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Growth Performance and Acreage Response of Pulse Crops: A State-Level Analysis

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I

INTRODUCTION

Economists have extensively investigated the growth performance of rice and wheat during the past four decades. It has been widely researched at the global, regional, national, state and household levels. Unfortunately, scant attention has been paid to the study of pulse crops, which play an important role in sustaining crop systems and maintaining the nutritional security of population in India. Although, evidences are available for the sixties, seventies and eighties, inadequate recent information has impaired the policy initiatives in the changed agricultural scenario in the country. Therefore, an attempt must be made to provide current evidence on temporal and spatial dimensions of the pulse development. The present paper is devoted to the analysis of growth performance in terms of area, production and yield of five important pulse crops (gram, arhar, moong, urad and massar) along with total pulses at the all India level and in major producing states of the country between 1980-81 and 2001-02. In addition, acreage response has also been examined. The entire period is sub-divided into two periods. The first period relates to eighties beginning from 1980-81 to 1990-91 and the second period of nineties from 1990-91 to 2001-02. These represent the pre-and post-reforms periods. The cut off point of 1990-91 has strategic significance, as pulse crops were included in the Technology Mission during this year.

The methodology followed for each aspect is different. For measuring the growth rates of area, production and yield, semi-log functions were used. The Nerlovian modified model of distributed lags was used to identify the factors influencing acreage of important pulse crops. The details of the methodology used are given at relevant places in the analysis.

This paper is organised as follows. The first section examines the state-wise growth performance of major pulses in India in order to assess the nature of stagnancy in pulse production in the background of the changing agricultural scenario in the country. The second section identifies the factors influencing acreage of major pulses in the core states in India.

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II

GROWTH PERFORMANCE

Some scholars have attempted to document the detailed performance of pulse crops since Independence (Chopra and Swamy, 1975; Satyapriya, 1989; Sadasivam, 1993; Joshi and Saxena, 2002). The annual growth rate of production in the pre-green revolution period (1949-50 to 1964-65) with a base year of triennium ending 1981-82 was 1.41 per cent per annum, which dropped significantly in the seventies. It was only in the eighties that the growth rate crossed 1 per cent per annum. During this period, pulse production grew at the annual growth rate of 1.52 per cent per annum. The economic re-structuring during the nineties did not prove beneficial for pulse production and its growth declined substantially. It became 0.61 per cent per annum between 1990-91 and 1999-2000 (Government of India, 2003). But, the individual pulse crops behaved differently. The annual increase in gram production was above average while it was negligible for arhar. Given this background, it is pertinent to examine the state-wise growth performance of individual pulse crops in India for the aforesaid periods. The semi-log equation of the form log y = a + bt is used to estimate state-wise growth rates in area, production and yield of gram, arhar, moong, urad, massar and total pulses during the first, second and entire study periods.

Gram

The most important pulse crop in India is gram which occupied an area of about 5712 thousand hectares during 2001-02. It constitutes nearly two-fifth share of the area of total pulses. It may be noticed that gram is extensively cultivated as a winter crop in India especially in the states of Madhya Pradesh (38.3 per cent), Rajasthan (15.3 per cent), Maharashtra (13.80 per cent) and Uttar Pradesh (13.5 per cent). These states together accounted for 81 per cent of all India area under gram. These are also leading states in terms of production but Uttar Pradesh crossed Maharashtra and Rajasthan due to highest productivity. Further, disparities in yield rates were also found significant. The state of Uttar Pradesh was leading with a yield rate of 996 kgs/ha.

The other high ranking state was Andhra Pradesh (923 kgs/ha). Nonetheless, these yield rates are much below the potential yield of 15-20 qtls/ha. It is largely due to low proportion of irrigated area to total area. Only 30.9 per cent of gram area was found irrigated during 2000-01. The states with higher irrigated area are Rajasthan and Madhya Pradesh. On the other hand, merely 6.8 per cent of gram area was found irrigated in Andhra Pradesh.

TABLE 1. AREA, PRODUCTION, YIELD AND IRRIGATED AREA OF GRAM IN IMPORTANT STATES IN INDIA (TE 2001-02)

(Area in '000 ha; Production in '000 tonnes; Yield in kgs/ha)

State (1)	Area 2001-2002 (2)	Area Per cent share (3)	Production 2001-2002 (4)	Production Per cent share (5)	Yield 2001-2002 (6)	Yield Rank (7)	Per cent of irrigated area 2000-2001 (8)
Madhya Pradesh	2187.1	38.3	2006.8	43.28	918	3	41.1
Uttar Pradesh	768.8	13.5	765.8	16.51	996	1	14.8
Rajasthan	872.6	15.3	603.0	13.00	691	4	50.8
Maharashtra	788.2	13.8	466.9	10.07	592	6	34.9
Karnataka	389.5	6.8	235.1	5.07	604	5	10.9
Andhra Pradesh	203.8	3.6	188.1	4.06	923	2	6.8
India*	5711.5	100.0	4637.2	100.00	812	-	30.9

Source: Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, New Delhi, 2004.

*Includes minor producing states.

After analysing the geographical spread of gram cultivation in India, it is imperative to examine the growth performance in terms of area, production and yield between 1980-81 and 2001-02. It may be observed from Table 2 that the growth rate of gram area was found negative at the all India level. The gram area declined at the rate of 0.7, 0.8 and 0.5 per cent per annum during the eighties, nineties and the entire study period. It appears that inclusion of pulses in the Technology Mission on Oilseeds and Pulses (TMOP) in 1990 did not make any impact to induce farmers to grow this crop.

TABLE 2. GROWTH PERFORMANCE OF GRAM IN IMPORTANT STATES OF INDIA (1981-2002)

(per cent per annum)

State (1)	Area 1981-91 (2)	Area 1991-2002 (3)	Area 1981-2002 (4)	Production 1981-91 (5)	Production 1991-2002 (6)	Production 1981-2002 (7)	Yield 1981-91 (8)	Yield 1991-2002 (9)	Yield 1981-2002 (10)
Madhya Pradesh	1.6	0.1	1.2	3.2	1.9	3.4	1.6	1.8	2.2
Uttar Pradesh	-1.7	-4.5	-3.6	-1.7	-3.1	-2.9	0.0	1.4	0.7
Rajasthan	-3.2	-2.6	-1.1	-4.0	-1.2	-0.7	-0.8	1.4	0.4
Maharashtra	5.1	3.6	3.3	10.8	3.3	6.2	5.7	-0.3	2.9
Karnataka	5.5	6.5	5.3	1.4	12.1	7.0	-4.1	5.6	1.7
Andhra Pradesh	2.5	11.5	7.9	8.1	14.0	12.7	5.6	2.5	4.8
India	-0.7	-0.8	-0.5	0.1	0.4	0.7	0.8	1.2	1.2

Source: Estimated from Government of India data.

The largest decline in gram area was noticed in the case of Uttar Pradesh (-3.6 per cent per annum) followed by Rajasthan, where irrigation facilities have increased in the recent period. The farmers here shifted to wheat, which yielded relatively higher profit per unit of land in irrigated regions. In rainfed areas of Uttar Pradesh and Rajasthan, mustard replaced gram. This could be due to low growth of gram yield in these states. But, productivity growth could not compensate for area decline and hence, production declined at a high rate of 2.9 per cent and 0.7 per cent per annum during the study period. The drop in gram production was relatively higher in the nineties for Uttar Pradesh and in the eighties for Rajasthan.

