CHAPTER IX
SUMMARY AND CONCLUSIONS

This chapter presents the main findings of this study and the policy implications for improving pulse production in India. The study is a departure from earlier literature in the sense that it provides an overall perspective ranging from growth performance to international competitiveness of major pulse crops grown in the country. The main focus of this research has been on mapping the diverse and complex factors, which play an important role in the growth of pulse production. At the outset, it would be useful to present a brief summary of objectives, data and methodology to provide a backdrop of issues related to pulse development in India.

Objectives

Stagnation in the pulse production is a serious problem in India and there is an urgent need to find its solution. For this purpose, it would be essential to examine the key determinants of pulse production in India. This study therefore has been undertaken with the following objectives in mind:

(i) to examine the growth performance of important pulse crops in terms of area, production and yield during the reference period at the all India and state levels;

(ii) to measure the magnitude of instability in area, production and yield of important pulse crops;

(iii) to estimate the contribution of price and non-price factors in determining acreage and yield of selected pulse crops in the core states;
(iv) to analyse district level status of pulse production in major growing states.

(v) to examine the impact of price on production of pulse crops.

(vi) to study the adoption of technology for pulse crops at the state and farm size levels;

(vii) to examine the domestic competitiveness of pulse crops vis-à-vis competing crops; and

(viii) to examine the international competitiveness of the Indian pulses;

Research Methodology

This study is based on secondary data collected from the Government publications, international publications and field based research studies. The important data sources included—Area and Production of Principal Crops in India, Agricultural Press in India, Farm Harvest Prices in India, Agricultural Statistics at a Glance, Reports of the Commission for Agricultural Costs and Prices, Foreign Trade Statistics, Economic Surveys, Bulletin on Food Statistics, Plan documents, Trade and Production Year Books of Food and Agriculture Organization. The analysis is confined to five major pulse crops (gram, arhar, moong, urad and massar), which cover around 85 per cent of pulse production in India. The study has covered a period of two decades beginning from 1980-81 to 2001-02. The entire period is divided into two sub-periods, which represent the pre (1980-81 to 1990-91) and post reforms period (1990-91 to 2001-02). The cut off point of 1990-91 has strategic significance too as pulse crops were included in the Technology Mission during this year. Besides, the process of economic reforms was also initiated during this year.

The methodology used in the analysis of set objectives differs for each part of the study depending on the availability of data and suitability
of statistical technique in facilitating the discussion. The growth of area, production and yield of individual and total pulses in major growing states during the study period was estimated by using semi-log functions while instability indices were based on log variance method. Further, identification of factors influencing the acreage of individual pulse crops in major states has been based on the modified Nerlovian model of distributed lags. The current year acreage was regressed on lagged year acreage, lagged year relative farm harvest price, lagged year relative yield, pre-sowing rainfall, yield risk and price risk. Besides, yield response function was estimated for gram in Madhya Pradesh, by including expenditure on seed and fertilizer in addition to rainfall as independent variables. The adoption of technology influences yield rates but it could not be included in the model due to non availability of data on pulse area covered by improved seeds. This exercise could not be undertaken for remaining four pulse crops for the same reason.

The district wise status of pulse production was examined in all the states, which contributed between 80 to 90 per cent to the total production in the country. Each district accounting for at least 1 per cent to the production of individual pulses in the selected states was included. The inter district variations in area, production and yield of gram, arhar, moong, urad, massar and total pulses were examined for latest available period. The coefficients of variation of included variables were estimated. In addition, influence of rainfall and lagged farm harvest price on area allocation and of rainfall on yield was estimated through regression equations. The main reason for including limited number of independent variables was non-availability of district level data.

Theoretically, price is one of the most important factors affecting production. In the Nerlovian model, relative price was used as one of the independent variables. In addition, production response of pulse prices was separately estimated by measuring elasticities of acreage and yield, which were clubbed together to arrive at the output response. The price
indices used in the regression equations were lagged farm harvest price or whole sale price indices deflated by input price indices. This was purposively done because farmers are also sensitive to input prices. In order to understand the underlying analytics of the price behaviour of pulses in India, trend, variability, inter-year changes and seasonality aspects were also incorporated in the analysis. The adoption of technology assumes special significance in improving production of agricultural commodities. The analysis of this aspect included a review of policies ensued by the Government for promotion and transfer of technology, yield gap between actual and potential yield, use of technology enhancing inputs in major states and by farm size. Further, relationship among the factors influencing adoption of technology was ascertained through a regression model which included percentage of pulse area under improved seeds as dependent variable and percentage of GCA under pulse crops, percentage of irrigated area, percentage of pulse area fertilized, manured and covered by pesticides and tractor use as independent variables. Farmers' experiences in terms of benefits of improved technology and their suggestions to popularize technology in pulse cultivation are added. Besides, prices and technology, the competitiveness of pulse crops is considered an important factor affecting pulse production in the country. The domestic competitiveness of important pulses was judged on the basis of relative profitability of competing crops in major producing states for the early eighties, early nineties and recent period. The profitability per hectare was worked out at the operational cost as well as at the fixed cost. Among the multiple factors, which are important for boosting pulse production, international competitiveness seems to be significant in liberalized and globalised scenario. It was estimated for five considered pulses in terms of conventional (Nominal Protection Coefficients (NPCs), Effective Protection Coefficients (EPCs) and Effective Subsidy Coefficients, (ESCs) as well as alternate indices (Domestic Resource Cost Ratios (DRCRs). The analysis
also incorporated important aspects related to pulse trade in India and in the world.

