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# Diagnosis of Pulses Performance of India

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**Abstract**

India is the largest producer and consumer of pulses in the world accounting for about 25 per cent of global production, 27 per cent of global consumption and about 33 per cent of the world's area under pulses. However, compared to cereals like wheat and paddy, the growth rate of area and production of pulses is negligible and there exists wide variability in their yield in different states of country. The study has explored the growth and dynamics of production and consumption of major pulses in different states of India and has made a comparative evaluation of key economic factors affecting their production. Pulses have exhibited a grim picture in their production performance both spatially and temporally. Area substitution coupled with the biased revenue terms of trade has shown preference of cereals and oilseeds over pulses. However, pulses have been found to be preferred over coarse grains. Further, a structural shift in production performance of pulses-producing states not only validates the lack of spatial and temporal stability in their production performance but also throws light on the hidden potential of minor states in pulses production for long-term sustainability of pulse production.

## Introduction

Pulses occupy a predominant position in any discussion related to food and nutritional security and environmental sustainability. Besides their nutritional value (about 20-30 per cent protein), pulses enhance productivity of soil in terms of yield of subsequent crops. Increase in yield of subsequent crop to the tune of about 20-40 per cent has been recorded (Pande and Joshi, 1995, IIPR, 1998; 1999). In India, owing to its diverse agro-climatic conditions, pulses are grown throughout the year. Presently, India is the largest producer and consumer of pulses in the world, accounting for about 25 per cent of their global production, 27 per cent of their global consumption and about 33 per cent of the world's area under pulses (FAO, 2008). However, production performance of pulses in India has remained stagnant. The growth in production and productivity of pulses has lagged behind the population growth rate which has resulted into a decline in per capita availability of pulses from 66 g/day during triennium ending (TE) 1965 to 33 g/day during TE 2005 (*Agricultural Statistics at a Glance, 2007*) against ICMR (Indian Council of Medical Research) norms of 40 g/day. Thus, poor production performance has not only created an imbalance in demand and supply of pulses but also has resulted in soaring import bills, unpredictable price rises and low net profit compared to their competing crops (Joshi and Saxena, 2002). This coupled with other economic factors like lack of assured market, ineffective government procurement, unfavourable parity in prices and trade liberalization make pulses cultivation unremunerative and less attractive compared to other crops (Byerlee and White, 1997; Joshi *et al.*, 2000; Chand, 2000). Further, only a few states contribute major share to pulses production in India and there exists a wide variability in their yield across different states of the country. Keeping this in view, the present paper has explored the growth and dynamics of production and consumption of major pulses in different states of India and has made a comparative evaluation of the key economic factors affecting their production.

## Data and Methodology

The study is primarily based on the secondary data collected from published sources like *Agricultural Statistics at a Glance*, *Estimates of Area*, *Production and Yield of Principal Crops*, etc. The production pattern of pulses was investigated using tabular analysis and the compound growth rates (CGR) of area, production and yield were estimated as follows:

$$Y_t = AB^t e$$

Writing it in semilag form as,

$$\ln Y_t = \ln A + (\ln B)\, t + \ln e$$

where,

B = (1+r)

$Y_t$ = Area/yield/production of major pulses in the $t^{th}$ period,

t = Time variable (1, 2, 3,……, n),

A and B = Parameters to be estimated,

r = Compound growth rate, and

e = Error-term.

The exponential function was transformed to the semilog model and estimated using ordinary least square (OLS). Further, to examine the stability in yield of pulses across different states, coefficient of variation (CV) was estimated which together with CGR was chosen as the criteria to classify states in different categories based on their production performance.

$$CV = \frac{\sigma_x}{\bar{X}} * 100$$

where,

$\sigma_x$ = Standard deviation of X, and

$\bar{X}$ = Mean of x.

Dynamics of change in pulses production vis-à-vis other crops was examined by using stationary form of the first order Markov Chain model. Transition probability matrix (TPM), calculated through this method, explains how area between different crops has shifted over the years (Dent, 1967). This model is a stochastic process which describes the finite number of possible outcomes $S_i$ (i=1,2,…,r) which is a discrete random variable $X_t$ (t=1,2,….,T) and assumes that (a) the probability of an outcome on the $t^{th}$ trial depends only on the outcome of the preceding trial, and (b) this probability is constant for all time periods. Markov chain analysis yields transitional probability matrix 'P' whose diagonal elements indicate the retention probability and off-diagonal elements represent switching-over probability (Atkin and Blandford, 1982).

The general form of the first order Markov model is

$$Q_{jt} = \sum_{i=1}^{r} Q_{i,t-1} P_{ij} + e_{jt}$$

where,

$Q_{jt}$ = Area under the '$j^{th}$' pulse crop during the year t,

$Q_{j,t-1}$ = Area under the '$j^{th}$' pulse crop during the year t-1,

$P_{ij}$ = Probability that area shifts from the $i^{th}$ crop to the $j^{th}$ crop, and

r = Number of crops included in the model.

