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Impact of irrigation on pulses production in India: A time-series study

Gourav Kumar Vani* and Pradeep Mishra

Jawaharlal Nehru Krishi Vishwa Vidyalaya,
Jabalpur-482 001, Madhya pradesh, India.
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ABSTRACT

Pulses are source of protein for Indians, production of which has not kept with increasing demand of the nation. Among efforts to enhance pulses production, role of irrigation as a critical input has not been given due importance. In present investigation attempt is to find out importance and contribution of irrigation in growth of pulses production in India. The time series data on area, production, productivity and area irrigated of pulses was obtained from DES Official website. The regression analysis and linear decomposition analysis were used as tools to carry out analysis. It was found that yield and area not-irrigated effect accounts for 52 per cent of growth of pulses which is not suitable for sustainability of pulses production system. Area not-irrigated effect contribution was 13.69 percent on pulses production. This also shows that irrigation has not been able to influence the production of pulses to desired level. The area irrigated accounted for 69 percent of variation in pulses yield. The result of present investigation is helpful to researcher as well as policymaker in attaining sustainable increases in pulses production in India.

Key words: Decomposition analysis, Growth decomposition, Irrigation, Pulses production, Regression analysis.

INTRODUCTION

Pulses contribute significantly in meeting dietary protein requirement across all income groups in Indian (Kumar, 2014). Pulses production was 8.41 million tonnes in 1950-51 and it has increased by nearly 2 times to 16.47 million tonnes in 2015-16 (Narayan and Sandeep, 2015). This compound annual growth of 1.04 per cent in supply of pulses has repeatedly been outstripped by growing demand for pulses. It has been estimated that pulses demand would be 43.61 million tonnes by 2020 (Chand, 2009). Pulses are also said to have got no benefit of green revolution. Compared to cereals, pulses variety and hybrid development lacks by several milestones. This has caused negative total factor productivity growth in pulses (-0.39 percent over 1986-2000) (Kumar, 2008). The yield gap from research station to on-farm are 14 per cent and on-farm to average farmer field is 48 per cent in chickpea crop (Bhatia *et. al.*, 2006). Similarly yield gaps are large in pigeon pea too. This shows that there is large existing potential in pulses production which can be exploited to enhance the production. Enhancing production requires increasing the application of crucial inputs to production process. These crucial inputs can be quality seeds, fertilizers, plant protection chemicals and irrigation. It is interesting at this point to note that in addition to quality seeds and fertilizers, irrigation has been a pivotal element in shaping the phenomenal increase in cereal production. It has been established that irrigation results in largely predictable increase in yields in cereals year after year, the same advantage may not be conferred by dryland technologies (Koohafkan, 2008). It has been reported that by 2010, only 15 percent of area under pulses was irrigated compared to 46 percent for foodgrains. The provision of scheduled and adequate irrigation can result in yield increase (Sundaram, 2010). This study is basically designed to find out the effect of irrigation on area, production and productivity of pulses in India. Since earlier studies on enhancing pulses production ignored the critical role of irrigation by assuming that pulses are best grown under dryland/ rainfed conditions. It is necessary to find out the contribution and importance of irrigation in spurring the growth of pulses production. With above background, the study has been carried out with following objectives:

1. To study the growth pattern of area, production, and yield of total pulses in the India.
2. To analyze the contribution and importance of irrigation for pulses production.
3. To study the relationship between area under irrigation and yield of pulses.

MATERIALS AND METHODS

The data for this study was obtained from the official website of Directorate of Economics and Statistics (DES), Government of India (eands.dacnet.nic.in). The information retrieved from the website are area, production, productivity and irrigated areas in pulses from 1950-51 to 2013-14. To fulfill the first objective, compound annual growth rates were calculated using formula $(e^{\ln(Y_t/Y_0)/t}-1) \times 100$, where Y_t is magnitude of variable Y at time t, t is the time duration.

*Corresponding author's e-mail: kumaragri.vani1@gmail.com

To decompose the change in production into its constituting factors, a simple linear decomposition was performed. The step by step derivation of scheme of decomposition is provided below.

