

Growth and instability of chemical fertilizers consumption in different divisions of Karnataka (India)

Abstract

Chemical fertilizers have played a vital role in the success of India's green revolution and consequent self-reliance in food-grain production. Fertiliser consumption in India has been increasing over the years and today India is one of the largest producers and consumers of fertilisers in the world. The analysis of growth is usually used in economic studies to find out the trend of a particular variable over a period of time. The necessary secondary data about consumption of NPK in Karnataka were collected from Directorate of Economics and Statistics, Karnataka for the year 1989-90 to 2015-16 and was estimated using the compound annual growth rate function. The results of CAGR (Compound Annual Growth Rates) in consumption of nitrogen fertilizer revealed that the consumption of NPK (Nitrogen-Phosphorus-Potassium) fertilizer witnessed significant growth during period-I (1989-90 to 1996-97) compared to period-II (1997-98 to 2009-10) and period-III (2010-11 to 2015-16). In the overall period, the growth in consumption of NPK fertilizer from 1989-90 to 2015-16 was noticed positive across all the divisions which were highest annum in Kalburagi division (24.74%) followed by Belagavi (24.50 %), Mysuru (21.32 %) and Bengaluru (20.53 %). Higher growth was noticed in the Kalburagi division and has less variability as compared to other divisions.

Keywords: Chemical fertilizers, Consumption, Growth, Production and Variability.

INTRODUCTION

Agricultural sector plays an important role in the economic development of developing countries. In India, this sector occupies a predominant position in the economy. It contributes about 13.9 per cent to the national income of the country during the year 2015-16 and sustains a two-thirds population of India. It is the single largest sector providing employment to the extent of more than 50 per cent of the country's workforce, thus agriculture continues to be a mainstay for the livelihood of rural people. The most challenging problem today is as the population growth increases the demand for food grain increases over the year. Whereas, the production of food grains dropped from 259.29 million tonnes to 251.56 million tonnes from 2011-12 to 2015-16 (GoI, 2017). Chemical fertilizer

was identified as one of the three most important factors, along with seed and irrigation, for raising agricultural production and sustaining food self-sufficiency in India (Chand and Pandey 2009).

The use of chemical fertilizers to increase agricultural production particularly in a developing country is a well-known fact. Some argue that fertilizer was as important as seed in the Green Revolution (Tomich *et al.*, 1995; Bagal et al., 2018) contributed as much as 50 percentages to the yield growth in Asia (Hopper, 1993 and FAO, 1998). Fertilizer consumption and production in India has been increasing over the last three decades and the country is currently the second largest consumer (after China) and third largest producer (behind China and USA) of fertilizers in the world. In India, fertilizer consumption is concentrated in about one-third of the cultivated area. It is a key element to increase sustainable agriculture production (Painuly and Dev, 1998). Indian farmers, who commonly overuse fertilizers in almost everything they grow, are being slowly nudged away from the dangerous practice. Growers who followed scientific recommendations based on their soil profile for at least a year, as part of a national program, are not only growing more with fewer inputs, but they also have cut down cultivation costs, a study involving 3,184 farmers across 199 villages in 16 states found.

Application of chemical fertilizers was popularised in our country during the Green Revolution of the 1960s and the 1970s. Incremental use of fertilizers in synergy with high yield seeds proved to be of tremendous contribution to the success of the green revolution. However, the prices of fertilizers kept increasing. Since the Government wanted to encourage the use of chemical fertilizers it passed the Fertilizer Control Order (FCO) under the Essential Commodity Act (EC Act) in the year 1957. In order to regulate the distribution of fertilizer, the Movement Control Order was passed in 1973. No subsidy was paid on Fertilizers till 1977 except Potash for which subsidy was paid only for a year in 1977.

On the recommendation of the Maratha committee, the Government had introduced the Retention Price Scheme (RPS) for nitrogenous fertilizers in November 1977. Joint Parliamentary Committee (JPC) submitted its report on 20th August 1992. The Committee recommended decontrol of import based phosphatic and Potassic fertilizers along with a marginal 10 per cent reduction in the consumer price of urea. During 1997-98, Department of Agriculture & Cooperation also started indicating an all India uniform Maximum Retail Price (MRP) for DAP (Di-ammonium Phosphate), NPK and MOP (Muriate of Potash). The responsibility of indicating MRP in respect of SSP rested with State Governments. The

planning commission's Soumitra Choudhary panel had recommended that the NBS (Nutrient Based Subsidy) policy, which is applicable only on P and K fertilizers needs to be extended for urea also. This has become all the more desirable to maintain the ratio between MRP of urea *vis-a-vis* P and K fertilizers, which is essential for balanced fertilisation.