On the other hand, gainer states of Andhra Pradesh, Karnataka, Maharashtra, Madhya Pradesh have exhibited a significant expansion in the area under gram. It was as high as 7.9 per cent in Andhra Pradesh and 5.3 per cent per annum in Karnataka during the study period. The clear-cut shift of production base from traditional to new southern states was noticed. The gram area in the southern states became almost equal to northern states. Since, yield performance was also commendable in these states, production grew at the rate of 12.7 per cent in Andhra Pradesh, 7 per cent in Karnataka, 6.2 per cent in Maharashtra and 3.4 per cent per annum in Madhya Pradesh during the reference period. The higher rate of gram production in Andhra Pradesh may be attributed to high productivity coupled with favourable prices, good monsoon and availability of improved variety of seeds and efficient extension services. In fact, gram's competitive edge has weakened in the northern states due to shift towards more profitable crops like wheat in the irrigated areas and mustard in unirrigated areas. Moreover, this period faced only three unfavourable monsoon years in the late eighties and one in 2001-02. This partially explains the good performance in production. In addition, there are evidences to show (NSSO Report, 451) that pulse growers in Andhra Pradesh are using improved seeds for pulse cultivation and adoption rate is as high as 70.96 per cent against an all India average of 47 per cent during 1999. The tendency of increasing area under gram in rainfed areas of these states may likely to continue due to availability of short duration varieties of gram with better adaptation in rainfed areas and efficient extension services available to the farmers.

Arhar

Arhar rank second amongst the pulse crops of India. It is a long duration crop. It is sown in July with first rains of the monsoon and ripens about March. But, now short duration varieties are available with lower maturity periods. At times, it is grown as a mixed crop with jowar, bajra and groundnut. This practice not only offers insurance against the crop failure but also enables the cultivator to obtain a variety of harvests from the same piece of land. The information on area, production, yield and irrigated area of arhar in important states of India in TE 2001-02 is presented in Table 3. It may be noticed that arhar was grown on 3493 thousand hectares of area in India. The crop is more extensively cultivated in states of Maharashtra (30.10 per cent), Karnataka (14.9 per cent), Andhra Pradesh (13.02 per cent) and Uttar Pradesh (11.67 per cent). Their shares in all India production were 31.68 per cent, 11.60 per cent, 7.74 per cent and 20.69 per cent respectively during triennium ending 2001-02. The state of Maharashtra is leading by showing little less than one-third of all India area and production. The yield rate for the country as a whole was 693 kgs./ha. Bihar was leading in productivity with an yield of 1257 kgs/ha. Among the major producing states, Uttar Pradesh was far ahead in productivity than Maharashtra, Karnataka and Andhra Pradesh. The proportion of irrigated area to cropped area was however, only 4.2 per cent. This indicates poor status of arhar in receiving irrigation. The highest proportion of irrigated area was observed in Uttar Pradesh and Gujarat against a low share in Bihar (0.3 per cent of cropped area).

TABLE 3. AREA, PRODUCTION, YIELD AND IRRIGATED AREA OF ARHAR IN IMPORTANT STATES IN INDIA (TE 2001-02)

(Area in '000 ha; Production in '000 tonnes; Yield in kgs/ha)

	Area		Production		Yield		Per cent of irrigated area
State (1)	2001-02 (2)	Per cent share (3)	2001-02 (4)	Per cent share (5)	2001-02 (6)	Rank (7)	2000-01 (8)
Madhya Pradesh	1051.3	30.1	766.5	31.7	729	4	1.8
Uttar Pradesh	407.6	11.7	500.6	20.7	1228	2	12.8
Karnataka	523.0	14.9	280.7	11.6	537	7	1.3
Madhya Pradesh	330.9	9.5	272.1	11.3	822	3	0.8
Gujarat	336.0	9.6	195.0	8.1	580	5	12.2
Andhra Pradesh	454.9	13.02	187.3	7.7	412	9	0.8
Orissa	142.3	4.1	74.3	3.1	522	8	0.6
Bihar	42.5	1.2	53.4	2.2	1257	1	0.3
Tamil Nadu	70.9	2.03	48.5	2.0	684	6	3.1
India*	3493.3	100.0	2419.1	100.0	693	-	4.2

Source: Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, New Delhi, 2004.

*Includes minor producing states.

Having looked into the geographical spread of area and production, we proceed to examine the state-wise growth performance of area, production and yield of arhar between 1980-81 and 2001-02. It may be observed from Table 4 that growth of arhar area in the country during the study period was 0.8 per cent per annum. The first period was the major contributor but area declined at the rate of 0.3 per cent per annum during the second period. The gainer states included Andhra Pradesh (2.9 per cent), Maharashtra (2.5 per cent), Orissa (1.8 per cent), Karnataka (1.2 per cent) and Gujarat (1 per cent). However, states of Madhya Pradesh (2.2 per cent) and Bihar (1 per cent) were found to be losers in terms of area during the study period. The states, which have gained in area, also exhibited positive growth rates in production. Andhra Pradesh and Rajasthan have gained more in terms of area during the study period. The states, which have gained in area, also exhibited positive growth rates in production. Andhra Pradesh and Rajasthan have gained more in terms of production due to yield improvement. The rate of increase in production was observed to be lower in the nineties as compared to the eighties. The state with significant growth rate in yield is Andhra Pradesh (3.2 per cent). The performance of all other states was found dismal. Thus, growth of arhar production was merely 0.3 per cent per annum and that too due to area expansion at the rate of 0.8 per cent per annum between 1980-81 and 2001-02. The contribution of yield was found negative. It implies that farmers are either not adopting improved seeds or their success rate is low.

TABLE 4. GROWTH PERFORMANCE OF ARHAR IN IMPORTANT STATES OF INDIA (1981-2002)

(per cent per annum)

State	Area			Production			Yield		
	1981-91	1991-2002	1981-2002	1981-91	1991-2002	1981-2002	1981-91	1991-2002	1981-2002
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Maharashtra	4.0	0.3	2.5	4.2	5.1	3.1	0.2	4.8	0.6
Uttar Pradesh	-0.7	-2.4	-1.0	-1.2	-1.5	-1.9	-0.5	0.9	-0.9
Karnataka	3.6	1.9	1.2	1.8	6.8	1.5	-1.8	4.9	0.3
Madhya Pradesh	-1.0	-1.5	-2.2	2.2	-2.0	-1.9	3.3	-0.5	0.3
Gujarat	2.5	-1.8	1.0	1.2	-5.0	0.6	-1.3	-3.2	-0.4
Andhra Pradesh	4.7	3.6	2.9	4.0	8.0	6.1	-0.7	4.4	3.2
Orissa	6.1	-1.0	1.8	10.0	-6.8	0.2	3.9	-5.8	-1.6
Bihar	-4.0	-2.6	-1.0	-0.9	-0.5	-2.1	3.1	2.1	-1.1
Tamil Nadu	6.8	-5.0	-0.4	8.3	-3.5	- 0.2	1.5	1.5	0.2
India	2.3	-0.3	0.8	2.2	0.3	0.3	-0.1	0.6	-0.5

Source: Estimated from Government of India data.