The transitional probabilities $P_{ij}$ have the properties

$$0 \le P_{ij} \le 1; \quad \sum_{i=1}^{r} P_{ij} = 1; \qquad \text{for all i.}$$

The P matrix was estimated in the linear programming framework using method of minimization of mean absolute deviation, as:

*Min* $0P^* + Ie$

*Subject to*

$XP^* + e = Y$

$GP^* = 1$

$P^* \ge 0$

where,

$P^*$ is a vector probabilities $P_{ij}$,

0 is a vector of zeros,

I is an identity matrix of appropriate dimension,

e is the vector of absolute errors,

Y is the vector of area of each crop,

X is a block diagonal matrix of lagged values of Y, and

G is a grouping matrix to add the row elements of P arranged in $P^*$ to unity.

Price is the most important economic factor affecting production of any crop. However, high price alone does not provide guarantee about more production unless it is coupled with a higher revenue to the producers. This issue was investigated through Revenue Terms of Trade (RTOT) between competing crops which indicates how one crop is preferred to other competing crops over the years.

$$RTOT = \frac{Y_1 * MSP_1}{Y_2 * MSP_2}$$

where,

$Y_1$ and $Y_2$ = Yield of pulses and competing crops, respectively.

$MSP_1$ and $MSP_2$ = Minimum Support price of pulses and competing crops, respectively.

## Results and Discussion

### Present Status of Pulses in India

Presently, in India, 23 Mha area is under pulses, producing about 13 Mt pulses, with the average yield of 565 kg/ha (Table 1). The estimated share of different states in total pulses area and production during the TE 2006 has shown that Madhya Pradesh (MP), Rajasthan (Raj), Maharashtra (Mah) and Uttar Pradesh (UP) contributed about 60 per cent to total pulses area, and about 70 per cent to the total pulses production (Appendix I). Thus, these four states were categorized as the major pulses-producing states, while other states like Andhra Pradesh (AP), Bihar, Gujarat (Guj), Karnataka (Kar), etc. were considered as minor pulses-producing states.

Further diagnosis of shares of states in area and production of individual pulses revealed that Mah, Kar and AP contributed maximum area under arhar with the respective share of 30 per cent, 15 per cent and 14 per cent. MP, followed by Raj and Mah contributed maximum area under gram in India with respective share of 39 per cent, 15 per cent, and 14 per cent. Urd was mainly grown in UP, Mah, MP and AP with the shares of 16 per cent, 15 per cent, 15 per cent and 14 per cent, respectively, while for moong, Raj ranked first, followed by Mah with the share of 25 per cent and 17 per cent, respectively. Similar pattern was found for the production of these crops (Appendix II). Thus, production of individual pulses was also concentrated in a few states with their respective dominated share.

### (A) Production Performance of Total Pulses

During the past 56 years, i.e. between the first and tenth Five-Year Plans, pulses area has increased by only 6 per cent as compared to about 22 per cent in the case of cereals. The increment in pulse production has been only 32 per cent as compared to about 280 per cent in the case of cereals during this period. Yield too has shown a similar trend with only 25 per cent increase in pulses as compared to 211 per cent in cereals. It reflects the stagnant condition of pulses production and a virtual failure of planning in pulses development.

In India, area under pulses has in fact marginally decreased from 24 Mha during TE 1975 to 23 Mha during TE 2005 due to shifting to non-pulses crops. When irrigation and other infrastructural facilities favouring other crops become accessible, the farmers shift to other remunerative crops. This might be one of the reasons why production of pulses hovered around

**Table 1. Area, production and yield of pulses in India**

| Period | Area (Mha) | | | Production (Mt) | | | Yield (kg/ha) | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Rabi* | *Kharif* | Total | *Rabi* | *Kharif* | Total | *Rabi* | *Kharif* | Total |
| TE 1975 | 13.13<br>(55.52) | 10.17<br>(42.99) | 24<br>(100) | 7.51<br>(61.92) | 3.96<br>(32.70) | 12<br>(100) | 572 | 389 | 500 |
| TE 1985 | 12.67<br>(53.84) | 10.89<br>(46.26) | 24<br>(100) | 7.84<br>(63.51) | 4.89<br>(39.65) | 13.2<br>(100) | 619 | 449 | 550 |
| TE 1995 | 10.84<br>(48) | 9.83<br>(43.54) | 23<br>(100) | 4.54<br>(34.34) | 3.39<br>(25.65) | 13<br>(100) | 419 | 345 | 565 |
| TE 2006 | 11.67<br>(51.21) | 11.21<br>(49.17) | 23<br>(100) | 8.43<br>(63.87) | 4.69<br>(35.53) | 13<br>(100) | 722 | 418 | 565 |

*Note:* Figures within the parentheses are percentages of total
Mt=Million tonnes, Mha=Million hectares

12-13 Mt, resulting in a decline in their per capita availability. Season-wise bifurcation revealed the comparative advantage of *rabi* pulses over *kharif* pulses as the share of *rabi* pulses in area and production of total pulses was more than *kharif* pulses. Further, *rabi* pulses were also found to be more productive than *kharif* pulses with the average yield of 722 kg/ha (Table 1).

The growth rate in the area of total pulses was found to be reversed from positive (0.23%) during 1970-80 to negative (-0.52%) during 1990-06. During the same period, the growth rate of production, though negative, increased marginally due to marginal increase in growth rate of yield. The growth rates of production and yield were significant during 1980-90 due to initiatives taken by the technological mission and other pulse development programmers, but these efforts probably could not sustain for a long time, as shown by the declining growth rate in the later period. Instability in yield of pulses over the years was also examined by estimating CV in different periods. It was found that CV declined from 11.58 per cent during 1970-80 to 7.51 per cent during 1980-90 due to technological and government interventions, but the increased value of CV (8.56 per cent) in a recent period (1990-06) has shown increasing instability in yield of pulses (Table 2). This raises concerns over the long-term sustainability of pulses production.