The application of essential plant nutrients particularly chemical fertilizer in optimum quantity and right proportion through correct methods is the key factor to increase crop production on a sustained basis. The success of modern agriculture depends largely on the use of off-farm produced inputs of which chemical fertilizers happen to be quite important ones. The chemical fertilizer technology became popular among the Indian farmers only after independence. A proper understanding of the observed pattern of fertilizer consumption at the district level and fertilizer use pattern at farmers' level can be emerged only after studying the behaviour of the individual farmer. It is important to undertake such a study because it gives feedback to researchers and policymakers.

Thus, it is clear that the studies on chemical fertilizer consumption will be of paramount importance to the planners as well policymakers in preparing realistic future plans to create a condition for a rapid increase in chemical fertilizer consumption to attain long term goals of agricultural productivity. Hence, the present paper has examined the trend in the consumption of chemical fertilizers in Karnataka.

Methodology

The secondary data related to the trend in consumption of chemical fertilizers in Karnataka across four divisions (Bengaluru, Mysuru, Belagavi and Kalburagi) from 1989-90 to 2015-16 secondary data were collected from Directorate of Economics and Statistics. to know the implications of different policies implemented by the government to know the implications of different policies implemented by the government To know implications of different policies implemented by the government, the whole period (1989-90 to 2015-16) was divided into three sub-periods viz.

Period-I (1989-90 to 1996-97),

Period-II (1997-98 to 2009-10),

Period-III (2010-11 to 2015-16) and

Overall period (1989-90 to 2015-16). Period-I which was considered under before

Maximum Retail Price (MRP) was fixed by the Government from 1997, period-II which was considered for after Maximum Retail Price (MRP) was fixed by the Government to before

97 Nutrient Based Subsidy (NBS) Policy 2010 and period-III which was consider for after
98 Nutrient Based Subsidy (NBS) Policy. The CV was derived between the years for each
99 subdivision.

100 In order to assess the growth in consumption of chemical fertilizers in Karnataka,
101 compound annual growth rates (CAGR) were worked out using the exponential function:

102
$$Y_t = AB^t o^{ut} \dots$$

103 Where, Y_t = Consumption of chemical fertilizers in Karnataka during time t

104 $A = Y$ in the base year consumption of chemical fertilizers

105 t = Time period consumption of chemical fertilizers

106 ut = Error term

107 $B = 1+g$, where g = growth rate.

108 The growth rate of nitrogen consumption was analysed for three periods viz.: period-I (1989-
109 90 to 1996-97) before MRP was fixed by the Government; period-II (1997-98 to 2009-10)
110 after MRP was fixed by the Government to before Nutrient Based Subsidy (NBS) Policy
111 2010 and period-III (2010-11 to 2015-16), after Nutrient Based Subsidy (NBS) Policy to the
112 present

113 Results and discussions

114 The growth rates in consumption of nitrogen (N) in Karnataka across four divisions
115 (Bengaluru, Mysuru, Belgravia and Kalburagi) along with the instability are presented in
116 Table 1. The results of CAGR in consumption of nitrogen fertilizer revealed that during
117 period-I and period-II there was positive growth of nitrogen consumption in all the divisions.
118 It might also be due to the higher priority given to nitrogenous fertilizer rather than
119 phosphorous and potash fertilizers. These results are in conformity with Makadia and Patel
120 (2014).

121 The highest growth rate of nitrogen consumption was observed in Bengaluru division
122 which increased at the rate of 131.50 per cent per annum during period-I followed by Mysuru
123 (112.24 %), Belagavi (109.61 %) and Kalburagi (102.99 %) and for the state as a whole
124 nitrogen consumption has increased at the rate of 120.68 per cent per annum. With respect to
125 variability in consumption of nitrogen was observed with a wide variation across all the
126 divisions of Karnataka during the same period, the highest variability 178.08 per cent was

observed in Kalburagi division followed by Belagavi (176.04 %), Mysuru (173.27 %), and Bengaluru (142.78 %) and Karnataka state as a whole the variability was 164.00 per cent.