Let , P, A and Y denote production, area and yield of a given crop. Let subscript *t* denote time. The changes in these variables will be denoted by use of Greek symbol Δ. The linear decomposition of change in production is popularly provided by the following equation:

$$\Delta P_t = \Delta A_t \times Y_{t-1} + \Delta Y_t \times A_{t-1} + \Delta Y_t \times \Delta A_t \quad ....(1)$$

Where $\Delta p_t = p_t - p_t\text{-}1$ and analogously for others.

Let area under irrigation be denoted by AI and area not-irrigated be denoted by ANI. This relationship can be presented as following:

$$A_t = ANI_t + AI_t \quad ......(2)$$

and in diffrence form, it is presented in following:

$$\Delta A_t = \Delta ANI_t + \Delta AI_t \quad .....(3)$$

Now substituting the (2)&(3)in (1) and simplifying the terms leads to following:

$$\Delta P_t = \Delta ANI_t \times Y_{t-1} + \Delta AI_t \times Y_{t-1} + \Delta Y_t \times ANI_{t-1} + \Delta Y_t \times AI_{t-1} + \Delta ANI_t \times \Delta Y_t + \Delta AI_t \times \Delta Y_t \quad ....(4)$$

The equation (4) can be further extended by decomposing the change in yield into yield irrigated (Y_t^I) and yield not-irrigated(Y_t^{NI}) by using following equations:

$$Y_t = \Theta_t \times Y_t^I + (1 - \Theta_t) \times Y_t^{NI} \quad ....(5)$$

$$Y_t^I = Y_t - (1 - \Theta_t) \times e_t \quad ....(6)$$

$$Y_t^{NI} = Y_t + \Theta_t \times e_t \quad ....(7)$$

where Θ_t is the percentage of area irrigated under given crop at time t and e_t is the residual from regression of yield on area under irrigation as provided by equation (8).

$$Y_t = \alpha + \beta AI_t + e_t \quad ....(8)$$

where AI_t is the pulses area under irrigation.

Now, the final equation for decomposing the changes in production of a given crop is as provided by equation (9)

$$\Delta P_t = \Delta ANI_t \times Y_{t-1}^I + \Delta ANI_t \times Y_{t-1}^{NI} + \Delta AI_t \times Y_{t-1}^I + \Delta AI_t \times Y_{t-1}^{NI} + \Delta Y_t^I \times ANI_{t-1} + \Delta Y_t^{NI} \times ANI_{t-1} + \Delta Y_t^I \times AI_{t-1} + \Delta Y_t^{NI} \times AI_{t-1} + \Delta ANI_t \times \Delta Y_t^I + \Delta ANI_t \times \Delta Y_t^{NI} + \Delta AI_t \times \Delta Y_t^I + \Delta AI_t \times \Delta Y_t^{NI} \quad ....(9)$$

Interpretation of terms on right hand side of (9) is provided below:

Effect	Description	
$\Delta ANI_t \times Y_{t-1}^{NI}$	Area not-irrigated effect	(1)
$\Delta ANI_t \times Y_{t-1}^I$	Area shift from not- irrigated to irrigated	(2)
$\Delta AI_t \times Y_{t-1}^{NI}$	Area shift from irrigated to not-irrigated	(3)
$\Delta AI_t \times Y_{t-1}^I$	Area irrigated effect	(4)
$\Delta Y_t^{NI} \times ANI_{t-1}$	Yield not-irrigated effect	(5)
$\Delta Y_t^I \times ANI_{t-1}$	Yield shift from irrigated to not-irrigated	(6)
$\Delta Y_t^{NI} \times AI_{t-1}$	Yield shift from not-irrigated to irrigated	(7)
$\Delta Y^I \times AI_{t-1}$	Yield irrigated effect	(8)
$\Delta ANI_t \times \Delta Y_t^{NI}$	First order interaction of change in area not-irrigated and yield not-irrigated	(9)
$\Delta ANI_t \times \Delta Y_t^I$	First order interaction of change in area not-irrigated and yield irrigated	(10)
$\Delta AI_t \times \Delta Y_t^{NI}$	First order interaction of change in area irrigated and yield not-irrigated	(11)
$\Delta AI_t \times \Delta Y_t^I$	First order interaction of change in area irrigated and yield irrigated	(12)

The numbers in bracket are numbering of the effects which shall be used in Table 1 in results and discussion section.