## Categorization of States as per Performance in Pulse Production

To examine the state-wise performance of pulses, the states were categorized according to the positive and negative growth rates in area, production and yield (Table 3).

Table 3 throws light on the structural shift in production of pulses in some states. During 1970-80, Gujarat showed positive growth rate in area, production and yield, but during 1990-06 (recent period), growth rate in area and production shifted from positive to negative, though growth rate in yield was positive. This might be due to large scale substitution of pulses area to other high-value crops which give comparatively higher returns and thus pulses production had impaired substantially in the state even at positive yield growth. In the case of Bihar and UP, during 1970-80, growth rate in the area and production of pulses was negative, but yield showed a positive growth rate. Thus, in the light of positive growth rate in yield, area in both these states has shifted from the negative to positive growth category in a recent period but, this could not be matched by yield performance, as yield could not be sustained and shifted from the positive to negative growth category. This had resulted in a negative growth rate in pulses production in a recent period in UP. The positive growth rate in production in Bihar might be due to large-scale area substitution in favour of pulses, negating the negative yield effect. Further, MP had shown a positive growth rate in pulses area during 1970-80, but due to a negative growth rate of yield, production showed a negative growth rate during that period. But in a recent period, substantial improvement in yield has been noticed due to concerted efforts on pulses development in this state, resulting in a positive growth rate in area and production of pulses.

As growth rate shows only a partial picture, major pulses-producing states were further classified according to CGR of yield together with CV, reflecting instability in yield (Table 4). Results have shown the structural shift in yield performance of pulses in major

**Table 2. Season-wise compound growth rate (CGR) in area, production and yield of pulses in India: 1970-2006**

| Period | Area (Mha) | | | Production (Mt) | | | Yield (kg/ha) | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Rabi* | *Kharif* | Total | *Rabi* | *Kharif* | Total | *Rabi* | *Kharif* | Total |
| 1970-1980 | -0.35 | 1.34 | 0.23 | -1.06 | 0.84 | -0.05 | -0.72 (10.42) | -0.49 (7.53) | -0.28 (11.58) |
| 1980-1990 | -0.29 | 0.89 | 0.14 | 1.24 | 3.43 | 1.84 | 1.54 (7.25) | 2.52 (13.18) | 1.70 (7.51) |
| 1990-2006 | -0.30 | 0.09 | -0.52 | 1.57 | 0.29 | -0.10 | 1.88 (29.41) | 0.20 (14.93) | 0.42 (8.56) |

*Note:* Figures within the parentheses are coefficients of variation

**Table 3. Categorization of states of India according to compound growth rate (total pulses)**

| Period | Area | | Production | | Yield | |
|---|---|---|---|---|---|---|
| | Positive CGR | Negative CGR | Positive CGR | Negative CGR | PositiveCGR | Negative CGR |
| 1970-80 | Guj, Mah, MP, Kar, AP | Bihar, Raj, UP | AP, Guj, Mah, Raj, Kar | Bihar, MP, UP | AP, Bihar, Guj, Mah, Raj, UP, Kar | MP |
| 1980-90 | AP, Guj, Mah, UP, Kar | Bihar, MP Raj | AP, Bihar, Guj, Mah,UP | Raj, Kar | AP, Bihar, MP, Mah, UP, Guj | Raj, Kar |
| 1990-06 | AP, Bihar, MP, Mah, UP, Kar | Guj, Raj | AP, Bihar, MP, Mah, Raj, Kar | Guj, UP | AP, Guj, Mah, MP, Raj, Kar | Bihar, UP |

**Table 4. Classification of states as per CGR and CV of pulses yield**

| CV | Positive CGR | | | Negative CGR | | |
|---|---|---|---|---|---|---|
| | 1970-80 | 1980-90 | 1990-2006 | 1970-80 | 1980-90 | 1990-2006 |
| Low (0-20) | AP, Bihar, UP | AP, Bihar, MP, Mah, UP, Guj | Guj, Mah, Kar | MP | Raj, Kar | - |
| Medium (20-40) | Guj, Mah, Raj, Kar | - | AP, MP, Raj | - | - | - |
| High (>40) | - | - | - | - | - | Bihar, UP |

states over the years. MP, which had shown a negative growth and low variability in yield during the 1970s, shifted to a positive CGR and low CV category during the 1980s, but could not sustain its yield during the recent period.

Thus, though MP is the highest pulses-producing state with positive growth, instability in its yield is more than in other states. A similar shift was noticed for Bihar and UP. The maximum improvement in yield performance was found during the 1980s, but subsequently, these states could not maintain the momentum, leading to a poor performance in pulses production.