During period-II, the state recorded a positive growth in consumption of nitrogen which was 2.97 per cent per annum, among different divisions Kalburagi shown the highest growth rate for nitrogen consumption at the rate of 4.56 per cent per annum and low growth in Bengaluru (1.35 %). Whereas, the variability in consumption of nitrogen during period-II in different divisions was highest in Kalburagi (21.24 %) followed by Belagavi (20.27 %), Mysuru (16.51 %) for the state as a whole the variability in nitrogen consumption was 17.21 per cent. During period-III, the consumption of nitrogen fertilizer declined across different divisions of Karnataka. It decreased at the rate of 1.85 per cent per annum in the Bengaluru division, followed by Kalburagi (-1.06 %) Belgravia (-0.61 %) and Mysuru (-0.33%). The highest variability in nitrogen consumption was noticed for Bengaluru division (12.18 %) and for the state as a whole (9.21 %).

The consumption of nitrogen (N) for the overall period (1989-90 to 2015-16) was found to be positive across all the divisions. However, the highest growth was observed in Kalburagi division in nitrogen consumption was due to the conversion of the dry area into the irrigated area under Upper Krishna Project (UKP) which irrigate land across the river Krishna. It provided irrigation to the drought-prone areas of Kalburagi and Raichur districts during phase-II.

Table 2 indicate division-wise growth and instability of phosphorus (P) fertilizer consumption in Karnataka. The growth in the consumption of phosphorous was positive during period-I and period-II. Whereas, in period-III a negative growth was noticed. Among the different divisions during period-I higher growth was Mysuru division at the rate of 88.92 per cent per annum followed by Bengaluru (87.37 %), Belagavi (81.29 %) and Kalburagi (78.05 %) and state recorded 84.96 per cent growth. With regard to the instability of phosphorous consumption, a wide variation was observed across all the divisions during period-I, whereas Kalburagi division, recorded the highest variability of 181.40 per cent, for the state as a whole the variability in phosphorous consumption was 179.74 per cent. During period-II, among different divisions, Kalburagi division witnessed the highest growth in phosphorous consumption which was 6.14 per cent, followed by Belagavi (452 %), Bengaluru (3.56 %) and Mysuru (3.27 %). The state recorded a positive growth of 4.49 per cent per annum. Among the different divisions, the variability in phosphorous consumption during period-II was highest in Belagavi division which accounted for 31.33 per cent, while

160 the state as a whole 26.59 per cent of variability was noticed in consumption of phosphorous.
161 The negative growth rate in consumption of phosphorous across all divisions of Karnataka
162 during period-III.

Table 1. Division-wise growth and instability of Nitrogen (N) consumption in Karnataka

(in per cent)

Divisions	Period –I (1989-90 to 1996-97)		Period –II (1997-98 to 2009-10)		Period –III (2010-11 to 2015-16)		Overall (1989-90 to 2015-16)	
	CAGR	CV	CAGR	CV	CAGR	CV	CAGR	CV
Bengaluru	131.50**	142.78	1.35 ^{NS}	13.37	-1.85 ^{NS}	12.18	20.11**	54.15
Mysuru	112.24**	173.27	2.29 ^{NS}	16.51	-0.33 ^{NS}	9.64	21.30**	58.08
Belagavi	109.61**	176.04	3.34*	20.27	-0.61 ^{NS}	10.53	23.88**	62.15
Kalburagi	102.99*	178.08	4.56**	21.24	-1.06 ^{NS}	8.39	24.19**	63.06
Karnataka	120.68**	164.00	2.97*	17.21	-0.94 ^{NS}	9.21	21.90**	59.12

Note: Period-I: Before Maximum Retail Price (MRP) was fixed by the Government from 1997

Period-II: Before Nutrient Based Subsidy (NBS) Policy 2010

Period-II I: After the NBS Policy

CAGR: Compound Annual Growth Rate

CV: Coefficient of variation

** Significant at one per cent level, * Significant at five per cent level, NS-Non significant.

Table 2. Division-wise growth and instability of Phosphorus (P) consumption in Karnataka

(in per cent)