Moong

Moong is fairly important as a pulse crop in India as it contributes 13.30 per cent in area and 8.30 per cent in production of total pulses at the country level. It is mainly cultivated as *kharif* season crop in Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu and Uttar Pradesh. But, in states of Andhra Pradesh, Bihar, Orissa, Tamil Nadu and Uttar Pradesh, it is also grown in *rabi* season as a second crop after paddy. In 1997-98, moong occupied 2372 thousand hectares in *kharif* season producing nearly 617 thousand tonnes of beans whereas during the *rabi* season only 617 thousand hectares were under this crop giving 245 thousand tonnes of production. It is also grown as a summer crop in states of Punjab and Haryana. Summer crop is generally sown in March and is harvested in June before the monsoon sets in, thus making the land available for the next paddy crop. The information on state-wise area, production and yield of moong in triennium ending 2001-02 is presented in Table 5.

TABLE 5. AREA, PRODUCTION AND YIELD OF MOONG IN IMPORTANT STATES IN INDIA (TE 2001-02)

(Area in '000 ha; Production in '000 tonnes; Yield in kgs/ha)

State (1)	Area 2001-2002 (2)	Area Per cent share (3)	Production 2001-2002 (4)	Production Per cent share (5)	Yield 2001-2002 (6)	Yield Rank (7)
Maharashtra	703.7	23.3	285.0	26.5	405	4
Andhra Pradesh	485.0	16.1	183.0	16.9	377	5
Karnataka	367.3	12.2	126.0	11.7	343	6
Rajasthan	525.0	17.4	109.0	10.1	208	10
Bihar	187.0	6.2	107.7	10.0	576	1
Tamil Nadu	141.3	4.7	63.7	5.9	450	3
Gujarat	142.0	4.7	48.0	4.5	338	7
Uttar Pradesh	100.0	3.3	47.7	4.4	477	2
Orissa	184.0	6.1	40.0	3.7	217	9
Madhya Pradesh	107.7	3.6	32.0	2.9	297	8
India*	3015.0	100.0	1077.0	100.0	357	-

Source: Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, New Delhi, 2004.

*Includes minor producing states.

The all India area under moong was 3015 thousand hectares in TE 2001-02. Maharashtra (23.3 per cent), Rajasthan (17.4 per cent), Andhra Pradesh (16.1 per cent) and Karnataka (12.2 per cent) together cropped around 70 per cent of all India area. Besides, it is grown in Bihar, Orissa, Gujarat, Tamil Nadu and Uttar Pradesh as well. The states of Maharashtra and Andhra Pradesh contributed more than 40 per cent of total production of the country. Surprisingly, Rajasthan and Karnataka had higher shares in area but due to dismal performance in the yield, their proportion in production declined. Specifically, the share of Rajasthan declined by almost 7 per cent. The yield of moong was observed to be as low as 357 kgs/ha in TE 2001-02. It could be partly due to drought conditions in 2001-02 and partly due to low yield in normal years too. It is not possible to analyse irrigation status due to non-availability of data on this aspect.

TABLE 6. GROWTH PERFORMANCE OF MOONG IN IMPORTANT STATES OF INDIA (1981-2002)

(per cent per annum)

State (1)	Area 1981-91 (2)	Area 1991-2002 (3)	Area 1981-2002 (4)	Production 1981-91 (5)	Production 1991-2002 (6)	Production 1981-2002 (7)	Yield 1981-91 (8)	Yield 1991-2002 (9)	Yield 1981-2002 (10)
Maharashtra	4.8	-1.0	1.9	11.6	-0.6	4.3	6.8	0.4	2.4
Andhra Pradesh	-2.0	-0.6	-0.9	-4.5	-0.4	-0.8	-2.5	0.2	0.1
Karnataka	5.9	3.0	3.4	8.6	-1.1	2.6	2.7	-4.1	-0.8
Rajasthan	2.5	4.6	5.9	4.1	1.6	8.4	1.6	-3.0	2.5
Bihar	3.9	-1.2	0.4	7.3	-1.0	2.2	3.4	0.2	1.8
Tamil Nadu	5.9	0.1	0.9	10.1	1.3	4.1	4.2	1.2	3.2
Gujarat	-2.1	-0.2	2.5	-14.2	0.3	2.2	-12.1	0.5	-0.3
Uttar Pradesh	-2.2	0.2	-2.2	-2.0	-0.3	-0.6	0.2	-0.5	1.6
Orissa	0.0	-9.2	-6.9	-1.4	-16.6	-12.9	-1.4	-7.4	-6.0
Madhya Pradesh	- 4.1	-3.5	-4.3	-3.2	-3.4	-3.3	0.9	0.1	1.0
India	2.1	-0.7	0.2	2.8	-2.3	-0.2	0.7	-1.6	-0.4

Source: Estimated from Government of India data.

The growth rates in area, production and yield of moong for India and important growing states between 1980-81 and 2001-02 are shown in Table 6. The data indicate that the all India area grew at the low rate of 0.2 per cent per annum during this period. The first period indicated a positive growth of 2.1 per cent while it was observed to be negative in the second period. At the state level, Rajasthan (5.9 per cent) followed by Karnataka (3.4 per cent) and Gujarat (2.5 per cent) were the major gainers while Orissa (6.9 per cent), Madhya Pradesh (4.3 per cent) and Uttar Pradesh (2.2 per cent) were the major losers in moong area during the study period. Surprisingly, production of moong in India has declined at the rate of 0.2 per cent per annum during the study period, particularly production performance was found to be poor in the second period with a negative growth rate of 2.3 per cent per annum. The performance of Rajasthan (8.4 per cent) followed by Maharashtra (4.3 per cent) and Tamil Nadu (4.1 per cent) was commendable. But, these gains could not compensate for the losses in major states.

Like arhar, productivity has been the greatest casualty in the case of moong, which declined at the rate of 0.4 per cent per annum during the reference period. Although, it grew at the rate of 0.7 per cent in the eighties, the dismal performance of the nineties with a negative growth rate of 1.6 per cent became responsible for the overall decline in the growth of production. To conclude, growth performance of moong during the past two decades had been extremely poor because neither area nor yield favoured this crop.

Urad

Urad, like moong is primarily a warm season crop. It is also grown both in *kharif* and *rabi* seasons. It is a *kharif* season crop in Andhra Pradesh, Bihar, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. But, some of these states like Andhra Pradesh, Tamil Nadu, Uttar Pradesh and West Bengal along with Assam cultivate urad in the *rabi* season too. The crop is mainly grown for its beans, which are used as a whole or split. The geographical distribution of area and production along with yield in TE 2001-02 is presented in Table 7. It may be observed that urad was grown on 3069 thousand hectares in India. The leading states in area allocation are Maharashtra (18.9 per cent), Madhya Pradesh (17.9 per cent), Andhra Pradesh (17.8 per cent) and Uttar Pradesh (12.3 per cent). Besides, it is also cultivated in Tamil Nadu (9.3 per cent), Karnataka (4.8 per cent), Rajasthan (4.5 per cent), Gujarat (4.4 per cent) and Orissa (4.0 per cent). Andhra Pradesh with 26 per cent share in all India production is the leading state. Maharashtra, Madhya Pradesh and Uttar Pradesh together grew around 42 per cent. The yield level of urad was found extremely low at all India level (446 kgs/ha.). The highest yield of 687 kgs/ha was reported in Bihar. It is depressing to note that states of Gujarat, Karnataka, Madhya Pradesh, Orissa and Rajasthan have exhibited yield of urad between three to four qtls per hectare.