Main Findings

Pulses have been a weak component in the food grains production mix of India. They covered an area of 18 per cent of all food grains and contributed only 8 per cent to production in 1980-81, which declined to 6 per cent in 2002-03. This was the outcome of extremely low productivity of pulse crops. The ratio of pulse yield to food grains yield dropped from 0.84 in 1950-51 to 0.33 in 2002-03. Consequently, share of pulse production in total food grains production has witnessed a declining trend. These developments worsened the position of pulses in total food grains scenario of India.

Growth Performance of Pulses

The all India pulse production grew at the dismal rate of 0.7 per cent per annum between 1980-81 and 2001-02. The growth in area was found almost stagnant whereas yield increased at a slow rate of 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 around 2 per cent per annum growth in pulse production. In three states, growth in production resulted from increase in area and yield while in Tamil Nadu and Madhya Pradesh, yield was the major contributor.

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 positive growth of 0.6 per cent in yield could not compensate for a negative growth of 0.9 per cent in area. The pattern of lower growth in pulse production
during the nineties in comparison to eighties was visible in the states of Madhya Pradesh, Maharashtra, Andhra Pradesh, Gujarat, Orissa, Haryana and Tamil Nadu. But, Karnataka, Andhra Pradesh and Maharashtra registered more than 3 per cent growth in pulse production between 1990-91 and 2000-01. The achievements of Tamil Nadu, Maharashtra and Andhra Pradesh with a phenomenal growth rate of 10, 6.2 and 5.1 per cent per annum in the eighties are worth emulating. Growth in pulse production in these states was largely due to area expansion and increase in yield. But, states like Punjab, Haryana showed a decline in pulse production. Therefore, overall production performance of total pulses deteriorated in India during the nineties despite inclusion of pulses in the Technology Mission since 1990-91. The pulse yield at the all India level was 597 kgs/ha which was much below the global level. This segment needs strengthening in view of the declining per capita availability of pulses from over 70 gms per day in the mid fifties to less than 30 gms per day in the recent period.

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. Gram, the most important crop in pulses, registered an increase of less than 1 per cent per year during the past two decades despite negative growth in area. However, it recorded a phenomenal increase of around 13 per cent per year in Andhra Pradesh due to exceptionally higher growth in area and around 5 per cent growth in yield. Karnataka followed by Maharashtra and Madhya Pradesh are the other states exhibiting this trend in production. In the first three, area expansion outsmarted yield growth while yield played a key role in Madhya Pradesh. The growth of gram production in Andhra Pradesh and Karnataka was higher in the nineties while reverse happened in Madhya Pradesh and Maharashtra. At the all India level, first as well as second period showed insignificant growth in gram production.
The production performance of arhar was found poorer than gram. It grew at the marginal rate of 0.3 per cent per annum at the all India level between 1980-81 and 2001-02. This miniscule growth came from area expansion. Yield emerged as the great casualty by showing a negative growth. However, some of the major growing states performed well. For instance, arhar production in Andhra Pradesh grew at the rate of 6.1 per cent per annum and yield contributed more than area. In other faster growing states of Haryana, Rajasthan and Maharashtra, area was primarily responsible for acceleration except Rajasthan where yield was the sole factor. When production performance is examined in the two sub-periods, eighties appeared to be far better than nineties. However, nineties were observed to be exceptionally impressive for the states of Andhra Pradesh, Rajasthan, Karnataka and Maharashtra where yield happened to be the major contributor in the growth of production.

The case of moong was the worst among all the individual pulse crops because its production declined at the rate of 0.2 per cent per annum during the study period at the aggregate level. Neither area expansion nor yield helped in arresting this declining trend. However, moong production in Rajasthan registered an increase of 8.4 per cent per year during this period. Other states with high growth in production were Tamil Nadu and Maharashtra. In Rajasthan, area contributed more than yield while in Maharashtra and Tamil Nadu, yield played an important role in boosting production. Moreover, period of eighties appeared to be much better than nineties in the leading states as well as in India. It is appreciable, that moong production in Maharashtra, Tamil Nadu and Karnataka grew at the phenomenal rate of 11.6, 10.1 and 8.6 per cent per annum during the eighties.