The area not-irrigated effect is the change in area evaluated at yields from not-irrigated lands from previous year. The area shift from not-irrigated to irrigated effect is the change in production due to change in area not-irrigated which received the yield levels of irrigated land from previous year. The yield not-irrigated effect is change in production due to change in yields from not-irrigated lands evaluated at area not-irrigated from previous year.

All the components can be converted to percentage form by dividing both sides of equation (9) by P_{t-1} and multiplying by hundred. Thus on left hand side, we have growth of pulses production instead of absolute change in pulses production. On right hand side all the components show percentage contribution to growth of pulses production.

Since this is a linear decomposition of change in pulses production and therefore components can be added over years to compute average for a given period. Hence, all the results of decomposition analysis have been presented according to five year plans of Government of India. To obtain the average contribution of each component to overall growth rate, the average of each component was divided by the overall growth rate. To confirm the significance of each component as well as its importance to the growth of pulses production, regression analysis with standardized data was performed. To standardized the data, each component series was divided by standard deviation of the series after deducting the arithmetic mean of the series from it. Since time series data is used and therefore, problem of auto-correlation is expected to occur. Hence, auto-correlation and partial auto-correlation plots were used to identify auto-correlation in the residuals. If all auto-correlation and partial-auto-correlations among the various lags of residual series are within the defined standard error lines on the plot then there exists no auto-correlation. All the analysis was performed using Libre Office Spreadsheet and Writer, R as well as JMP statistical software.

RESULTS AND DISCUSSION

Table 1 priovides the average annual performance of pulses as per five year plans of India. It can be observed from the table that for time period 1950-2013 pulses area grew at a dismal rate of 0.44 per cent per annum while production grew at a rate of 1.30 per cent per annum. The growth of production was supported by growth of productivity which grew at 0.86 per cent per annum. This remarkable growth of production could not be possible without there being growth of area irrigated at the rate of 1.60 per cent per annum. This implies a growth of 1.16 per cent per annum of percent of area irrigated. Among all five year plans, sixth five year plan achieved the breakthrough in production and area of pulses. This breakthrough can be attributed to AICRP on pulses started in first plan holidays and pulses development scheme launched in fourth five year plan. Before fourth five year plan, there was no concerted effort by Government of India to mobilise resources for development of pulses. With advancement of time, Government of India started new programmes and merged old programmes with other existing programmes for better implementation and efficacy. This is evident from the last column of Table 1.

From the government's PDS (Pulses Development Schemes) after 1980's it is clearly evident that the improvement in growth rates of pulses production in India with remarkable improvements in area under irrigation. In the same period, the pulses area has also increased and same improvement can be found in production and productivity, respectively. Also from 1970-85, the growth rate has continuous improvement except the period of rolling plan with aborted growth rate. The phenomenal increase in two successive plans can be partially attributed to the effect of NFSM (National Food Security Mission) and BGREI (Bringing Green Revolution in Eastern India). From the Table 2, it is observed that growth of pulses production was the highest in sixth plan (7.34%). After gradually declining for first two consecutive plans, it touched a low of -3.76 % in third plan. This was the lowest possible decline in all plans completed so far. The third plan saw the stagnation in agricultural production for first three years and after a bumper crop during 1964-65, there was a severe drought in the following year. This led to substantial decline in production of pulses by about two and half million tonnes. This decrease in production can be attributed to substantial decline in yield levels of pulses. The first plan holiday witnessed good growth of pulses production in India. After this period, pulses production in India did not see a major decline in production with marginal decline in some years.