## Crop-wise Comparison of State Level Yield with National Level during TE 2006

Analyzing disaggregated data of pulses and comparing yield of individual pulses with the national average yield during TE 2006, it was found that Mah and Kar, which had maximum share in area and production of arhar (Appendix II), had yield less than the national average. In the case of gram, Raj and Mah, which ranked second after MP in area and production, showed a lower yield than the national average. Similar is the case for urd and moong, where the major producing states had yield lesser than the national average (Table 5). Thus, the results have shown stagnant conditions of pulses crops in their respective major producing states and have revealed the potential of minor pulses producing states in pulses development, as yield of pulse crops in their minor producing states was higher than the national average. Front line demonstrations have successfully shown that through adoption of improved production technologies, yield of pulses in general and moong and gram in particular can be increased by 46 per cent and 31 per cent, respectively (Gautam *et al.*,2007). So the appropriate policies for minor pulses producing states will have long-term implications for pulses development and production sustainability.

## Crop-wise Categorization of States Based on CGR in Yield during 1990-06

Crop-wise growth rate (Table 6) has shown that during 1990-06, Raj had a positive growth rate in yield of arhar, though with a yield lesser than the national average (Table 5) and with a smaller share in national area and production of arhar as compared to other states (Appendix II). On the other hand, UP, which had a major share in national area and production of arhar

**Table 5. Crop-wise comparison of state yield with national average during TE 2006**

| Yield status | Arhar | Gram | Urd | Moong |
|---|---|---|---|---|
| Yield more than national average | Bihar, Guj, MP, UP | AP, Bihar, MP, UP | AP, Bihar, Guj, Mah | Bihar, Guj, Mah, UP |
| Yield less than national average | AP, Mah, Raj, Kar | Guj, Mah, Raj, Kar | MP, Raj, Kar, UP | AP, MP, Raj, Kar |

**Table 6. Crop-wise categorization of states as per CGR in yield during 1990-06**

| CGR (1990-06) | Arhar | Gram | Urd | Moong |
|---|---|---|---|---|
| Positive | AP, Mah, Raj, Kar | AP, Bihar, Guj, MP, Raj, UP, Kar | Bihar, MP, Mah, Raj | AP, Bihar, Guj, MP |
| Negative | Bihar, Guj, MP, UP | Mah | AP, UP, Kar | Mah, Raj, UP, Kar |

and also had higher yield than the national average, has shown a negative growth rate in yield during 1990-06. In the case of gram, almost all major states have depicted a positive growth in yield during 1990-06, except Mah (-0.5). For urd, the major producing states like AP and UP have shown a negative growth rate in yield, while minor urd-producing states like Bihar and Raj have shown a positive growth rate in yield during 1990-06. A similar pattern was found for moong where major-producing states like Mah and Raj have depicted a negative growth rate in yield and minor states like Bihar and Guj presented a positive growth rate in yield. This brings out the dynamics of pulses production in the country and shows how minor pulses producing states are moving ahead, surpassing the major states in terms of yield of individual pulses, except in the case of gram where major pulses producing states have shown a better performance.

### (B) Dynamics of Area Substitution between Crop Groups

To find the dynamics of area substitution between different crop groups, Markov Chain analysis was used to get the transition probability matrix (expressed in per cent terms) which explains how the area has shifted among the competing crops over the years. Rows of the matrix show the area of the corresponding group lost to the other group. On the other hand, columns indicate area gained by the respective group. Results given in Table 7 show that during 1995-2006 pulses could retain only 24.38 per cent of their area and 70.73 per cent of their area was substituted by oilseeds, while 4.89 per cent was lost to other crops. On the other hand, pulses gained 29.49 per cent of oilseeds area and 22.88 per cent of other crops area. Thus, substitution was witnessed between pulses and oilseeds crops while, as expected, pulses and cereals did not show any substitution among each other during the period under consideration. Substitution between pulses and oilseed might be possible because of similarity in production requirement for both crop groups as both can be grown in marginal lands and under rainfed conditions as compared to cereals which mainly require irrigated conditions to grow. Further, transition probability matrix has confirmed distinct preference of cereals over pulses and oilseed as none of the cereals area was found to have shifted to pulses and oilseeds. At the same time, cereals have gained about 60 per cent of oilseed area during this period. No area was substituted from pulses to cereals because the land suitable for pulses may not be as suitable for cereals production unless large investments are made.

### Dynamics of Area Substitution within Pulses

Transition probability matrix given in Table 8 shows area substitution between individual pulses during 1995-2006. Among major pulses, gram had an advantageous position with the retention of 48.51 per cent of its area during the period under consideration. About 16 per cent of its area was lost to arhar and marginally to urd and moong crops. On the other hand, arhar could retain only 14 per cent of its area due to its annual and highly risky nature and it was found to be replaced by minor pulses. High degree of substitutability was noticed between urd and moong during 1995-2006 as shown by the Matrix.

