011-12	1191483	6.37
1998-99	852001	7.93	2012-13	1198611	0.60
1999-00	878292	3.09	2013-14	1257133	4.88
2000-01	853741	-2.80	2014-15	1228006	-2.32
2001-02	907624	6.31	2015-16	1206717	-1.73
2002-03	814309	-10.28	2016-17	1275548	5.70
2003-04	910642	11.83	2017-18	1321941	-0.57

Sample Standard Deviation	2,01,538.22	Mean	9,58,020.54
Sample Variance	4.06E+10	Standard Error of The Mean	38,087.14
Minimum	661396	Skewness	0.31
Maximum	1321941	Kurtosis	-1.15
Range	660545	Coefficient of Variation (CV)	21.04%

Table 2. Descriptive Statistics

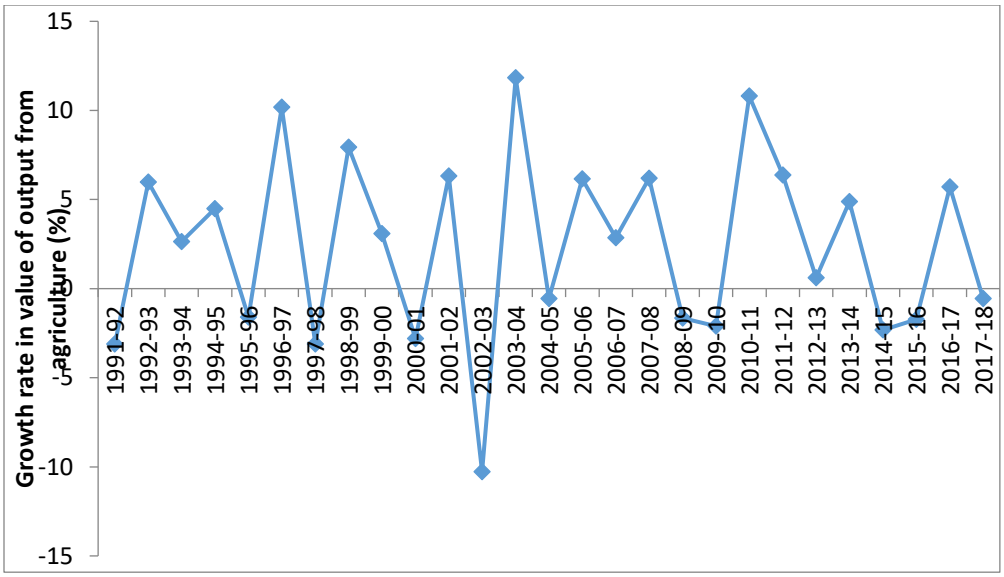

Fig. 1. Trend in agriculture output

While introducing the economic reforms it was assumed that the agriculture sector would be benefited and Indian agriculture which is presently subsistence sector will become profitable occupation. But the current scenario of agriculture indicates that these expectations could not be actualized. The main problem of agriculture sector in India is that there are too many people who depend on agriculture for their employment and livelihood. Overcrowding and the consequent pressure of population has caused fragmentation of holdings, sub-division of land, and a fall in per capita availability of land which ultimately led to disguised unemployment. The prevalence of obsolete equipment and practices is common feature of Indian agriculture. The most significant factor causing low productivity and quality of production in agriculture sector is lack of adequate infrastructure. Indian agriculture has suffered because of the shortage of infrastructural facilities like irrigation, road network, electricity, finance and marketing. Due to absence of proper marketing and credit facilities, the agriculture sector could not become gainful occupation in India.