Divisions	Period –I (1989-90 to 1996-97)		Period –II (1997-98 to 2009-10)		Period –III (2010-11 to 2015-16)		Overall (1989-90 to 2015-16)	
	CAGR	CV	CAGR	CV	CAGR	CV	CAGR	CV
Bengaluru	87.37*	178.77	3.56*	24.72	-7.33 ^{NS}	27.98	23.25**	65.03
Mysuru	88.92*	178.59	3.27*	22.70	-6.14 ^{NS}	30.09	23.29**	64.85
Belagavi	81.29 ^{NS}	180.39	4.52*	31.33	-7.54 *	28.00	25.62**	69.10
Kalburagi	78.05 ^{NS}	181.40	6.14**	29.41	-7.04 ^{NS}	26.78	26.25**	70.72
Karnataka	84.96 ^{NS}	179.74	4.49*	26.59	-7.05 ^{NS}	27.74	24.59**	67.33

Note: Period-I: Before Maximum Retail Price (MRP) was fixed by the Government from 1997

Period-II: Before Nutrient Based Subsidy (NBS) Policy 2010

Period-II I: After the NBS Policy

CAGR: Compound Annual Growth Rate

CV: Coefficient of variation

** Significant at one per cent level, * Significant at five per cent level, NS-Non significant.

The growth in consumption of phosphorous (P) fertilizer in the overall period was found to be positive across all the divisions. The growth was observed in Kalburagi division at the rate of 26.25 per cent per annum followed by Belagavi (25.62 %), Mysuru (23.29 %) and Bengaluru (23.25 %). Among the different divisions, the variability in consumption of phosphorous was highest in Kalburagi (70.72 %) followed by Belgavi (69.10 %), Mysuru (65.03 %) and Bengaluru (64.85 %) and it was 67.33 per cent for the state as a whole.

Division-wise growth and instability of potash (K) fertilizer consumption in Karnataka is presented in Table 3. The growth in consumption of potash was highest during period-I compared to period-II and period-III. In period-III a negative growth was observed across all divisions of Karnataka. The instability in consumption of potash was declined across all the divisions from period-I to period-III.

The highest growth rate for potash consumption during period-I was observed in Bengaluru division which has increased at the rate of 123.64 per cent per annum, followed by Mysuru (120.75 %), Belagavi (98.89 %) and Kalburagi (87.59 %) whereas state as a whole, it was 117.19 per cent per annum. The high instability was noticed for phosphorus fertilizer consumption during period-I and the highest variability was seen in Kalburagi division (185.43 %) followed by Belagavi (175.98 %), Mysuru (147.28 %), and Bengaluru (141.27 %) whereas for the Karnataka it was 143.34 per cent.

During period-II there was a marginal increase in the growth of potash consumption across different divisions of Karnataka. The highest growth was noticed at the rate of 10.41 per cent per annum in Belagavi division, followed by Kalburagi (9.64 %), Bengaluru (7.02 %) and Mysuru (4.63 %), while the state as a whole grew at a compound annual growth rate of 7.51 per cent. With respect to the variability in potash consumption period-I has witnessed high variability compared to period II and period III. Among the divisions, Belagavi division showed the highest variability which accounted for 47.44 per cent, followed by Kalburagi (43.04 %), Mysuru (28.55 %) and Bengaluru (28.51 %), and for the state as a whole, the variability was 33.90 per cent.

The growth rate of potash consumption during period III revealed a declining trend in all divisions and for the state as a whole. The decline in growth was highest at the rate of 8.50 per cent in the Bengaluru division, followed by Belagavi (-8.19 %), Kalburagi (-5.77 %) and Mysuru (-2.36 %). Similarly, the decline in growth was 5.72 per cent per annum for the state during the same period. With respect to variability in consumption of phosphorous, it was found that period III recorded the lowest variability compared to the period I and period-II across all the divisions.

Table 3. Division-wise growth and instability in Potash (K) consumption in Karnataka

Divisions	Period –I (1989-90 to 1996-97)		Period –II (1997-98 to 2009-10)		Period –III (2010-11 to 2015-16)		Overall (1989-90 to 2015-16)	
	CAGR	CV	CAGR	CV	CAGR	CV	CAGR	CV
Bengaluru	123.64*	141.27	7.02**	28.51	-8.50 ^{NS}	25.86	20.40**	59.30
Mysuru	120.75**	147.28	4.63**	28.55	-2.36 ^{NS}	14.00	21.24**	59.79
Belagavi	98.89*	175.98	10.41**	47.44	-8.19 ^{NS}	19.88	26.10**	73.81
Kalburagi	87.59*	185.43	9.64**	43.04	-5.77 ^{NS}	18.88	25.13**	71.56
Karnataka	117.19*	143.34	7.51**	33.90	-5.72 ^{NS}	17.30	22.34**	63.52

Note: Period-I: Before Maximum Retail Price (MRP) was fixed by the Government from 1997

Period-II: Before Nutrient Based Subsidy (NBS) Policy 2010

Period-II I: After the NBS Policy

CAGR: Compound Annual Growth Rate

CV: Coefficient of variation

** Significant at one per cent level, * Significant at five per cent level, NS-Non significant.

Bengaluru division showed the highest variability which accounted for 25.86 per cent, followed by Belagavi (19.88 %), Kalburagi (18.88 %) and Mysore (14.00 %) and for the state as a whole the variability was 17.30 per cent.