**Table 7. Transition probability matrix between crop groups for the period of 1995-2006**

| Crop groups | Cereals | Pulses | Oilseeds | Others |
|---|---|---|---|---|
| Cereals | 59.32 | 0.00 | 0.00 | 40.68 |
| Pulses | 0.00 | 24.38 | 70.73 | 4.89 |
| Oilseeds | 60.46 | 29.49 | 10.05 | 0.00 |
| Others | 53.33 | 22.88 | 23.79 | 0.00 |

**Table 8. Transition probability matrix for different pulses for the period 1995-2006**

| Pulses | Arhar | Gram | Urd | Moong | Others |
|---|---|---|---|---|---|
| Arhar | 14.32 | 0.00 | 0.00 | 0.00 | 85.68 |
| Gram | 16.49 | 48.51 | 0.26 | 0.88 | 33.86 |
| Urd | 4.84 | 0.00 | 38.13 | 57.03 | 0.00 |
| Moong | 35.84 | 20.96 | 31.17 | 12.03 | 0.00 |
| Others | 18.30 | 50.38 | 15.31 | 16.01 | 0.00 |

## (C) Consumption Pattern of Pulses in Different States

The per capita consumption of pulses and their share in total food expenditure were diagnosed in pulses-producing state over two household consumer expenditure surveys (50th and 61st round) of National Sample Survey Organisation (NSSO). The per capita annual consumption of pulses in India had declined from 9.44 kg to 8.82 kg between 1993-94 (50th round) and 2004-05 (61th round). The major pulse crops, viz. arhar, gram (split), moong and urd have exhibited the same declining pattern in per capita annual consumption in India. Among states, per capita annual pulses consumption varied between 6 kg and 10 kg in 2004-05 while, individual crops showed greater variability in consumption among states (Appendix III). Income elasticity of pulses has been estimated as 0.6 for very poor consumer and positive for all income classes (Kumar, 1998), which shows a positive relationship between income and consumption. But, as per capita income in India has increased significantly in recent times, the declining per capita consumption has suggested that factors other than income, particularly, limited supply and changes in relative prices, might have accounted for the declining trend in consumption. On the other hand, negative own price elasticity, estimated as -0.775 for very poor and negative for all income classes (Kumar, 1998), have made pulses price sensitive. Thus, undue price rise due to poor production performance has resulted into a decline in per capita consumption of pulses in the period under consideration.

Further, the share of pulses in the total food expenditure in India was about 5 per cent, with variation of 6 kg to11 kg among states in 2004-05. Among pulses, arhar was found to be preferred over other pulses with about 38 per cent share in total pulses expenditure of households in India in 1993-94, which has been reduced to 34 per cent in the year 2004-05. Other pulses have also exhibited a declining share in pulses expenditure because of undue price rise. From nutritional security point of view, declining share of pulses in food basket is of great concern, particularly in India, where pulses are the major source of protein.

## (D) Price Behaviour and Revenue Terms of Trade (RTOT) of Pulses

Wholesale price index (base year, 1993-94 =100) for different crop groups has shown an increasing trend during 1990-2006 and the price index was higher for pulses compared to cereals and oilseeds (Figure 1). This shows that pulses had the distinct absolute price advantage over cereals and oilseeds. Further, CV for the wholesale price index of pulses was 30.10 per cent during 1990-2006, reflecting a wide fluctuation in price of pulses compared to cereals and oilseeds, which had lower CV value of 26 and 24 per cent, respectively. Among pulses, urd followed by moong have shown maximum increase in WPI during the period under consideration (Figure 2). Further, CV for WPI of arhar, moong, urd and gram was estimated as 10.60 per cent, 18.91 per cent, 25.61 per cent and 19.73 per cent, respectively, while for rice and wheat, CV was only 8.29 per cent and 11.93 per cent, respectively. This showed that price of urd was most unstable compared to the price of other pulses and the overall pulses prices were more unstable than of rice and wheat.

As far as production incentives to farmers are concerned, it is revenue rather than price which is important to them. Thus, revenue terms of trade between pulse crops and their close substitutes were evaluated and it was found how preference was biased towards cereals rather than pulses even though MSP for pulses was more than of cereals. The value of more than one for wheat-gram revenue terms of trade (WGRTOT) has shown the preference for wheat over gram, though it was declining over the years (Table 9). Similarly, the value less than one for RTOT between