Barley	-2.62	-0.64	2.03	-0.65	1.33	2.00
Coarse Cereals	-2.12	-0.02	1.82	-0.80	3.00	4.44
Total Cereals	0.04	-0.02	1.59	0.14	2.33	3.33
Gram	1.26	2.96	1.68	4.18	5.91	1.66
Tur	-0.66	0.89	1.55	1.34	1.85	0.50
Other Pulses	-1.61	-1.58	0.04	0.21	1.76	1.55
Total Pulses	-0.60	0.59	0.93	1.60	3.45	2.00
Total Food grains	-0.07	2.02	1.52	0.41	2.43	3.03
Sugarcane	-0.07	2.73	1.05	1.38	2.07	0.68
Groundnut	-2.31	-1.25	1.08	-1.26	1.42	2.72
Sesamum	-5.52	-4.84	0.72	1.93	3.06	1.10
Rapeseed and Mustard	0.71	0.78	0.07	2.57	4.69	2.06
Sunflower	-2.97	-3.20	-0.24	-2.82	-0.64	2.25
Soyabean	10.23	13.06	2.56	5.20	8.79	3.42
Nine Oilseeds	0.17	1.42	1.42	1.85	4.98	3.11
Total Oilseeds	-0.86	1.63	1.15	2.13	3.75	2.65
Cotton	2.71	2.29	-0.41	3.21	13.53	9.99
Jute	1.48	2.32	0.83	-0.69	0.64	1.33
Mesta	-2.47	-2.08	0.40	-5.87	-5.54	0.35
Jute and Mesta	1.81	1.81	0.87	-1.44	0.15	2.26
Total Fibres	2.45	2.21	-0.27	2.75	11.40	8.56
Potato	3.84	5.44	1.54	4.71	6.33	1.55
Tobacco	1.56	1.00	-0.55	4.41	5.45	0.99
Non Foodgrains	1.18	2.69	1.09	2.26	3.83	2.39
All Principal Crops	**0.27**	**2.29**	**1.33**	**0.97**	**2.76**	**3.27**

Table 3. Compound Growth Rates of Area, Production and Yield of Principal Crops in India (% per Annum)

Note: A: Growth Rates of Area. P: Growth Rates of Production. Y: Growth Rates of Yield

Table 4. Index Number of All Crops in India

	2012-13	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**
A	108.9	112.3	111.9	111.6	112.6	112.7
P	124.2	129.8	124	120.8	132.8	139.4
Y	114	115.5	110.8	108.3	117.9	123.6

Note: A: Area. P: Production. Y: Yield

Table 5. Sown and Irrigated Areas in India
(In Million Hectare)

Year	Net Sown Area	Gross Sown Area	Area Sown more than Once	Net Irrigated Area	Gross Irrigated Area	Area Irrigated more than Once
1990-91	143.00	185.74	42.74	48.02	63.20	15.18
1991-92	141.63	182.24	40.61	49.87	65.68	15.81
1992-93	142.72	185.70	42.98	50.29	66.76	16.47
1993-94	142.34	186.58	44.25	51.34	68.26	16.92
1994-95	142.96	188.05	45.09	53.00	70.65	17.65
1995-96	142.20	187.47	45.27	53.40	71.35	17.95
1996-97	142.93	189.50	46.57	55.11	76.03	20.91
1997-98	141.95	189.99	48.04	55.21	75.67	20.46
1998-99	142.75	191.65	48.90	57.44	78.67	21.23
1999-00	141.06	188.40	47.33	57.11	78.79	21.69
2000-01	141.34	185.34	44.00	55.20	76.19	20.98
2001-02	140.73	188.01	47.28	56.94	78.37	21.44
2002-03	131.94	173.89	41.95	53.90	73.06	19.16
2003-04	140.71	189.66	48.95	57.06	78.04	20.98
2004-05	140.64	191.10	50.46	59.23	81.08	21.85
2005-06	141.16	192.74	51.57	60.84	84.28	23.44
2006-07	139.82	192.38	52.56	62.74	86.75	24.01
2007-08	141.16	195.22	54.21	63.19	88.06	24.89
2008-09	141.90	195.33	53.43	63.64	88.90	25.26
2009-10	139.17	189.19	50.02	61.95	85.09	23.14
2010-11	141.56	197.68	56.12	63.67	88.94	25.27
2011-12	140.98	195.80	54.82	65.71	91.79	26.08
2012-13	139.93	194.22	54.29	66.29	92.24	25.96
2013-14	141.43	200.95	59.53	68.12	95.76	27.64
2014-15	140.13	198.38	58.25	68.38	96.75	28.37
2015-16	139.51	197.05	57.55	67.30	96.62	29.32

Source: Directorate of Economics and Statistics, Ministry of Agriculture, Government of India.