TABLE 7. AREA, PRODUCTION AND YIELD OF URAD IN IMPORTANT STATES IN INDIA (TE 2001-02)

(Area in '000 ha; Production in '000 tonnes; Yield in kgs/ha)

State	Area		Production		Yield	
	2001-2002	Per cent share	2001-2002	Per cent share	2001-2002	Rank
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra Pradesh	545.7	17.8	355.7	26.0	652	2
Maharashtra	580.0	19.0	248.3	18.1	428	6
Madhya Pradesh	548.3	17.8	165.0	12.0	301	11
Uttar Pradesh	378.7	12.3	162.7	11.9	430	5
Tamil Nadu	286.0	9.3	128.3	9.4	449	4
Karnataka	146.3	4.8	52.7	3.8	360	8
Bihar	71.3	2.3	49.0	3.6	687	1
West Bengal	72.3	2.4	45.7	3.3	631	3
Orissa	123.3	4.0	46.0	3.4	373	7
Rajasthan	138.3	4.5	44.3	3.2	320	9
Gujarat	135.7	4.4	42.3	3.1	312	10
India*	3069.0	100.0	1370.0	100.0	446	-

Source: Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, New Delhi, 2004.

*Includes minor producing states.

The estimates of growth rates of area, production and yield of urad in all India and major growing states indicate (Table 8) that area under urad remained almost stagnant (0.2 per cent per annum) during the study period. The period of eighties was favourable indicating a growth rate of 2.4 per cent per annum but the negative growth (0.7 per cent) in the nineties was responsible for overall stagnation in area. The major states with positive growth in area were Karnataka (5.8 per cent), Andhra Pradesh (4.8 per cent) and Uttar Pradesh (3.7 per cent). The states which indicated negative growth in area constituted Orissa (-7.8 per cent), Bihar (-2.7 per cent) and West Bengal (-2.3 per cent). Despite stagnation in area, production of urad grew at the rate of 1.3 per cent per annum during the reference period. The major contributors were Karnataka (6.7 per cent), Uttar Pradesh (6.5 per cent), Andhra Pradesh (4.8 per cent), Maharashtra (4.1 per cent) and Tamil Nadu (3.9 per cent). It could happen due

TABLE 8. GROWTH PERFORMANCE OF URAD IN IMPORTANT STATES OF INDIA (1981-2002)

(per cent per annum)

State	Area			Production			Yield		
	1981-91	1991-02	1981-02	1981-91	1991-02	1981-02	1981-91	1991-02	1981-02
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Andhra Pradesh	10.5	0.0	4.8	16.5	0.3	4.8	6.0	0.3	0.0
Maharashtra	-1.2	3.2	1.1	5.2	3.0	4.1	6.4	-0.2	3.0
Madhya Pradesh	-1.8	-0.9	-2.2	-0.8	-0.1	-0.6	1.0	0.8	1.6
Uttar Pradesh	3.5	3.1	3.7	6.6	3.0	6.5	3.1	-0.1	2.8
Tamil Nadu	9.7	-1.1	0.9	14.8	-0.9	3.9	5.1	0.2	3.0
Karnataka	6.2	3.7	5.8	6.1	2.1	6.7	-0.1	-1.6	0.9
Bihar	-2.5	-2.4	-2.7	0.7	0.4	-0.6	3.2	2.8	2.1
West Bengal	0.4	-6.1	-2.3	2.5	-5.9	-1.1	2.1	0.2	1.2
Orissa	2.9	-11.2	-7.8	2.3	-15.2	-11.2	-0.6	-4.0	-3.4
Rajasthan	-0.7	-0.5	0.1	-3.6	0.0	0.6	-2.9	0.6	0.5
Gujarat	N.A.	0.7	N.A.	N.A.	1.6	N.A.	N.A.	0.9	N.A.
India	2.4	-0.7	0.2	5.8	-1.1	1.3	3.4	-0.4	1.1

Source: Estimated from Government of India data. N.A. not available.

to good performance of area in the first three cases and of yield in the remaining two cases. The growth of yield in India was 3.4 per cent per annum in the eighties, but growth rate of yield in the entire study period was merely 1.1 per cent per annum due to negative growth of yield (0.4 per cent) in the nineties. Among the high yield performers, Maharashtra and Tamil Nadu are the most important. On the contrary, yield of urad in Orissa declined at the rate of 3.4 per cent per annum during the study period.

Massar

Massar is recognised as a valuable pulse crop. It is known to be the most nutritive of the pulses due to high protein content. It is grown as a winter crop and the sowing time extends from October to December. Since it is a short duration crop, it becomes ready for harvest in about three months. The crop is harvested from February to April depending upon the time of sowing.

The information of area, production and yield of massar presented in Table 9 shows that massar grew on 1413 thousand hectares and gave a production of 1134.7 thousand tonnes in India during TE 2001-02. Uttar Pradesh with 42.4 per cent of all India area and 40.89 per cent of production is the key state. Next in the array are Madhya Pradesh (33.64 per cent) and Bihar (12.5 per cent) which produced around 20.1 per cent and 13.0 per cent of country’s total massar. Rajasthan is a minor player in massar cultivation but its yield was as high as 1309 kg/ha during the triennium ending 2001-02. The productivity in Uttar Pradesh was less than 10 qtls per hectare. Amazingly, Madhya Pradesh, a second ranking state in area and production has exhibited a low productivity of 479 kgs/ha. It may be highlighted that yield of massar was observed to be the second highest among the major pulse crops of India.

TABLE 9. AREA, PRODUCTION AND YIELD OF MASSAR IN IMPORTANT STATES IN INDIA (TE 2001-02)

(Area in ’000 ha; Production in ’000 tonnes; Yield in kg/ha)

State	Area		Production		Yield	
	2001-2002	Per cent share	2001-2002	Per cent share	2001-2002	Rank
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Uttar Pradesh	598.7	42.4	464.0	40.9	775	4
Madhya Pradesh	475.3	33.6	227.7	20.1	479	5
Bihar	177.3	12.6	147.3	13.0	831	3
West Bengal	53.7	3.8	57.7	5.1	1057	2
Rajasthan	27.0	1.9	35.3	3.1	1309	1
India*	1413.0	100.0	1134.7	100.0	803	-

Source: Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, New Delhi, 2004.

*Includes minor producing states.

Massar has exhibited best growth performance among the referred pulses by recording around two per cent growth in area and yield during the study period. The acreage under massar grew at the rate of 1.8 per cent per year during this period but production has increased at more than double pace, i.e., 4 per cent per annum. It could happen due to commendable performance of yield (2.2 per cent per annum). For expansion of area, the nineties was a favourable period but for yield growth the period of eighties were far more important. Among major growing states, Uttar Pradesh has indicated area growth of around 2.6 per cent per annum during the study period. However, it was higher than 5 per cent during the eighties. Yield also increased at the rate of 3.4 per cent per annum in this period. As a result, production of massar in Uttar Pradesh increased at the rate of 9 per cent per year in the eighties. The area expansion along with yield was responsible for production growth in Madhya Pradesh, Uttar Pradesh and Rajasthan.

Thus, massar emerges as the most important pulse crop in terms of growth during the study period.