From Table 2, it can be observed that all effects except first order interaction of change in area irrigated and

Table 1: Average annual performance of pulses during five year plans of India.

FYP	Period	Area (million ha)	Production (million tonnes)	Yield (Kg/ha)	Percentage of Area Irrigated	Area Irrigated (million ha)	Programmes and Schemes[#]
-	1950-51	19.09	8.42	441	9.40	1.79	-
1	1951-56	21.10	10.05	476	9.14	1.93	-
2	1956-61	23.71	11.75	495	8.26	1.96	-
3	1961-66	23.86	11.14	467	8.89	2.12	AICRP on Pulses
-	Plan Holiday	22.01	10.28	467	9.79	2.16	PDS
4	1969-74	22.21	10.90	491	8.60	1.91	PDS
5	1974-79	23.32	11.72	502	7.70	1.80	PDS
-	Rolling Plan	22.26	8.57	385	8.80	1.96	**PDS**
6	**1980-85**	**23.08**	**11.77**	510	8.22	**1.90**	NPDS
7	1985-90	23.08	12.55	544	9.35	2.16	TMOP
-	Plan Holiday	22.97	13.29	578	11.12	2.55	TMOPO, TMOPO & M
8	1992-97	22.44	13.57	604	12.97	2.91	TMOPO, TMOPO & M
9	1997-02	21.82	12.72	583	13.55	2.96	TMOPO&M, ISOPOM
10	2002-07	22.92	14.32	625	15.77	3.61	NFSM (A3P-2010 onwards), BGREI(2010 onwards)
11	2007-12	24.58	18.02	733	17.43	4.28	NFSM (A3P), BGREI
-	2013-14	25.21	19.26	764	19.70	4.97	
-	1950-2014	22.80	12.34	541	10.71	2.44	
	CAGR	0.44%	1.30%	0.86%	1.16%	1.60%	

Note: PDS: Pulses Development Scheme, NPDS: National Pulses Development Scheme,TMOPO & M: Technology Mission on Oilseeds and Pulses, Oil Palm & Maize,NFSM: National Food Security Mission, A3P: Accelerated Pulse Production Programme, ISOPOM: Integrated Scheme of Oilseeds, Pulses, Oil Palm and Maize, BGREI: Bringing Green Revolution to Eastern India.

[#] *Source: Directorate of Pulses Development, GOI.*

Table 2: Decomposition of growth of pulses production in India as per five year plans.

FYP	Period	1	2	3	4	5	6	7	8	9	10	11	12	Growth Rate
1	1951-56	3.52	0.38	0.15	0.02	1.37	0.07	0.15	0.01	0.08	0.00	0.00	0.00	5.75
2	1956-61	0.36	0.08	-0.04	-0.01	3.24	-0.01	0.38	0.00	0.43	0.00	-0.09	0.00	4.34
3	1961-66	-0.80	-0.10	0.19	0.02	-2.86	0.04	-0.27	0.00	0.03	0.00	0.01	0.00	-3.72
-	Plan Holiday	-1.93	-0.10	-0.05	-0.04	5.46	-0.05	0.82	-0.01	0.99	-0.02	-0.35	0.01	4.72
4	1969-74	2.13	0.20	-0.18	-0.02	-2.26	-0.08	-0.19	-0.01	-0.12	0.01	0.00	0.00	-0.52
5	1974-79	0.33	0.03	0.03	0.00	3.76	0.03	0.33	0.00	0.36	0.01	0.03	0.00	4.90
-	Rolling Plan	-5.83	-0.47	0.35	0.03	-23.37	-0.05	-2.01	0.00	1.60	0.00	-0.10	0.00	-29.85
6	1980-85	0.56	0.08	-0.13	-0.01	6.18	0.01	0.60	0.00	0.07	0.00	0.00	0.00	7.35
7	1985-90	0.32	0.01	0.45	0.03	0.99	0.14	0.11	0.01	0.35	0.01	0.00	0.00	2.42
-	Plan Holiday	-1.61	-0.19	0.16	0.02	-1.13	0.04	-0.15	0.00	0.40	0.02	0.05	0.00	-2.40
8	1992-97	-0.40	-0.05	0.36	0.04	3.29	0.16	0.42	0.02	0.07	0.00	0.01	0.00	3.92
9	1997-02	-0.23	0.00	0.06	-0.03	-0.06	-0.04	-0.14	-0.03	0.12	-0.01	0.19	0.03	-0.18
10	2002-07	0.55	0.16	0.50	0.09	0.24	0.24	0.08	0.04	0.62	0.03	0.05	0.00	2.61
11	2007-12	0.84	0.20	0.28	0.05	2.16	0.18	0.41	0.03	0.12	0.02	-0.01	0.00	4.28
12	2012-17*	-0.40	-0.03	1.81	0.36	3.34	0.88	0.58	0.18	-0.51	-0.01	0.04	0.02	6.23
-	Overall	0.33	0.05	0.20	0.03	1.26	0.07	0.18	0.01	0.22	0.02	0.00	0.00	2.36
-	Contribution	13.69	2.55	8.44	1.04	52.54	3.62	7.28	0.53	10.11	0.26	-0.04	0.21	1
	(Rank)	(2)	(7)	(4)	(8)	(1)	(6)	(5)	(9)	(3)	(10)	(12)	(11)	
-	Importance^	0.3259	0.0433	0.0609	0.0096	0.6965	0.02692	0.0801	0.0045	0.0421	0.0019	0.0096	<0.0001	
	(Rank)	(2)	(5)	(4)	(9)	(1)	(7)	(3)	(10)	(6)	(11)	(8)	(12)**	