The production of urad increased at the rate of 1.3 per cent in India between 1980-81 and 2001-02 due to yield improvement. The period of eighties exhibited an exceptional growth of 5.8 per cent per annum, which occurred due to yield improvement and area expansion. Among the major
growing states, Karnataka (6.7 per cent) and Uttar Pradesh (6.5 per cent) were most successful but growth in first came from area expansion whereas in the second case, both area and yield were found important. Andhra Pradesh, Maharashtra and Tamil Nadu were other states with more than 3 per cent growth in the production of urad during the reference period.

The production performance of masar has been most impressive during the study period. Its production increased at the rate of 4 per cent per year against a growth rate of 0.7 per cent for total pulses. This success is the outcome of positive growth in area as well as in yield. The states of Rajasthan, Uttar Pradesh and Madhya Pradesh have shown commendable results by indicating 5.5, 4.1 and 4.3 per cent per annum growth in the production of masar during the reference period.

The pattern of growth in case of rabi and kharif pulses was different during the study period. They have almost same share in the total area under pulses at the country level but rabi pulses outsmarted kharif pulses and contributed 64 per cent to total pulse production. Further, kharif pulses have their base in states of Maharashtra, Rajasthan, Karnataka and Madhya Pradesh where yield rates are extremely low. The high yield rates in Uttar Pradesh and Bihar indicate the potential, which can be realized in other states too. Rabi pulses are also primarily grown in rainfed areas of Madhya Pradesh and Uttar Pradesh. The productivity of rabi pulses was 896 kgs./ha. in Uttar Pradesh against 789 kgs./ha. in Madhya Pradesh. However, production of kharif as well as rabi pulses grew at the marginal rate of 0.6 and 0.9 per cent per annum during the past two decades. The first period was important in terms of growth while second period was gloomy due to negative growth in production of kharif pulses and low growth in production of rabi pulses.

One notable feature of pulse production in the country worth mentioning is that growth in production of kharif pulses has been less than that of rabi pulses which grew at the rate of 0.9 per cent per annum in the
study period despite declining trend in area. It was primarily achieved due to yield improvement. The period wise growth rates indicated that production performance of rabi pulses in the eighties was better than the nineties. In kharif pulses too, a moderate production growth of 3 per cent per year was noticed in the pre-reforms period. The production performance of rabi and kharif pulses during the past two decades reveals that neither area nor yield has been effective in pushing production over the past two decades.

The common belief that production performance of pulses is poor due to low growth in area and yield was fully confirmed for total pulses at the all India level. But, state level findings partially support this hypothesis as Andhra Pradesh and Maharashtra exhibited above three per cent and Karnataka followed by Madhya Pradesh and Tamil Nadu around two per cent growth in pulse production due to area expansion, yield improvement or both during the study period. The aforesaid hypothesis for gram, arhar, moong and urad was substantiated but it was rejected for massar at the country level because massar exhibited 4 per cent growth in production resulting from 1.8 per cent and 2.2 per cent per annum growth in area and yield during the reference period. It was also rejected for gram in Madhya Pradesh, Maharashtra, Andhra Pradesh and Karnataka; for arhar in Maharashtra and Andhra Pradesh; for moong in Maharashtra and Rajasthan; for urad in Maharashtra, Uttar Pradesh, Tamil Nadu and Karnataka and for massar in Uttar Pradesh, Madhya Pradesh and Rajasthan.

Instability in Pulse Production

The instability indices of area, production and yield of individual and total pulses at the state and all India level were found diverse. The following important conclusions emerged from the analysis. First, the production of total pulses showed uncertainty level of 12.81 per cent. The role of yield
instability was higher than that of area instability. Moreover, it was higher in nineties than eighties. This implies that economic reforms and policies pursued for the improvement of pulse production under the Technology Mission on Oil seeds and Pulses (TMOP) did not help in reducing the uncertainty in the pulse production of India. Second, degree of instability in the production of individual pulses did not coincide with the overall pattern. The crops of urad and massar indicated lower instability in comparison to major crops like gram and arhar. The evidences of higher instability in yield are much more than area except for gram, which has shown reverse pattern. In 75 per cent of analysed cases, yield variability has been responsible for uncertainty in production. Third, range of instability in production of total pulses is quite wide across the states. It was estimated as high as around 96 per cent in Haryana. In contrast, it was found around 11 per cent in Uttar Pradesh due to very low index of area instability (3.89 per cent). Fourth, majority of the referred states have indicated pulse production instability above the all India level.