Total Pulses

Table 10 provides state-wise information on area, production and yield of pulse crops taken as a whole. Pulses were grown on around 21 million hectares of area and produced nearly 13 million tonnes of grain in TE 2001-02. It is clear that while pulses are widely grown in the country, some states are far more important than others as producers of these protein rich foods. Madhya Pradesh, Uttar Pradesh, Maharashtra and Rajasthan are the most important pulse producing states in that order and accounted together for nearly 66 per cent of their total production in the country (See Table 11). Andhra Pradesh and Karnataka come next, contributing over 14 per cent of the total production. The yield levels across the states show that yield of pulses in India is much below the potential yield of 10-15 qtls/ha. This is true of areas, which are rainfed as well as irrigated. The all India yield of pulses in TE 2001-02 was 597 kgs/ha however, it was above average in Uttar Pradesh (883 kgs/ha), Bihar (845 kgs/ha) and Madhya Pradesh (737 kgs/ha). Pulses can be further popularised in these areas in lean seasons so that these crops could become part of a crop rotation without disturbing the existing major crops. It is feasible because pulses are known for low water requirement and adaptability over a wide range of agro-climatic conditions. It would enhance income of the farmers by utilising the available land in the lean periods and increase sustainability in agriculture. It would make a significant contribution to total production of pulses and also help to evolve a sustainable cropping pattern particularly in northern states with paddy, wheat rotation.

TABLE 10. GROWTH PERFORMANCE OF MASSAR IN IMPORTANT STATES OF INDIA (1981-2002)

(per cent per annum)

	Area			Production			Yield		
State (1)	1981-91 (2)	1991-2002 (3)	1981-2002 (4)	1981-91 (5)	1991-2002 (6)	1981-2002 (7)	1981-91 (8)	1991-2002 (9)	1981-2002 (10)
Uttar Pradesh	5.6	1.3	2.6	9.0	1.3	4.1	3.4	0.0	1.5
Madhya Pradesh	1.4	3.5	3.3	4.0	3.3	4.3	2.6	-0.2	1.0
Bihar	0.7	-0.1	0.2	2.9	0.0	1.4	2.2	0.1	1.2
West Bengal	-0.3	-2.7	-3.4	7.0	2.4	0.5	7.3	5.1	3.9
Rajasthan	-5.0	9.5	2.9	-2.0	13.0	5.5	3.0	3.5	2.6
India	1.7	2.1	1.8	5.8	3.8	4.0	4.1	1.7	2.2

Source: Estimated from Government of India data.

TABLE 11. AREA, PRODUCTION, AND YIELD OF TOTAL PULSES IN IMPORTANT STATES OF INDIA (TE 2001-02)

(Area in '000 ha; Production in '000 tonnes; Yield in kgs/ha)

	Area		Production		Yield	
State	2001-02	Per cent share	2001-02	Per cent share	2001-02	Rank
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Madhya Pradesh	4106.7	19.5	3025.3	24.1	737	4
Uttar Pradesh	2712.0	12.9	2395.3	19.7	883	1
Maharashtra	3514.0	16.7	1908.0	15.2	543	9
Rajasthan	2735.0	13.0	1016.3	8.1	372	14
Andhra Pradesh	1819.0	8.7	996.3	7.9	548	8
Karnataka	1953.7	9.3	853.7	6.8	437	11
Bihar	762.3	3.6	644.3	5.1	845	2
Gujarat	688.3	3.3	325.3	2.6	473	10
Tamil Nadu	742.3	3.5	324.7	2.6	437	12
Orissa	672.3	3.2	251.3	2.0	374	13
India*	21040.0	100.0	12561.7	100.0	597	

Source: Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, New Delhi, 2004. *Includes minor producing states.

TABLE 12. GROWTH PERFORMANCE OF URAD IN IMPORTANT STATES OF INDIA (1981-2002)

(per cent per annum)

	Area			Production			Yield		
State	1981-91	1991-2002	1981-2002	1981-91	1991-2002	1981-2002	1981-91	1991-2002	1981-2002
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Madhya Pradesh	-0.1	-1.7	-0.4	2.4	0.0	1.8	2.5	1.7	2.2
Uttar Pradesh	0.3	-0.9	-0.4	0.7	-1.1	-0.3	0.4	-0.2	0.1
Maharashtra	2.1	0.8	1.4	6.2	3.0	3.6	4.1	2.2	2.2
Rajasthan	-2.1	-0.9	0.0	-1.8	-0.8	0.4	0.3	0.1	0.4
Andhra Pradesh	1.2	1.2	1.2	5.1	3.1	3.2	3.9	1.9	2.0
Karnataka	1.4	1.9	1.1	0.5	3.5	2.1	-0.9	1.6	1.0
Bihar	-1.1	-3.8	-2.7	0.6	-2.6	-1.3	1.7	1.2	1.4
Gujarat	2.5	-2.6	0.9	2.7	-4.7	1.2	0.2	-2.1	0.3
Tamil Nadu	5.3	-1.3	0.2	10.0	-0.9	1.8	4.7	0.4	1.6
Orissa	1.4	-7.9	-5.7	2.2	-12.3	-8.1	0.8	-4.4	-2.4
West Bengal	-3.9	-1.3	-3.5	-1.4	0.2	-1.9	2.5	1.5	1.6
Haryana	-3.8	-10.6	-6.5	1.3	-11.8	-4.1	5.1	-1.2	2.4
Punjab	-7.7	-6.9	-7.5	-4.7	-8.3	-6.8	3.0	-1.4	0.7
India	0.2	-0.9	-0.3	1.9	-0.3	0.7	1.7	0.6	1.0

Source: Estimated from Government of India data.

Over the study period, from 1980-81 to 2001-02, production of pulses in India has registered a slow growth rate of 0.7 per cent per annum (Table 12). The states of Maharashtra and Andhra Pradesh have shown more than 3 per cent per year growth in pulse production. In addition, Karnataka, Tamil Nadu and Madhya Pradesh recorded around 2 per cent growth in the same period. On the other hand, Orissa and Bihar have exhibited negative growth in pulse production. If we consider two sub-periods, our conclusions change. The period of eighties with 1.9 per cent growth in pulse production in India appeared to be much better than the nineties with negative growth of –0.3 per cent per annum. The state-wise changes in production of pulses in the sub-periods show that the rates of growth of total pulse production in the eighties were more than one per cent in six states out of the ten major states. But, in the nineties, this number has been reduced to three only.

The differential growth rates in the pulse production have brought some important changes in the locational pattern of pulse production in the country. The higher growth of production in states of Maharashtra, Andhra Pradesh, Karnataka and Madhya Pradesh in the nineties implies that growth centres of pulse production shifted to the southern states. In most of these states, acceleration of production was primarily due to yield improvement specially, states like Maharashtra, Andhra Pradesh and Karnataka exhibited a yield growth of 2 per cent per annum in the study period. The area expansion in these states was also around one per cent per year. Thus, whatever little growth has been achieved in pulse production came mainly from yield growth. The contribution of yield growth to production growth was higher in the eighties. However, yield growth itself was low. The yield growth of total pulses between 1980-81 and 2001-02 was merely one per cent per annum. Agricultural scientists believe that yield of pulses can be easily raised to above 10 qtls/ha. in rainfed areas. Therefore, efforts should be made to raise yield levels by popularising available improved technology for pulse cultivation through implementation of pragmatic policies.

III

ACREAGE RESPONSE OF PULSE CROPS

The foregoing analysis revealed that growth of pulse production in India has been extremely poor between 1980-81 and 2001-02. The production of pulses like other agricultural commodities is primarily determined by acreage. Therefore, it would be worthwhile to investigate the factors influencing acreage. We have used area response model based on the Nerlovian framework for this purpose (Nerlove, 1958).