Note: Numbers in the first row of the table are number assigned to effect in methodology section.
***For 12th Plan data is available only up to 2013-14, ^ the coefficient for importance have been obtained from Table 2.**
** This effect is not significant.

yield from area irrigated found to have a significant effect on growth of pulses production. The ranking of effect's contribution is also provided along with contribution. While yield effect under area not-irrigated contributed 52 % to the average growth of pulses production followed by area effect without irrigation (14 %) and first order interaction effect of change in area not-irrigated and yield from area not-irrigated (10%). This result is in sharp contrast to the findings of (Dashora *et al.* 2000) who found that area contributed 53 percent to the production while yield contributed 22 percent in Rajasthan. The dependence of pulses growth on yield not-irrigated effect is a perilous for sustainability of pulses production system. A healthy system is ought to have balanced contributions from various effects at play. This is also supported by the graphical representation of first five contributors to growth of pulses production. From Fig 2, it is evident that the least variability was found in the third largest contributor (2.67%) and the highest variability was found in second largest contributor (15.27%) followed by the first largest contributor (8.5%). The result of standardized regression (Table 3) provides the beta coefficient which can indicates the relative importance of effect in change in

Table 3: Effects of components from decomposition analysis on change in pulses production using regression analysis (1951-2013).

Effects	Estimate	Std. Error	t value	Pr(>|t|)
1	3.259e-01	1.007e-15	3.236e+14	0.000
2	4.333e-02	1.097e-15	3.951e+13	0.000
3	6.091e-02	4.304e-15	1.415e+13	0.000
4	9.573e-03	8.249e-15	1.160e+12	0.000
5	6.965e-01	4.034e-15	1.726e+14	0.000
6	2.692e-02	7.347e-15	3.664e+12	0.000
7	8.009e-02	6.500e-15	1.232e+13	0.000
8	4.504e-03	6.226e-15	7.234e+11	0.000
9	4.208e-02	3.135e-16	1.342e+14	0.000
10	1.864e-03	4.473e-16	4.167e+12	0.000
11	9.615e-03	8.052e-16	1.194e+13	0.000
12	2.446e-16	4.288e-16	5.700e-01	0.571

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1, Residual standard error: 1.928e-15 on 51 degrees of freedomMultiple R-squared:1, Adjusted R-squared:1, F-statistic: 1.39e+30 on 12 and 51 DF, p-value: < 0.0001
Note: Numbers in the first column of the table are number assigned to effect in methodology section.