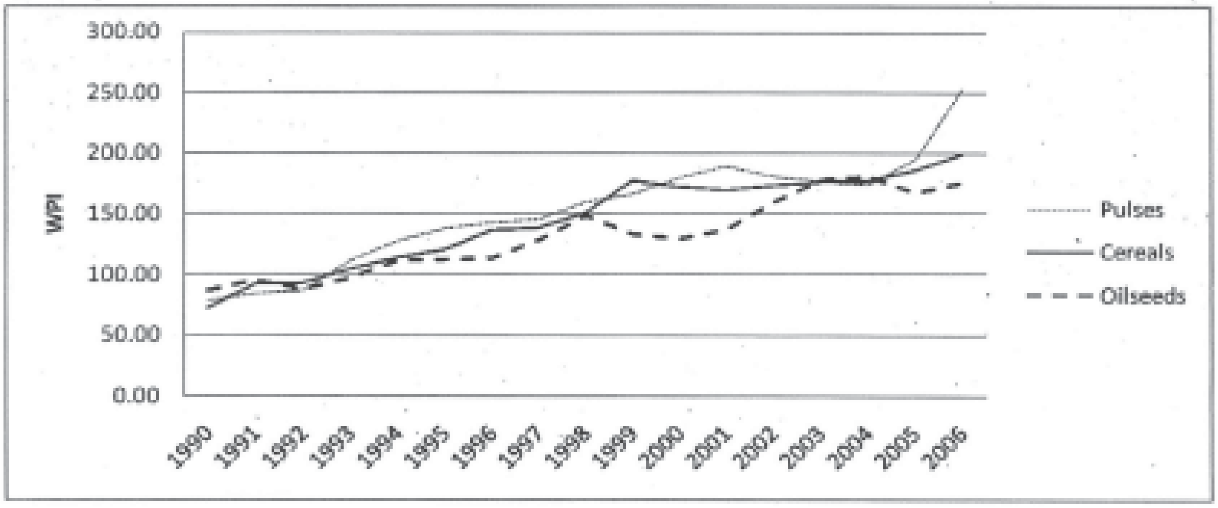



**Figure 1. Trend in wholesale price index during 1990-2206 (base year 1993-94=100)**

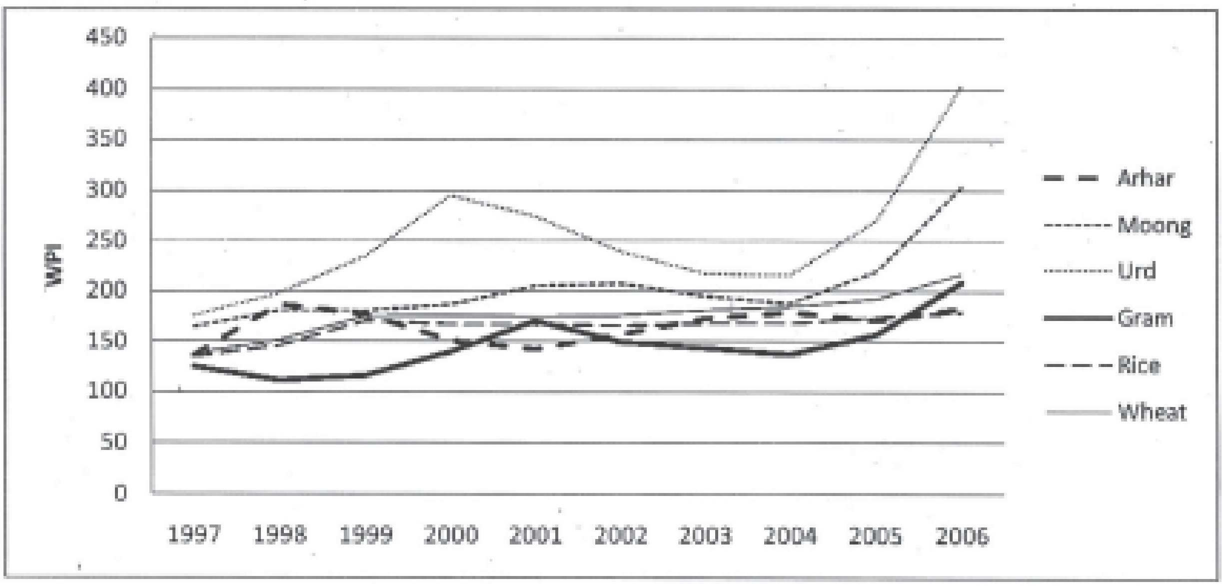


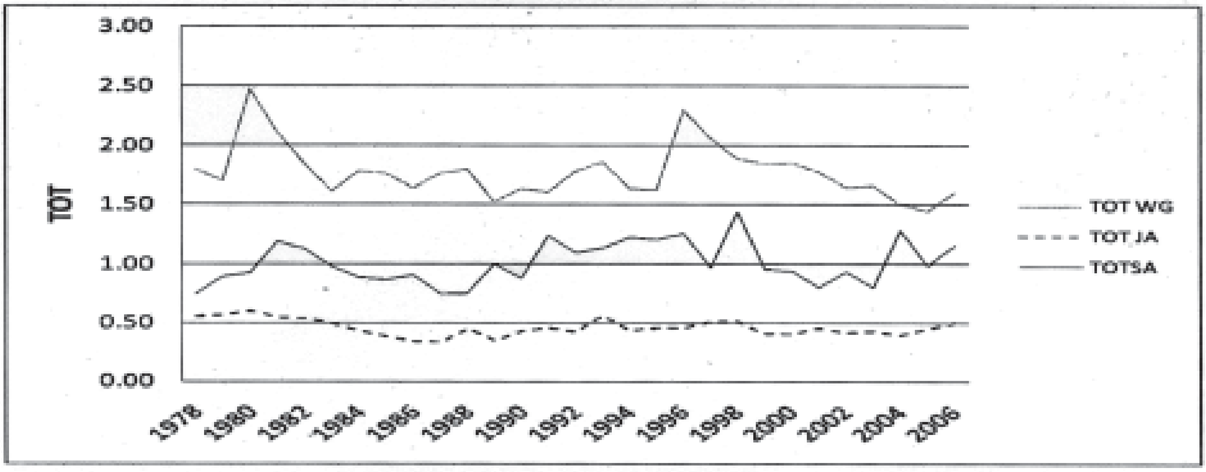

**Figure 2. Crop-wise trend in wholesale price index during 1997-2006**

**Table 9. Revenue terms of trade (RTOT) between competing crops**

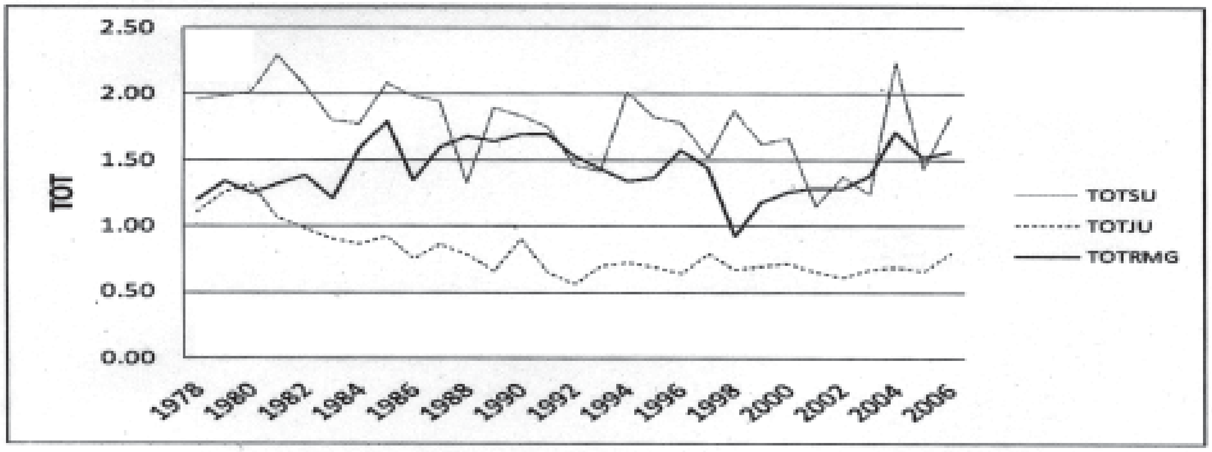
| Period | Wheat-Gram | Jowar-Arhar | Soyabean -Urd | Jowar- Urd | R& M – Gram | Soyabean-Arhar |
|---|---|---|---|---|---|---|
| TE 1985 | 1.71 | 0.43 | 1.88 | 0.89 | 1.52 | 0.90 |
| TE1995 | 1.70 | 0.48 | 1.73 | 0.70 | 1.38 | 1.19 |
| TE 2005 | 1.61 | 0.43 | 1.60 | 0.67 | 1.56 | 1.04 |

jowar and arhar has shown preference for arhar over jowar. Thus, one can conclude that over the time, cereals and oilseeds were preferred to pulses and pulses were preferred over coarse grains as far as parity was concerned.

Further, time series plot of RTOT has shown year by year changes in parity price of different crops (Figures 3a and b). It is clearly reflected from the plot that after the year 1996 gram was preferred over wheat, as shown by declining RTOT (wheat-gram), but from 2005 reversal in this trend was noticed, which was again in favour of wheat. Similarly, trend reversal was found in favour of soyabean against arhar. Soyabean and rapeseed & mustard were preferred over urd and gram, respectively, as shown by the upward moving RTOT




(a)




(b)

**Figure 3. Revenue terms of trade (RTOT) between competing crops**

with the value more than one. Consistently less than one value of jowar-urd RTOT and jowar-arhar RTOT over the years has shown distinct preference of pulses over the coarse grains.

## Conclusions

Pulses, which play an important role in food and nutritional security and environmental sustainability, have shown a grim picture of their production performance both spatially and temporally. In the light of high population growth, poor production performance has resulted in reduction in per capita availability of pulses which together