The overall consumption of potash fertilizer for the period from 1989-90 to 2015-16 recorded positive growth in all divisions. The highest growth was observed in Belagavi division at the rate of 26.10 per cent per annum followed by Kalburagi (25.13 %), Mysuru (21.24 %) and Bengaluru (20.40 %), while state recorded 22.34 per cent growth per annum. Among different divisions, the variability was noticed highest in Belagavi (73.81 %) followed by Kalburagi (71.56 %), Mysuru (59.79 %) and Bengaluru (59.30%) and state as a whole recorded 63.52 per cent.

Table 4 depicts the growth and instability of NPK fertilizer consumption in different divisions of Karnataka. It was found that the consumption of NPK fertilizer witnessed significant growth during period-I compared to period-II and period-III. Whereas period-III witnessed a negative growth across all divisions of Karnataka. The highest growth was observed during period-I in Bengaluru division which was 123.92 per cent per annum followed by Mysuru (114.16 %), Belagavi (102.14 %) and Kalburagi (95.26 %) while state recorded a growth of 115.36 per cent. With regard to instability, wide variation was observed across all the four divisions for NPK consumption during period-I. Highest variability was observed in Kalburagi (178.76 %) followed by Belagavi (176.86 %), Mysuru (166.15 %), and Bengaluru (141.83 %) and the instability was 162.33 per cent for the state as a whole.

During period-II also the positive growth was noticed in the consumption of NPK across the divisions of Karnataka, but the growth was less when compared to period-I. Among different divisions, Kalburagi division showed highest growth rate for NPK consumption at the rate of 5.82 per cent per annum, followed by Mysuru (3.18 %), Bengaluru (2.98 %) and Belagavi (1.52 %),

whereas, the state recorded 4.28 per cent per annum during the same period, with regard to variability during period-II across all the divisions which has decreased as compared to period-I, Bengaluru division has the lowest variability accounted for 17.64 per cent, followed by Mysuru (20.97 %) Kalburagi (26.71 %), and Belagavi (27.74 %) and state accounted for 22.73 per cent. Whereas, during period-III decline in growth was noticed for consumption of NPK fertilizers across different divisions of Karnataka, the highest decline was noticed at the rate of 4.37 per cent per annum in Bengaluru division, followed by Belagavi division (-4.00 %), Kalburagi (-3.73 %) and Mysuru (-2.46 %), during

Table 4. Division-wise growth and instability in NPK consumption in Karnataka

Divisions	(in per cent)							
	Period –I (1989-90 to 1996-97)		Period –II (1997-98 to 2009-10)		Period –III (2010-11 to 2015-16)		Overall (1989-90 to 2015-16)	
	CAGR	CV	CAGR	CV	CAGR	CV	CAGR	CV
Bengaluru	123.92**	141.83	2.98*	17.64	-4.73 *	17.47	20.53**	56.32
Mysuru	114.16**	166.15	3.18*	20.97	-2.46 ^{NS}	15.23	21.32**	59.31
Belagavi	102.14*	176.86	1.52**	27.74	-4.00 *	15.08	24.50**	64.91
Kalburagi	95.26*	178.76	5.82**	26.71	-3.73 ^{NS}	14.25	24.74**	65.61
Karnataka	115.36**	162.33	4.28**	22.73	-3.71 ^{NS}	14.95	22.27**	61.28

Note: Period-I: Before Maximum Retail Price (MRP) was fixed by the Government from 1997

Period-II: Before Nutrient Based Subsidy (NBS) Policy 2010

Period-II I: After the NBS Policy

CAGR: Compound Annual Growth Rate

CV: Coefficient of variation

** Significant at one per cent level, * Significant at five per cent level, NS-Non significant.

the same period, the variability in Kalburagi division was 14.25 per cent followed by Belagavi (15.08 %), Mysuru (15.23 %) and Bengaluru (17.47 %), while for the state was 14.95 per cent.