Table 6. Variability in Sown and Irrigated Area in India

Variable	Min.	Max.	Mean	Std. Deviation	Std. Error of Mean	Skewness	CV
Net Sown Area	132	143	141.04	2.144	0.4203	-3.1371	1.52
Gross Sown Area	174	201	190.46	5.729	1.1265	-0.6502	3.02
Area Sown more than Once	41	60	49.50	5.420	1.0597	0.2013	10.92
Net Irrigated Area	48	68	58.58	6.074	1.1844	0.0480	10.30
Gross Irrigated Area	63	97	80.69	9.987	1.9484	0.0295	12.32
Area Irrigated more than Once	15	29	21.92	3.908	0.7713	0.0212	17.87

The table 5 shows the variability in sown and irrigated area in India during the 1990-91 to 2015-16 period. Area sown more than once is the area on which corps has been cultivated more than once in agriculture year and table reflects that there have been massive fluctuations in area irrigated more than one. Similarly, area sown more than once and gross irrigated area and net irrigated areas have experienced wide variations While there has been stability and consistency in the data of net sown area (C.V. is 1.52%). Net sown area shows the total cultivated area during the agriculture year without taking into account the number of times of cultivation during the year. The agriculture equipment like tractor, pump set etc. affect it to a great extent. Other than geographical and climatic conditions, area more than once and area irrigated more than once are affected many infrastructure facilities like irrigation, availability of fertilizers, marketing and credit.

Table 7. Primary Agriculture Credit Societies

Year	Advanced				Amount Outstanding	
	No. of Borrowers		Amount			
	(in Lakh)	Variation (%)	(Rs. Crore)	Variation (%)	(Rs. Crore)	Variation (%)
2009-2010	600	-	74935	-	76480	-
2010-2011	520	-13.33	91304	21.84	87768	14.76
2011-2012	450	-13.46	107300	17.52	91243	3.96
2012-2013	500	11.11	161909	50.89	139400	52.78
2013-2014	480	-4.00	171420	5.87	130054	-6.70
2014-2015	500	4.17	159050	-7.22	147225	13.20
2015-2016	462	-7.60	180823	13.69	158487	7.65
2016-2017	520	12.55	200678	10.98	170459	7.55

Source: Based on collected from Reserve Bank of India.

Table 8. Growth of Primary Agriculture Cooperative Marketing Societies in India

Year	Number	Growth Rate (%)	Year	Number	Growth Rate (%)
1990-91	7346	-	1997-98	8871	0.08
1991-92	7506	2.18	1998-99	8878	-11.16
1992-93	8364	11.43	2000-01	7887	-8.96
1993-94	8483	1.42	2008-09	7180	0.31
1994-95	8628	1.71	2009-10	7202	23.23
1995-96	8451	-2.05	2014-15	8875	-16.63
1996-97	8680	2.71	2016-17	7399	0.08

Source: Based on collected from Reserve Bank of India

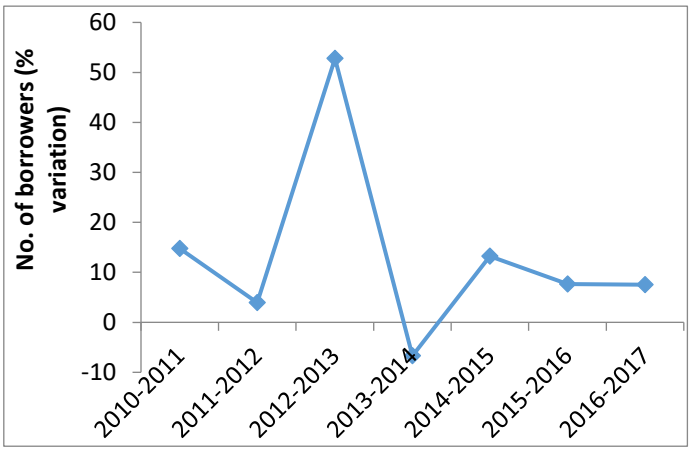

Fig.2. Trend in no. of borrowers (PACS)