Various price and non-price factors influence the farmers' decisions regarding land allocation to various crops. The first segment includes input and output prices. These range from last year's harvest price of the crop, availability of minimum support price, last year's harvest price of the competing crop to prices of fertiliser, power, seed, water, insecticides and availability of credit. Similarly, a host of non-price factors also play an important role. The major factors are last year's acreage and yield, availability of improved seeds and irrigation, rainfall, facility of procurement by government agencies, resistance of crop to pest attacks, extension services, home consumption, availability of alternate crops, credit and assured market (Tuteja, 1999; 2000). Unfortunately, crop-specific information on all these variables is lacking and therefore, even tabular analysis is not possible. Owing to this difficulty, the findings of acreage response models are based on a few variables for which data are available. Thus, factors affecting pulse acreage are numerous and their contribution is generally estimated through an acreage response model. Existing literature on the nature of acreage response to price and non-price factors in case of pulse crops is mixed. Some studies have concluded that there is a positive acreage response to changes in the prices of pulses while others have observed a reverse phenomenon. However, most of the researchers held the view that the non-price factors are more important than the price factors in explaining the acreage response behaviour of the farmers (Chopra and Swamy, 1975; Chopra, 1982; Deshpande and Chandrashekar, 1982; Acharya, 1988; Sadasivam, 1993; Dhindsa and Sharma, 1997).

Most of these studies cover a period up to early nineties but policy scenario has dramatically changed after gradual liberalisation of agriculture. Secondly, most of the studies confine to gram, arhar and total pulses while moong, urad and massar also play an important role in the pace of growth. Moreover, the nature of acreage response differs from crop to crop and region to region.

This emphasises the need for regional studies on the acreage response of different pulse crops. Keeping this in mind, the responsiveness of price and non-price factors in area allocation by farmers under gram, arhar, moong, urad, massar and total pulses in the states which covered between 80-90 per cent of production of these crops is estimated through a modified Nerlovian supply response function. The empirical knowledge of acreage response of pulses will be useful for rational formulation of policies in bringing a breakthrough in the production of pulses.

For the model, required time series data on acreage, yield, farm harvest price and pre-sowing rainfall were collected from secondary sources like *Area and Production of Principal Crops*, *Agricultural Statistics at a Glance*, *Farm Harvest Prices in India and Agricultural Prices in India* for the period 1980-81 to 2000-01. Rainfall data were obtained from Statistical Abstract, India published by Central Statistical Organisation, Ministry of Statistics and Programme Implementation, Government of India, New Delhi. When farm harvest price for the crop was not available, wholesale price of the main market in the state for harvesting month was used as a proxy. The relative word refers to competing crop, which can be grown on the same piece of land. For *rabi* pulses such as gram and massar, wheat in irrigated areas and mustard in rainfed areas are considered as competing crops. Mustard is used particularly, due to higher share of gram area under rainfed conditions. In case of *kharif* pulses such as arhar, moong and urad, competing crops are jowar and bajra but jowar is preferred because of its importance as a competing crop in the major growing states. To examine the acreage response of different pulse crops during the current year, pulse acreage has been regressed on lagged acreage, lagged relative price, lagged relative yield, price risk, yield risk, and pre-sowing rainfall in the leading states in terms of production of gram, arhar, moong, urad, massar and total pulses. One-year lag is used in acreage, yield and price assuming that the current year acreage, yield and price generally influence the decision about area allocation in the next year. Besides, use of lagged independent explanatory variables in the Nerlovian model addresses the problems of time trend to a large extent. Consequently, this problem by and large does not affect the results. Using Nerlovian adjustment lag model as a basic framework, the reduced form of equation for the acreage response function for pulses is specified as follows.

$$A_t = a + b_1 A_{t-1} + b_2 R P_{t-1} + b_3 R Y_{t-1} + b_4 P R + b_5 Y R + b_6 R F_t + u_t$$

Where

A_t – Area in hectares under the crop,
A_{t-1} – Area in hectares under the crop in the year t-1,
RP_{t-1} – Relative price in year t-1,
RY_{t-1} – Relative yield in the year t-1,
PR_y – Price risk measured in terms of standard deviation of past three years,
YR_y – Yield risk measured in terms of standard deviation of past three years,
RF_t – Pre-sowing rainfall (mm) in the year t.

The empirical results on the extent of responsiveness of price and non-price factors in area allocation under gram, arhar, moong, urad, massar and total pulses for all India and major growing states are summarised in Table 13. Apparently, elasticities of lagged acreage, lagged relative price, lagged relative yield, price risk and pre-sowing rainfall vary significantly across the individual pulses in different milieu. However, some uniformity in the acreage response behaviour of farmers growing *rabi* pulses as well as *kharif* pulses may be noticed.

The impact of previous year's acreage was found most pronounced on area allocation under gram at the national level and in important growing states. Its elasticities are positive and significant in six out of seven cases. The highest coefficient of lagged acreage was estimated for Maharashtra (0.77) and the lowest for Rajasthan (0.13). Another factor affecting area under gram appears to be lagged relative price. Its elasticity is weak but significant at the country level. Similarly, farmers in major growing states seemed to be responsive to price factor except Uttar Pradesh where it turned out to be insignificant. The highest coefficient of lagged relative price was estimated in Andhra Pradesh (0.23) followed by Maharashtra (0.19) where growth performance of gram was commendable during the study period. This result implies that gram growers are responding to commercial stimuli in some locations and at the aggregate level. Further, elasticity of pre-sowing rainfed, though insignificant at the country level, showed its impact on acreage allocation to gram in Madhya Pradesh, Rajasthan and Maharashtra where gram is mostly grown under rainfed conditions. The coefficient of rainfall was negative and significant in these states. The responsiveness of RY, PR and YR is found poor and insignificant in most of the cited cases except for Andhra Pradesh where these factors seemed to be influencing gram acreage. The impact of yield risk was found significant in Uttar Pradesh too. This implies that farmers in these states consider yield risk as one of the factors in land allocation under gram. The most appropriate function was obtained for Uttar Pradesh, which explained 85 per cent variation in the area allocation to gram.

TABLE 13 RESULTS OF NERLOVIAN MODEL ON ACREAGE RESPONSE OF GRAM, ARHAR, MOONG, URAD, MASSAR AND TOTAL PULSES IN IMPORTANT GROWING STATES OF INDIA