The growth in consumption of NPK fertilizer from 1989-90 to 2015-16 was noticed positive across all the divisions which were highest 24.74 per cent per annum in Kalburagi division (24.74%) followed by Belagavi (24.50 %), Mysuru (21.32 %) and Bengaluru (20.53 %). This was due to the rapid expansion of irrigation, spread of HYV seeds, distribution of fertilizers to farmers at affordable prices, expansion of dealer's network, improvement in fertilizer availability and virtually no much change in farm gate fertilizer prices until recent years were the major reasons for the increase in fertilizer consumption (Bagal et al., 2018). The earlier studies by Vijay and Hrima (2011) and Jayanthi *et al* (2013) also revealed similar findings. Thus, it was clear that growth rate and variability in the consumption of NPK was not uniform in different periods.

Among different divisions the lowest variability of 56.32 per cent was noticed in Bengaluru division, followed by Mysuru (59.31 %) Belagavi (64.91 %) and Kalburagi (65.61 %) and state as whole accounted for 61.28 per cent. Hence, it is clear that the highest growth was noticed in Kalburagi division for consumption of NPK fertilizer, while instability showed a declining trend over the periods.

Disclaimer:

This paper is based on the preliminary dataset. Readers are requested to consider this paper as a preliminary research article, as authors wanted to publish the initial data as early as possible. Authors are aware that detailed statistical analysis is required to get a scientifically established conclusion. Readers are requested to use the conclusion of this paper judiciously as statistical analysis is absent. Authors also recommend detailed statistical analysis for similar future studies.

Conclusion

The growth trend in NPK consumption in Karnataka across four divisions, during period-I and period-II, was found positive in all the divisions. Whereas in period-III the consumption of NPK has negative growth across all divisions of Karnataka, in the overall period NPK consumption among different divisions in Karnataka was significantly increased in all the divisions. Among different divisions, higher growth was noticed in the Kalburagi division and

has less variability as compared to other divisions. Among different nutrients (nitrogen, phosphorous and potash) the highest consumption growth was in nitrogen during period-I whereas, potash and phosphorous has the highest growth during the period-II and overall period. The variability in consumption of different nutrients (N, P and K) in Karnataka has shown that during period-I overall potash consumption was more stable, while, during period-II and period-III nitrogen consumption was more stable while during the overall period potash consumption was more stable.

Ethical: NA

Consent: NA

References

- Anonymous, 2017, Ministry of Agriculture and farmers' welfare Government of India. *Annual Report-2017*.
- Bagal, Yudhishter Singh., L.K. Sharma, Gunjan Preet Kaur, Arjun Singh and Priya Gupta.2018. Trends and Patterns in Fertilizer Consumption: A Case Study. *Int.J.Curr.Microbiol.App.Sci.*7(04): 480-487. doi: <https://doi.org/10.20546/ijcmas.2018.704.056>
- Chand, and Pandey, L. M., 2009, Fertiliser use, nutrient imbalances and subsidies: trends and implications, *J. of Appl. Econ. Res.*, 3 (4) : 409–432.
- FAO., 1998, Guide to efficient plant nutrition management, *FAO Publication, Rome*.
- Hopper, W., 1993, Indian agriculture and fertilizer: An outsider's observation key note address to the FAI Seminar on emerging scenario in fertilizer and agriculture: global dimensions, *The Fertilization Association of India*.
- Jayanthi, G., Sherley T., Benny J. G., 2013, An Analysis of pattern and growth of fertilizer consumption in India. *Academicia.*, 3(1):197-212.
- Makadia, J. J. and Patel, K. S., 2014, Regional spatio-temporal growth and instability of fertilizer consumption in Gujarat state. *Int. Res. J. of Agric. Eco. and Stat.*, 1 (5): 16-22.
- Painuly, J. P. and Dev, S. M., 1998, Environmental dimensions of fertilizer and pesticide use: Relevance to Indian agriculture. *Int. J. Environmental and Pol.*, 10 (2): 273-288.

Tomich, T., Kilby, P. and Johnson, B., 1995, Transforming agrarian economies: opportunities seized, opportunities missed Ithaca. NY: *Cornell University Press*.

Vijay, P. and Hrima, T., 2011, Demand for fertiliser in India. *Determinants and Outlook for Research and Publications*, IIM Ahmedabad, pp: 1-32.