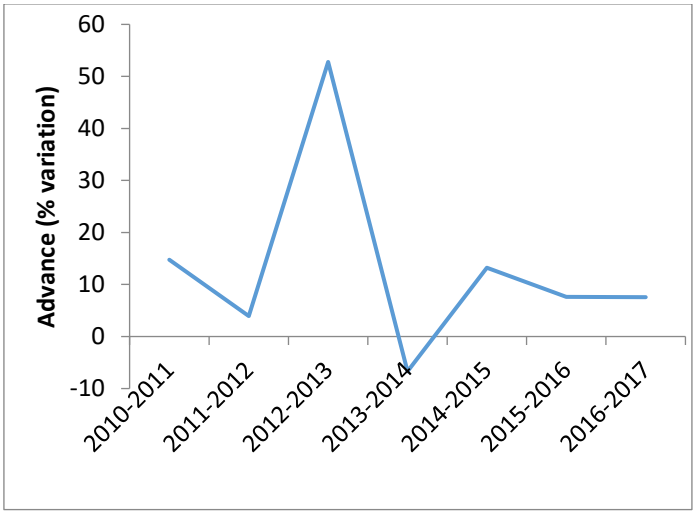

Fig.3. Trend in amount of advance (PACS)

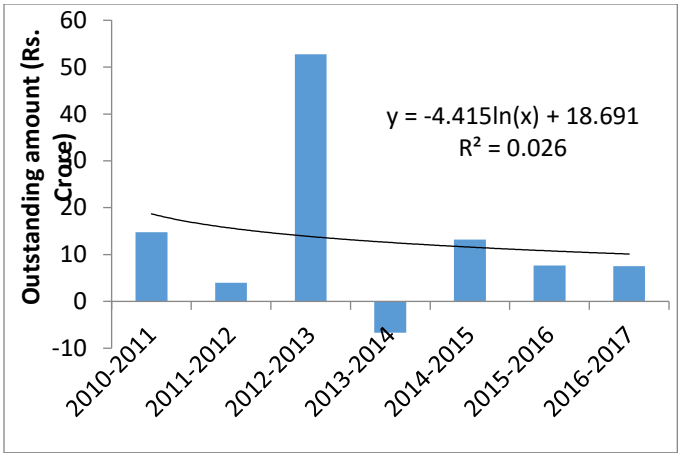

Fig. 4 Outstanding amount of credit

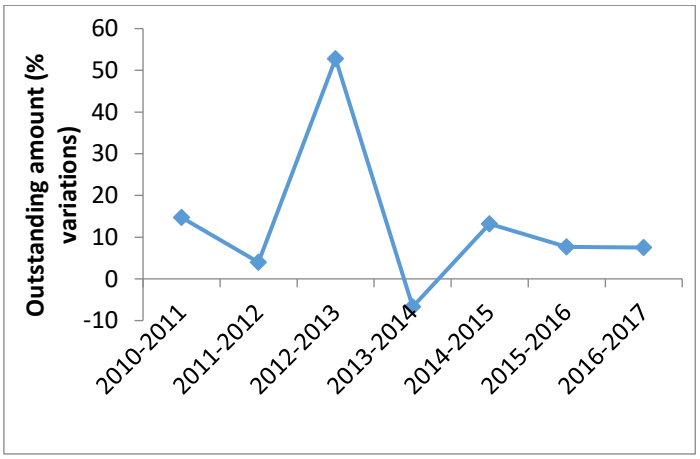

Fig. 5. Variations in outstanding amount of credit

Table 9. Primary Agriculture Credit Societies (PACS) in India (Amount: Rs. in Crore)