State (1)	Intercept (2)	$Area_{t-1}$ (3)	RP_{t-1} (4)	Ry_{t-1} (5)	Price Risk (6)	Yield Risk (7)	Pre-sowing Rainfall (8)	Ad. Coeff (9)	$\bar{R}^2$ (10)
				GRAM					
Madhya Pradesh	6.18	0.49	0.06	0.04	0.03	0.07	-0.10	0.51	0.64
		(2.32)*	(2.96)*	(0.46)	(1.13)	(0.76)	(-1.73)**		
Uttar Pradesh	-1.34	0.73	0.03	-0.01	-0.02	-0.04	-0.09	0.27	0.85
		(8.25)*	(1.90)**	(-0.15)	(-1.25)	(-1.76)**	(-1.33)		
Rajasthan	14.04	0.13	0.09	0.13	0.03	-0.02	-0.46	0.87	0.33
		(0.39)	(1.40)	(0.27)	(0.24)	(-0.12)	(-1.79)**		
Maharashtra	0.41	0.77	0.19	-0.17	0.01	0.02	-0.21	0.23	0.49
		(3.15)*	(1.73)**	(-0.82)	(0.31)	(0.14)	(1.90)**		
Karnataka	1.51	0.50	0.17	-0.01	0.01	0.03	0.22	0.50	0.65
		(3.11)*	(2.87)*	(-0.02)	(0.25)	(0.41)	(0.52)		
Andhra Pradesh	1.77	0.47	0.23	0.43	-0.12	0.17	0.11	0.53	0.84
		(2.62)*	(3.47)*	(2.60)*	(-1.73)**	(1.84)**	(0.25)		
All India	11.36	0.64	0.06	0.05	-0.03	-0.04	-0.24	0.36	0.41
		(1.91)**	(1.81)**	(0.28)	(-0.88)	(-0.96)	(-0.97)		
				ARHAR					
Maharashtra	0.24	0.94	0.10	0.04	-0.01	0.01	-0.22	0.06	0.93
		(8.35)*	(1.81)**	(1.15)	(-0.72)	(0.13)	(1.74)**		
Uttar Pradesh	1.91	0.63	0.01	0.07	-0.01	-0.01	-0.09	0.37	0.29
		(2.05)**	(0.01)	(0.81)	(-0.42)	(-0.22)	(-1.82)**		
Karnataka	3.27	0.58	0.14	0.03	-0.03	0.01	-0.16	0.42	0.37
		(2.46)*	(0.76)	(0.34)	(-0.79)	(0.20)	(1.48)		
Madhya Pradesh	5.68	0.21	0.06	0.46	-0.07	-0.05	-0.12	0.79	0.40
		(1.82)**	(0.28)	(2.17)*	(-0.34)	(-0.59)	(-1.73)**		
Gujarat	1.35	0.55	0.05	0.07	0.02	-0.02	-0.25	0.45	0.50
		(2.65)*	(0.39)	(0.74)	(0.91)	(-0.03)	(1.91)**		
Andhra Pradesh	0.36	0.84	0.12	-0.02	-0.01	0.01	0.90	0.16	0.55
		(4.05)*	(0.62)	(-0.19)	(-0.33)	(0.26)	(0.34)		
All India	2.77	0.60	0.11	-0.02	-0.01	0.00	-0.08	0.40	0.60
		(3.12)*	(0.81)	(-0.46)	(-0.64)	(0.04)	(-1.96)**		
				MOONG					
Maharashtra	0.20	0.66	0.01	-0.03	0.03	0.01	-0.39	0.34	0.79
		(4.03)*	(0.07)	(-0.54)	(0.86)	(0.34)	(-2.14)*		
Andhra Pradesh	1.82	0.67	-0.08	-0.01	0.01	-0.01	0.07	0.33	0.40
		(3.19)*	(-0.71)	(-0.18)	(0.14)	(-0.24)	(0.44)		
Karnataka	4.53	0.71	0.19	-0.02	-0.03	0.12	-0.81	0.29	0.29
		(2.72)*	(0.96)	(-0.15)	(-0.31)	(0.97)	(-1.80)**		
Rajasthan	-0.06	0.85	0.23	-0.09	-0.03	0.12	-0.04	0.15	0.78
		(6.65)*	(1.87)**	(-0.96)	(-0.36)	(2.68)*	(-1.88)**		
Bihar	0.56	0.70	0.04	0.02	-0.01	0.03	0.19	0.30	0.76
		(4.01)*	(0.50)	(0.31)	(-0.35)	(0.93)	(1.92)**		
Tamil Nadu	4.94	0.66	-0.27	-0.08	-0.05	-9.23	-0.11	0.34	0.38
		(1.87)**	(-0.83)	(-0.33)	(0.63)	(-0.00)	(-1.74)**		
All India	4.58	0.49	0.12	0.05	0.02	-0.01	-0.14	0.51	0.37
		(2.13)*	(1.14)	(0.49)	(0.70)	(-0.05)	(-1.81)**		

(Contd.)

TABLE 13. (*Concld.*)

State (1)	Intercept (2)	$Area_{t-1}$ (3)	RP_{t-1} (4)	Ry_{t-1} (5)	Price Risk (6)	Yield Risk (7)	Pre-sowing Rainfall (8)	Ad. Coeff. (9)	$\bar{R}^2$ (10)
				URAD					
Andhra Pradesh	1.66	0.87	0.11	0.12	0.02	-0.01	-0.14	0.13	0.92
		(8.45)*	(1.10)	(1.65)	(0.63)	(-1.22)	(2.15)*		
Maharashtra	2.70	0.6	-0.03	-0.04	0.00	0.01	-0.08	0.37	0.28
		(2.36)*	(-0.31)	(-0.43)	(0.14)	(0.19)	(-1.80)**		
Madhya Pradesh	1.20	0.93	-0.05	0.16	-0.02	-0.02	-0.09	0.07	0.91
		(9.83)*	(-1.12)	(1.73)**	(-0.95)	(-1.08)	(-0.70)		
Uttar Pradesh	3.08	0.74	0.01	0.42	-0.01	-0.01	-0.27	0.26	0.82
		(4.73)	(0.01)	(2.17)	(-0.22)	(-0.04)	(-1.00)		
Tamil Nadu	0.20	0.63	-0.03	0.03	-0.10	-0.14	0.64	0.37	0.40
		(3.00)*	(-0.13)	(0.12)	(-1.39)	(-0.96)	(1.83)**		
Karnataka	0.02	0.89	-0.07	-0.04	0.04	0.09	0.07	0.11	0.96
		(4.80)*	(-0.76)	(-0.88)	(1.45)	(3.14)*	(0.39)		
All India	3.39	0.64	0.02	0.18	-0.02	0.00	-0.09	0.36	0.53
		(3.78)*	(0.46)	(2.23)*	(-1.05)	(-0.11)	(-2.10)*		
				MASSAR					
Uttar Pradesh	2.34	0.84	0.07	0.28	-0.05	0.04	-0.26	0.16	0.51
		(4.03)*	(1.82)**	(1.39)	(-1.21)	(0.76)	(-1.15)		
Madhya Pradesh	0.59	0.73	0.08	-0.16	-0.01	-0.06	-0.13	0.27	0.96
		(8.51)*	(2.62)*	(-1.99)**	(-0.63)	(-1.51)	(-1.88)**		
Bihar	2.29	0.57	0.01	0.07	-0.02	0.01	-0.02	0.43	0.23
		(2.37)*	(0.07)	(1.07)	(-1.11)	(0.56)	(-0.17)		
West Bengal	3.53	0.72	-0.14	0.24	-0.07	0.02	-0.42	0.28	0.64
		(4.25)*	(-0.83)	(1.45)	(-1.25)	(0.55)	(-1.13)		
Rajasthan	0.69	0.78	0.24	-0.66	0.02	0.28	-0.35	0.22	0.61
		(2.71)*	(0.59)	(-1.33)	(0.18)	(1.30)	(-0.47)		
All India	1.89	0.77	0.09	-0.02	-0.01	0.01	-0.03	0.23	0.43
		(3.39)*	(1.90)**	(-0.17)	(-0.29)	(0.17)	(-0.14)		
				TOTAL PULSES					
Madhya Pradesh	7.24	0.53	0.01	-0.01	-0.01	0.04	-0.17	0.47	0.56
		(2.84)*	(0.07)	(-0.02)	(-0.30)	(1.43)	(-1.83)**		
Uttar Pradesh	6.15	0.49	0.04	-0.05	-0.03	0.00	-0.07	0.51	0.45
		(2.03)*	(1.14)	(-0.26)	(-1.33)	(-0.37)	(-0.36)		
Maharashtra	8.06	0.42	0.11	0.06	0.06	-0.06	-0.23	0.58	0.73
		(1.76)**	(1.81)**	(0.67)	(1.02)	(0.67)	(-2.28)*		
Rajasthan	12.91	0.38	0.15	0.16	-0.03	-0.23	-0.63	0.62	0.47
		(1.41)	(0.88)	(0.48)	(-0.38)	(-2.21)*	(-2.21)*		
Andhra Pradesh	4.14	0.39	0.11	-0.01	0.00	-0.05	-0.01	0.61	0.81
		(1.97)**	(3.99)*	(-0.14)	(0.34)	(-3.61)**	(-0.01)		
Bihar	1.41	0.78	0.05	0.11	0.01	0.02	-0.19	0.32	0.51
		(2.15)*	(0.91)	(0.72)	(0.30)	(0.17)	(-1.73)**		
Karnataka	7.65	0.37	0.05	-0.09	0.02	0.05	-0.28	0.63	0.52
		(1.83)**	(1.98)	(-0.58)	(0.63)	(0.88)	(-1.47)		
All India	15.82	0.52	0.05	0.10	-0.02	-0.03	-0.13	0.48	0.46
		(1.90)**	(0.47)	(1.55)	(-1.65)	(-0.92)**	(-1.82)**		