Table 4: Effect of pulses area under irrigated on yield using regression analysis (1951-2013).

Variable	Coefficient	Std. Error	t-ratio	p-value	
constant	309.786	19.879	15.58	<0.0001	***
AI	94.0189	7.793	12.06	<0.0001	***
Mean dependent variable	539.48	S.D. dependent variable		83.01	
Sum squared residual	129692.3	S.E. of regression		45.74	
R-squared	0.7013	Adjusted R-squared		0.6965	
F(1, 62)	145.6	P-value(F)		< 2.2e-16	
rho	-0.1416	Durbin-Watson		1.72 (p-value=0.1022)	

Breusch-Godfrey test for first-order autocorrelation, OLS, using observations 1952-2014 (T = 63)Test statistic: LMF = 1.018216,with p-value = P(F(1,60) > 1.01822) = 0.317

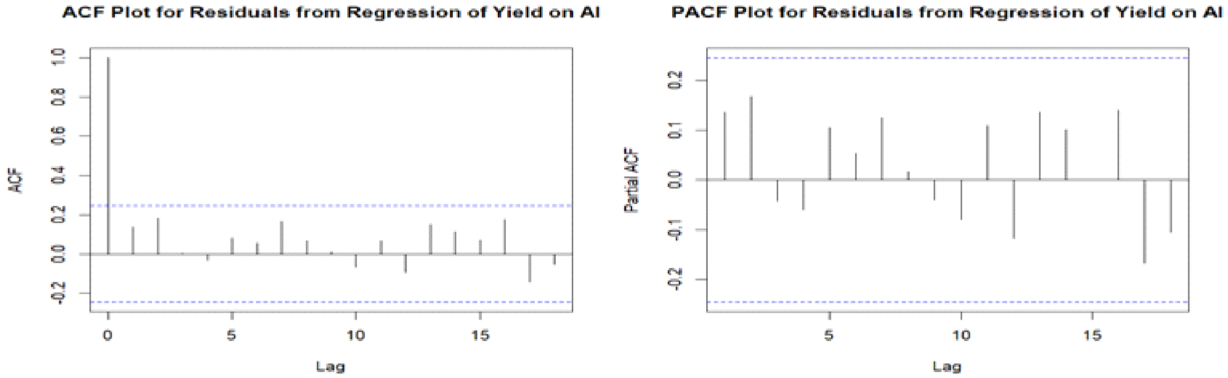

Fig 1: ACF and PACF plot for residuals from regression of yield Vs. AI**.**

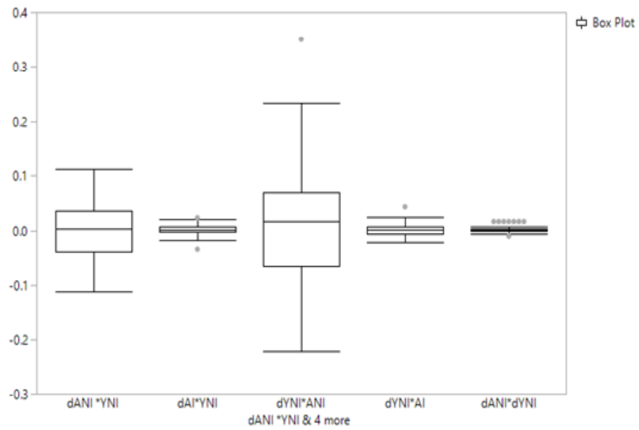

Fig 2: Box plot of top five contributors to growth of pulses production.

production. The summary of importance of effects and its ranking is also provided in the last row of Table 2. It can be observed that importance of variables is in following order: yield effect under area not-irrigated (0.696), area not-irrigated effect (0.326), yield shift from not irrigated to irrigated (0.080), area shift from irrigated to not- irrigated (0.061) and area shift from not irrigated to irrigated (0.043). This sequence of importance is helpful to policymakers as well as researchers and extension agencies in planning for enhancing pulses production.