with undue price rise has distorted consumption pattern of households. Substitution of pulses area to other crops together with the biased revenue terms of trade has shown preference of cereals and oilseeds over pulses. However, pulses have been found to be preferred over coarse grains. Since the yield of pulses is stagnant vis-à-vis other crops, income of pulses growing farmers can be considerably increased by yield improvement through technological breakthrough. Thus, yield improvement can fetch higher revenue to farmers and may negate the advantage of cereals and oilseeds over pulses. Further, a structural shift in production performance of pulses producing states not only validates the lack of spatial and temporal stability in their production performance but also throws light on the hidden potential of minor states in pulses production for long-term production sustainability. Hence, for different pulses, minor pulses producing states should be encouraged to identify the region-specific constraints and efforts should be made for creation of necessary infrastructure and efficient execution of pulses development schemes to provide favourable conditions for pulses production.

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**Appendix I**

**Share of states in total pulses area and production during TE 2006**

(per cent)

| States | *Rabi* | | *Kahrif* | | Total | |
|---|---|---|---|---|---|---|
| | Area | Production | Area | Production | Area | Production |
| AP | 8.30 | 9.21 | 8.51 | 8.99 | 8.43 | 9.10 |
| Bihar | 4.92 | 4.65 | 0.83 | 1.75 | 2.83 | 3.58 |
| Guj | 1.36 | 1.54 | 5.57 | 8.52 | 3.40 | 4.08 |
| MP | 29.85 | 34.01 | 8.72 | 9.85 | 19.62 | 23.09 |
| Mah | 8.78 | 7.52 | 21.25 | 23.43 | 15.07 | 14.97 |
| Raj | 9.54 | 7.86 | 22.30 | 9.13 | 16.20 | 14.87 |
| UP | 15.63 | 20.05 | 8.24 | 12.79 | 11.91 | 18.92 |
| Kar | 5.43 | 3.20 | 11.90 | 11.96 | 8.63 | 6.32 |
| Others | 16.19 | 11.94 | 12.68 | 13.58 | 13.91 | 10.75 |
| India | 100 | 100 | 100 | 100 | 100 | 100 |
| | (11.67) | (8.43) | (11.21) | (4.69) | (23) | (13) |