	As at end-March		Variation (%)	
	2017	**2018**	**2016-17**	**2017-18**
A. Liabilities				
1. Total Resources (2+3+4)	273697	278907	14.9	1.9
2. Owned Funds (a+b)	32982	30942	34.9	-6.2
a. Paid-up Capital	14122	14142	15	0.1
of which				
Government Contribution	829	807	3.9	-2.7
b. Total Reserves	18860	16800	55.1	-10.9
3. Deposits	115884	119632	14.7	3.2
4. Borrowings	124831	128333	10.8	2.8
5. Working Capital	239967	24356	19.2	1.5

		3		
B. Assets				
1. Total Loans Outstanding (a+b)	170459	169629	7.6	-0.5
a) Short-Term	122194	120823	4.4	-1.1
b) Medium-Term	48265	48806	16.5	1.1

Source: Directorate of Economics and Statistics, Ministry of Agriculture, Government of India

Table 10. Sale of Tractors and Power Tillers in India

Year	Tractors	Growth Rate (%)	Power Tillers	Growth Rate (%)
1990-1991	139828	-	6316	-
1991-1992	151121	8.08	7528	19.19
1992-1993	144337	-4.49	8642	14.80
1993-1994	138753	-3.87	9449	9.34
1994-1995	164770	18.75	8376	-11.36
1995-1996	191329	16.12	10045	19.93
1996-1997	222684	16.39	11000	9.51
1997-1998	248141	11.43	12200	10.91
1998-1999	262169	5.65	14488	18.75
1999-2000	273182	4.20	16891	16.59
2000-2001	251939	-7.78	16018	-5.17
2001-2002	217456	-13.69	13563	-15.33
2002-2003	168182	-22.66	14613	7.74
2003-2004	189518	12.69	15665	7.20
2004-2005	246469	30.05	17481	11.59
2005-2006	291680	18.34	22303	27.58
2006-2007	352827	20.96	24791	11.16
2007-2008	346501	-1.79	26135	5.42
2008-2009	347010	0.15	35294	35.04
2009-2010	440331	26.89	38794	9.92
2010-2011	545109	23.80	55000	41.77
2011-2012	607658	11.47	60000	9.09
2012-2013	590672	-2.80	47000	-21.67
2013-2014	696828	17.97	56000	19.15
2014-2015	626839	-10.04	46000	-17.86
2015-2016	571249	-8.87	46453	0.98
2016-2017	744536	30.33	45200	-2.70
2017-2018	796873	7.03	51680	14.34

Source: Ministry of Agriculture & Farmers Welfare, Govt. of India

Agriculture credit is one of the crucial inputs for the agricultural output. In past, farmers have been dependent a lot on private money lenders for credit needs. This is very costly and insufficient. But after independence an institutional credit mechanism was commenced for granting cheaper and adequate credit to agriculture sector. The primary agriculture credit societies

are playing crucial role in meeting the agricultural input requirement. Table 6 presents the number of borrowers, amount of loan extended and outstanding amount provided by primary agriculture credit societies in India. Table 7 shows the growth of primary agriculture cooperative marketing societies in India. The cheapest and easiest source of rural financing is cooperative finance. There have been an upwards trend of both the number of co-operative members and primary credit societies. Table 7 shows the annual growth rate of number primary agriculture cooperative marketing societies in India.

Table 11. Availability of Agricultural Equipments in India

Type of Equipment	Availability in No. Per 1000 Hect. Net Area Sown	Type of Equipment	Availability in No. Per 1000 Hect. Net Area Sown
Manual Seed Drill/Seed Cum Fertilizer Drill	153.2	Tractors	16.7
Animal Drawn Seed Cum Fertilizer Drill	36.1	Power Tillers	2
Tractor Drawn Seed Cum Fertilizer Drill	7.2	Tractor Operated Dise Harrow	6.6
Animal Drawn Leveller	84.8	Tractor Operated Cultivator	12.5
Tractor Operated Levellers	6.2	Tractor Operated Rotavator	0.9
Manually Operated Plant Protection Equipment	28.5	Potato Digger	2.1
Power Operated Plant Protection Equipment	4.3	Straw Reaper	18.8
Drip & Sprinkler Equipments	8.3	Forage Harvester	18.2
Horticultural Tools (Power Operated)	8.9		