This sequence of contribution and importance however does not go hand in hand. The inconsistency results when the third largest contributor is ranked sixth most important variable for effecting change in production. Another inconsistency is that the third most important variable is fifth largest contributor. Both inconsistencies have its roots in the fact that 69 per cent of variation in yield is attributed to proportion of area irrigated for pulses production [results of regression analysis presented in Table 4 and ACF and PACF plot given in Fig 1]. The average area irrigated under pulses cultivation for whole period averaged out to be 11 percent. This reflected that increase in pulses area under irrigation was needed to improve the yield and production levels of pulses in India.

CONCLUSION

The present study has brought to notice of research and academic community the effect of irrigation in effecting pulses area, production and productivity. It was and is truth that pulses have been grown in drylands for long and dominance of area and yield not-irrigated effect would continue till further advances in breeding varieties and hybrids responsive to irrigation are brought out. These two effects together contribute nearly 65 percent towards growth of pulses production and have large variability. Thus third largest contributor, the synergy effect between area and yield not irrigated, must be a focus in policy making relating to sustainability of pulses production. This is the time to overcome the dark shadow of Green revolution on pulses production and provide all critical inputs necessary to give a big boost to pulse production. Although, currently pulses area under irrigation is not enough to improve pulses production and bringing the additional area under irrigation is a herculean task. Therefore, it remains an open suggestion from Reddy (2009) that cultivation of pulses in paddy fallows can be done to utilize the residual soil moisture as a short term measure to enhance pulses production.

REFERENCES

Directorate of Pulses Development, Government of India. Development Programmes on Pulses: Government Efforts, Accessed from http://dpd.dacnet.nic.in/Article%20on%20Pulses%20programmes.pdf

Bhatia, V.S., Singh, P., Wani, S.P., Rao, A.K. and Srinivas, K. (2006). Yield Gap Analysis of Soybean, Groundnut, Pigeonpea and Chickpea in India Using Simulation Modeling: Global Theme on Agroecosystems Report no. 31.

Chand, Ramesh. (2009). Policy Brief: Demand for foodgrains during 11th Plan and towards 2020, NCAP-ICAR, New Delhi.

Dashora, S.K., Dhaka, J.M., Agarwal, N.L. (2000). Growth in Production of Important Pulses Crops in Rajasthan. Agricultural Situation in India. **57**(8): 453-458.

Koohafkan, P. (2012). Chapter III Enhancing Cereals Production in Drylands in Water and Cereals in Drylands, Routledge. Food and Agriculture Organization of The United Nations (FAO), Rome.

Kumar, R. (2014). Assessment of technology gap and productivity gain through Crop technology demonstration in chickpea. *Indian J. Agric. Res.* **48**(2): 162-164.

Mythili, G. (2006). Supply response of Indian farmers: Pre-and-Post reforms. *Working Paper 2006-009*, Mumbai: Indira Gandhi Institute of Development Research.

Negi, A. and Roy, D. (2015). The cooling effect of pulse imports on price: The case of the pigeon pea in India.

Narayan, P. and Kumar, S. (2015). Constraints of growth in area production and productivity of pulses in India: An analytical approach to major pulses. *Indian Journal of Agricultural Research*. **49**(2): 114-124.

Praduman Kumar, Surabhi Mittal and Mahabub Hossain. (2008). Agricultural Growth Accounting and Total Factor Productivity in South Asia: A review and Policy Implications, *Agricultural Economics Research Review*. **21**(2): 145-172

Praduman Kumar, P Shinoj, S.S.Raju, Anjani Kumar, M. Rich and SiwaMsang. (2010). Factor demand, output supply elasticities and supply projections for major crops of India, *Agricultural Economics Research Review*. **23**(1): 1-14

Reddy, A. Amarender. (2009). Pulse Production Technology: Status and Way Forward, *Economics and Political Weekly*. **64** (52): 73-80.

Sundaram, I.S. (2010). India needs a pulses revolution. *Facts For You (New Delhi)*. **31**(3): 10-12.