*Note:* Figures within the parentheses are actual area (Mha) / production (Mt)

**Appendix II**

**Share of states in individual pulses area and production during TE 2006**

(per cent)

| States | Arhar | | Gram | | Urd | | Moong | |
|---|---|---|---|---|---|---|---|---|
| | Area | Production | Area | Production | Area | Production | Area | Production |
| AP | 14.08 | 9.92 | 5.55 | 8.81 | 13.38 | 18.41 | 13.12 | 17.06 |
| Bihar | 1.02 | 1.82 | 0.94 | 1.09 | 3.72 | 1.45 | 3.08 | 8.87 |
| Guj | 7.58 | 10.40 | 2.13 | 2.15 | 3.23 | 4.67 | 5.80 | 7.75 |
| MP | 9.09 | 10.09 | 39.34 | 44.44 | 16.43 | 14.96 | 2.61 | 2.27 |
| Mah | 30.43 | 28.83 | 13 | 10.63 | 16.20 | 21.50 | 17.65 | 25.09 |
| Raj | 0.54 | 0.56 | 15.57 | 11.32 | 5.68 | 4.62 | 25.47 | 28.88 |
| UP | 10.72 | 15.64 | 10.78 | 12.04 | 16.96 | 14.78 | 2.66 | 3.10 |
| Kar | 15.97 | 12.45 | 6.39 | 4.10 | 3.49 | 2.29 | 12.99 | 4.60 |
| Others | 10.6 | 10.29 | 6.29 | 5.42 | 20.90 | 17.32 | 16.61 | 28.47 |
| India | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | (3.5) | (2.4)` | (6.9) | (5.5) | (3.2) | (1.2) | (3.1) | (1.2) |

*Note:* Figures within parentheses are actual area (Mha) / production (Mt)

**Appendix III**

**Per capita pulses consumption and share in food expenditure (Rs) in major states**

(kg/annum/person)

| States | Arhar# | | Gram# | | Urd# | | Moong# | | Pulses* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1993-94 | 2004-05 | 1993-94 | 2004-05 | 1993-94 | 2004-05 | 1993-94 | 2004-05 | 1993-94 | 2004-05 |
| AP | 4.50 | 5.16 | 0.67 | 0.62 | 1.23 | 1.48 | 2.03 | 1.03 | 8.90 | 8.73 |
| | (55.02) | (61.08) | (7.47) | (6.68) | (11.86) | (15.82) | (20.80) | (11.40) | (6.39) | (5.81) |
| Bihar | 1.79 | 0.93 | 0.39 | 0.81 | 0.22 | 0.03 | 0.72 | 0.86 | 8.75 | 8.69 |
| | (25.44) | (13.65) | (5.21) | (9.28) | (2.22) | (0.34) | (8.56) | (10.02) | (5.55) | (6.12) |
| Guj | 3.99 | 4.47 | 0.76 | 0.66 | 0.52 | 0.47 | 3.52 | 2.55 | 10.74 | 9.98 |
| | (41.00) | (47.44) | (7.14) | (5.93) | (3.97) | (4.54) | (29.64) | (24.33) | (6.38) | (5.64) |
| MP | 4.45 | 4.26 | 0.93 | 1.08 | 1.66 | 0.63 | 1.32 | 1.16 | 11.81 | 9.46 |
| | (44.77) | (51.12) | (8.20) | (9.43) | (11.44) | (6.07) | (10.91) | (12.65) | (7.88) | (7.16) |
| Mah | 4.65 | 4.75 | 1.39 | 1.69 | 0.55 | 0.48 | 1.61 | 1.59 | 11.16 | 10.71 |
| | (45.55) | (47.45) | (12.80) | (13.89) | (4.32) | (4.21) | (13.97) | (14.93) | (7.12) | (6.67) |
| Raj | 0.26 | 0.17 | 1.53 | 0.94 | 1.24 | 0.68 | 2.58 | 2.37 | 8.52 | 6.08 |
| | (4.36) | (3.58) | (20.19) | (14.06) | (14.19) | (12.65) | (34.33) | (37.38) | (4.37) | (3.49) |
| UP | 5.14 | 3.60 | 0.62 | 0.47 | 2.21 | 1.55 | 0.43 | 0.43 | 11.66 | 10.15 |
| | (49.42) | (42.31) | (5.05) | (4.17) | (16.62) | (14.99) | (4.31) | (4.60) | (7.52) | (6.96) |
| Kar | 4.18 | 4.14 | 0.84 | 0.76 | 0.87 | 0.92 | 1.12 | 0.98 | 9.82 | 9.61 |
| | (51.02) | (48.09) | (8.79) | (7.33) | (9.29) | (10.83) | (11.42) | (9.16) | (6.66) | (6.30) |
| India | 3.17 | 2.76 | 0.39 | 0.33 | 1.20 | 0.99 | 1.30 | 1.17 | 9.44 | 8.82 |
| | (38.14) | (34.77) | (8.54) | (7.62) | (11.42) | (10.91) | (14.67) | (13.51) | (5.87) | (5.64) |

*Date source:* National Sample Survey Organisation: 50th (1993-94) and 61st (2004-05) round reports.

*Figures within the parentheses are the shares in total food expenditure

#Figures within the parentheses are the shares in total pulses expenditure