Source: Ministry of Agriculture, Govt. of India

Table 12. Annual Growth Rate (%) Infrastructure Indicators

Infrastructure Indicators	1990-91 to 1999-2000	2000-01to 2009-10	2010-11 to 2017-18
Irrigation intensity	2.23	2.09	1.87
Number of electric pumps/1000 hectare of GCA.	5.52	4.67	2.84
Fertilizer consumption/1000 hectare of GCA.	3.51	4.45	3.23

Number of Tractors/1000 hectare of GCA	10.8	7.90	5.54
Number of primary agricultural credit societies/lakh of pop.	2.65	2.91	2.14
Villages Electrified (%)	8.11	1.65	0.29
Regulated Agricultural Markets	2.45	-0.91	-0.24
Rural Road density	3.47	3.24	1.89

Source: Based on collected from Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India

Tractors and power tillers are key infrastructure for agriculture mechanization in farming. Their extensive use increases the productivity, raises the income opportunities to farmers, and reduces the time of operation and cultivation. Such type of infrastructure facilities with proper road connectivity improves the quality of work, and efficiency, reduces the operating cost and makes the agriculture a remunerative occupation. A glance at table 9 shows that during 2008-09 there has been a remarkable growth of 35% in the sale of tractors and power tillers. In 1990-91 it was around 19% and declined to 14% in 1991-92. Year 1994-95 was very dismal for the sale of these equipment. The connectivity of rural roads is a crucial aspect of rural development. Because of road connectivity farmers have easy access to market for purchasing inputs like seeds, fertilizer, pesticides and selling their products. In the absence of road connectivity, farmers are generally compelled to sell their products at very low prices to middlemen. Data indicate that the rural road density is considerably increased in 2000s. In this respect the role of flagship scheme Pradhan Mantri Gram Sadak Yojana (PMGSY) has been very crucial which seeks to link all the unconnected rural residential units with a population of more than 500 by the end of Tenth Plan period.

Table 13. Correlation Matrix

	IRI	EP	FC	TRAC	PACS	VE	RAM	RRD	AP
IRI	1.00								
EP	0.865	1.00							
FC	0.852	0.499	1.00						
TRAC	0.670	0.464	0.775	1.00					
PACS	0.645	0.523	0.696	0.695	1.00				
VE	0.743	0.794	0.362	0.323	0.375	1.00			
RAM	0.446	0.268	0.439	0.669	0.255	0.404	1.00		
RRD	0.525	0.381	0.453	0.688	0.234	0.338	0.345	1.00	
AP	0.656	0.323	0.581	0.396	0.424	0.381	0.643	0.733	1.00

Note: IRI: irrigation intensity, EP: electric pumps, FC: fertilizer consumption, TRAC: no. tractors, PACS: primary agricultural credit societies, VE: villages electrified, RAM: regulated agricultural markets, RRD: rural road density, AP: Agriculture productivity

Table 14. Regression Results

Dependent variable: Agricultural productivity				
Variable	Coefficient	Standard Error	t-statistics	Significance
Irrigation intensity	0.34571	0.2017887	1.71323	0.048781*
Electric pumps	0.57342	0.4220515	1.35865	0.323301
Fertilizer consumption	0.49896	0.2387650	2.08975	0.051216*
Tractors	0.34222	0.2678965	1.27743	0.207353
Primary agricultural credit societies	0.35346	0.3886809	0.90938	0.050567*
Villages Electrified	0.26788	0.1966547	1.36218	0.276360
Regulated Agricultural Market	0.12356	0.2876121	0.42961	0.048443*
Rural Road density	3.23556	0.4754507	6.80525	0.031218*
Constant	3.77987412	2.860223	1.321531	0.653467
R-squared		0.90197		
S.E. of estimate		0.84559		
Durbin-Watson statistics		2.43567		
Sum of squared residual		9.35786		
F-Statistics		26.5781		
Prob (F statistic)		0.00001		