Figures in parentheses indicate t-values, * and ** indicate level of significance below 5 per cent and 10 per cent level of probability.

Adjustment coefficient.

An examination of the estimated elasticities of six included variables in the acreage response model of arhar at the all India and state level indicate that coefficient of lagged acreage was positive, high and significant in all the analysed cases. Its magnitude was found to be the highest in Maharashtra (0.94) and the lowest in Madhya Pradesh (0.21). The low and insignificant acreage response of lagged relative price in most of the states reveals weak responsiveness of price factor. But it was significant at 10 per cent level in Maharashtra. On the other hand, the influence of pre-sowing rainfall was negative and significant at the all India level and in four major states. Its elasticity was the maximum in Gujarat. The low and insignificant coefficients of RY, PR and YR imply that farmers do not attach any importance to these variables in decision-making about area allocation to arhar. But, the impact of relative yield was significant in Madhya Pradesh. The included explanatory variables explained the highest variance in Maharashtra (0.93). The overall findings of the model reveal dominance of non-price factors over price factor in acreage allocation to arhar in major growing states and at the all India level.

The results of the acreage response model for other *kharif* pulses, i.e., moong and urad were on the similar lines. Like arhar, the most important factor influencing acreage of these crops was lagged acreage. Its elasticities were significant in all the cases. The elasticities of relative price were found to be low and insignificant. However, it was positive and significant in Rajasthan. On the other hand, pre-sowing rainfall has shown its impact on area at the all India level and in majority of the referred states. The relative yield showed its impact on area allocation under urad in Madhya Pradesh, Uttar Pradesh and at the all India level. The PR and YR in the analysed states did not play any role in acreage decisions of the farmers related to moong and urad cultivation. But, coefficient of yield risk was significant in Rajasthan for moong and in Karnataka for urad. The overall results clearly show that growers of these crops do not respond to commercial incentives. The value of R^2 ranged between 0.28 to 0.96. This suggests that model was a good fit in some cases while it could partially explain variations in other cases due to dominance of other factors in acreage decisions of the farmers. The estimates of elasticities of explanatory variables for massar appear to be somewhat consistent with the results obtained for gram. The responsiveness of area was skewed towards lagged area followed by lagged relative price at the all India level. But, at the state level, price factor was found to be significant in two states (Uttar Pradesh and Madhya Pradesh) out of five referred states. The impact of relative yield was significant in Madhya Pradesh. Generally, the influence of relative yield, price risk, yield risk and pre-sowing rainfall on area allocation was found insignificant. The pre-sowing rainfall showed significant impact on area allocation to massar in Madhya Pradesh.

An analysis of the estimated elasticities of selected variables for total pulses at the all India and state level reveals that the responsiveness of lagged acreage was positive, high and significant in all the cases except Rajasthan. The magnitude of coefficient above 0.40 is indicative of moderate to high responsiveness of cropped area in the previous year. The influence of lagged relative price, despite being low was found significant in the states of Karnataka, Andhra Pradesh and Maharashtra where growth performance of total pulses was observed to be creditable. The factors like RY, PR and YR do not seem to be contributing to acreage allocation under total pulses. The pre-sowing rainfall appeared to be impacting area allocation decisions of the farmers in majority of the analysed cases. But, influence varied from region to region. For instance, its elasticity was estimated to be 0.63 in Rajasthan against 0.10 in Andhra Pradesh. Its impact was negative and significant at the all India level. This result merits notice because increase in rainfall reduces area under pulse crops because traditional varieties of these crops give low yield and profitability in comparison to superior cereals. It may be noticed that the acreage response of total pulses is lower than some of the individual pulses primarily because the magnitude of elasticity depends on the extent to which farmers would increase acreage and other inputs and their possibility in individual cases in high.

The Nerlovian coefficient of adjustment provides information about the speed of adjustment of acreage to changing levels of the explanatory variables in the supply response equation. In the case of pulses, this coefficient ranged from a low of 0.06 to a high of 0.87. However, around 60 per cent cases indicate the magnitude of adjustment below 0.40. This implies that farmers are adjusting their area under the cultivation of pulses at a slow rate with changing levels of institutional and technological factors. To sum up, lagged acreage and lagged relative price appeared to be most important determinants of area allocation under *rabi* pulses, while lagged acreage and pre-sowing rainfall were found most crucial in the case of *kharif* pulses. The overall findings of acreage response model suggest that non-price factors still influence the area of pulse crops more than price factor like the sixties and seventies. But, commercial incentives have started showing their impact in some locations for gram, massar and total pulses.

IV

SUMMARY AND CONCLUSIONS

The all India pulse production grew at the dismal rate of 0.7 per cent per annum between 1980-81 to 2001-02. The growth in area was found almost stagnant whereas yield increased at a slow rate of around 1 per cent. The growth pattern of pulse production varied widely across the major growing states. It exceeded 3 per cent per year in Maharashtra and Andhra Pradesh. The states of Karnataka, Madhya Pradesh and Tamil Nadu also recorded an annual growth rate of 2 per cent in pulse production. The growth in production occurred due to area and yield in three states but yield was the major contributor in Tamil Nadu and Madhya Pradesh. The pre-economic reforms period with 1.9 per cent per annum growth in pulse production in India was far better than the post-reforms period with negative growth of 0.3 per cent per annum. The tendency of slow growth in the production visible for total pulses at the all India level was also observed for individual pulse crops except massar. It emerged as the fastest growing crop in production due to area as well as yield growth.

The empirical results on the extent of responsiveness of price and non-price factors to acreage of gram, arhar, moong, urad, massar and total pulses in India and major growing states varied widely in different milieu. The results revealed that acreage allocation in *rabi* pulses, i.e., gram and massar got influenced by lagged acreage followed by relative price in most of the analysed cases. This judgment, however, does not apply to *kharif* pulses. In allocating land to arhar, moong and urad, farmers considered lagged acreage and magnitude of pre-sowing rainfall as the most important factors.

Given the international scenario and ground realities of pulse production in India, it would be prudent to plan on the premise that a good part of the anticipated demand in future may have to be met through domestic production and the rest can be imported. There is a need to address the structural issues that stymie growth of pulse production. The pulse growers face challenges on yield, marketing and prices. The real need is to increase yield through wider adoption of technology. This is possible by making critical inputs available, accessible and affordable. But, transfer of technology can be impeded by unfavourable price regime. Hence, a favourable price support to pulse growers is the utmost need to incentivise farmers in the adoption of technology.

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