*Significant at 5% level of significance

Infrastructural facilities are essential for the growth and development of agriculture sector. In fact, these are key determinants of agricultural productivity levels. In order to examine the relationship between agricultural productivity and infrastructural facilities multiple regression has been applied. Agricultural productivity as the dependent variable (Y) and eight variables/indicators of infrastructure have been taken as independent variables. The eight indicators for representing the rural infrastructure are: irrigation intensity, electric pumps fertilizer consumption, number of tractors, primary agricultural credit societies, villages electrified, regulated agricultural market and rural road density. The results of regression analysis (table 12) indicates that there is significant impact of electricity, irrigation, fertilizer consumption, regulated agricultural markets and road infrastructure on agricultural output at 5% level of significance while the impact of electric pump, tractors and village electrification has not been found statistically significant. All these variables together explained around 90 percent variations in agricultural productivity. The F-values are significant at one percent level of significance showing that the explanatory power of the model is significant. From the analysis of the above results it is observed that the contribution of irrigation, fertilizers, credit, road network, market for agricultural products is major determinants of agricultural growth. The availability of regulated market for agricultural product is necessary to ensure remunerative price to the farmers for their produce. A system of

agricultural infrastructural facilities provided to the farmers creates scope and offer incentives to induce the farmers to work for increased agricultural production by increasing the agricultural productivity.

Conclusion

The infrastructure is pre-requisite not only for the economic development of rural areas but also for the agriculture growth, as it impacts the millions of rural people and their standards of living. The findings of the present study indicates that some infrastructures have significant impact on agricultural productivity and there are others which are correlated with agriculture productivity but do not affect significantly. Irrigation, road connectivity, and credit facilities occupy a leading position, among the infrastructural variables. The study concludes that in any economy infrastructure constitutes the backbone of economic development. Adequate infrastructure raises productivity and lowers the production costs, but it has to expand fast enough to accommodate growth. In case of agriculture, the main emphasis of infrastructural development has been on developing irrigation (major and medium works), markets/mandis and roads etc. These are claimed to be not only driving the agricultural growth at the macro level but also to significant differences in the growth of various regions. As the central and state governments are responsible for infrastructure development, policy makers prefer to spend heavily in areas in which there is a potential for rapid agricultural development.

References:

1. Barnes, D.F. and Binswanger H. P., (1986). Impact of Rural Electrification and Infrastructure on Agricultural Changes, 1966-1980". *Economic and Political Weekly*., Vol.21.
2. Bhalla, G. S., and Alagh Y. K., (1983). "Labour Productivity in Indian Agriculture", Economic and Political Weekly.
3. Bhatia, M.S., (1999). Rural Infrastructure and Growth in Agriculture. *Economic and Political Weekly*, March 27, A43-A 48, 1999.
4. Bhalla, G.S., & Singh, G. (2012). Economic liberalization and Indian agriculture. New Delhi: SAGE Publications.
5. Binswanger, H.P., Khandker, S.R., & Rosenzweig, M.R. (1993). How infrastructure and financial institutions affect agricultural output and investment in India. *Journal of Development Economics, 41*(2), 337–66.
6. Chakraborty, D., & Guha, A. (2009). Infrastructure and economic growth in India: Analysing the village-level connectivity scenario of the states. *Journal of Infrastructure Development,* 67-86.

7. Satish, P. (2007). Rural infrastructure and growth: An overview. *Indian Journal of Agricultural Economics, 62*(1), 32–51.
8. Thorat, S., & Sirohi, S. (2004). State of the Indian farmer: A millennium study, *Rural infrastructure*, *Vol. 4:* Sponsored by Ministry of Agriculture, Government of India. New Delhi: Academic Foundation and Ministry of Agriculture, Government of India.
9. World Bank. (1994). *World development report 1994: Infrastructure for development*. New York: Oxford University Press.
10. World Bank (1997), *Rural Development: Vision to Action: A Sector Strategy*, The World Bank, Washington, D.C.,U.S.A.