**District Level Status of Pulse Production**

The status of individual and total pulses is analysed in the major growing districts in important states of India for the latest available year.

The study revealed that variations in the presence of pulses among the districts show a mirror image of changes in area and production from one district to another district. The identification of important districts in the production of gram, arhar, moong, urad and massar in India highlighted that major producing districts of each pulse crop by and large showed regional concentration. For instance, top-producing districts of gram, arhar, moong and massar belonged to Rajasthan, Maharashtra and Uttar Pradesh. This tendency was found lower in case of urad as top producing districts were scattered in the states of Andhra Pradesh, Maharashtra and Tamil Nadu. The status of pulses in crop economy is largely determined
by the availability of water through irrigation or rainfall. If availability of water were high, farmers would prefer alternate profitable crops. Otherwise, they stick to cultivation of drought resistant crops like pulses. The low yield rates of pulses appeared to be serious constraint demanding urgent attention of the policy makers.

A corresponding analysis of top districts with highest productivity of pulses in the country revealed that most of these districts belonged to Uttar Pradesh, Tamil Nadu and Andhra Pradesh. The highest yield rates of gram, arhar, moong, urad, massar and total pulses were achieved in Prakasham, (1954 kgs/ha, Andhra Pradesh), Allahabad (2630 kgs/ha, Uttar Pradesh), Salem (889 kgs/ha, Tamil Nadu), Selam (872 kgs/ha, Tamil Nadu) and Birbhum (1026 kgs./ha, West Bengal), Karuli (1765 kgs/ha, Rajasthan). These results indicate the significant possibilities of harnessing yield potential in the country. The factors responsible for impressive yield levels achieved in these locations cannot be spelt out due to the absence of micro level studies; however, higher adoption of technology could be the main force behind attaining higher productivity. For replicating such fruitful experiences for boosting pulse production through increased yield rates in other districts, these should be treated, as model districts and research should be carried out in order to understand the factors behind the success.

The estimated coefficient of variations of area, production and yield of gram, arhar, moong, urad, massar and total pulses across the districts in major growing states indicated an extremely high variability in area and production. However, value of coefficient for yield was also estimated more than 20 per cent in large number of cases.

Adoption of Technology

Since the late sixties, a variety of programmes have been initiated to induce technological change in pulse production in the country with a view
to increasing productivity. But, their implementation over the two decades did not lead to any discernible impact on the slow growth of yield and production of pulses in India. The limited micro evidences attributed this to inadequate allocation of funds, late sanctions and poor network of extension services. The fact remains that past programmes including Technology Mission could not succeed in inducing widespread adoption of improved technology for pulse cultivation. Despite the diversities of policies adopted and the differences in the agro-climatic conditions in which programmes are implemented, three conclusions emerge with some clarity. First, policies do not automatically lead to technological breakthroughs. Further, it requires careful ancillary provisions in the form of inputs. Second, lack of interest on the part of farmers in the absence of proven benefits of technology made their adoption slow. Third, the country could not reap the benefits of these programmes in terms of increased pulse production along the lines expected by the policy makers.

A scrutiny of recent state-wise and farm size data on the use of improved seeds, fertilizer, manure, pesticides and tractor for pulse cultivation suggests that progress of adoption of improved technology in pulse farming has been uneven across different parts of the country. The states of Gujarat, Tamil Nadu, Andhra Pradesh and West Bengal have progressed better than rest of the country. But, major pulse growing states like Madhya Pradesh are lagging far behind. Unfortunately, in the progressive states like Punjab and Haryana, percentage of pulse area covered by improved seeds was lower than the national average. Thus, low adoption of technology emerges as a serious constraint despite its importance in increasing pulse production. Pulses are cultivated by all categories of farmers but small holders devoted higher proportion of GCA to pulse crops. This pattern was observed in Madhya Pradesh, Uttar Pradesh, Maharashtra and Andhra Pradesh except Rajasthan where variations across farm size were minimal. The pattern of pulse area under improved seeds was the reverse. The farm size and proportion of area
under improved seeds are found positively related. This relationship was clearly visible at the all India level. The difference in adoption rate between marginal and large farmers was as high as 26 per cent. It sounds logical because modern farming based largely on the use of improved seeds, chemical fertilizers and pesticides with assured supply of water for irrigation demands high investments, which small farmers cannot afford. This phenomenon observed at the all India level was found true for Madhya Pradesh and Rajasthan but rest of the three major pulse-producing states i.e. Uttar Pradesh, Maharashtra and Andhra Pradesh did not reflect it. The regression model was used to unravel association between percentage of pulse area under improved seeds and some of the important factors inducing technological change. It revealed strong influence of area irrigated and fertilization on the adoption of improved seeds.

The findings of micro level studies of Andhra Pradesh, Punjab and Haryana showed that improved varieties were slowly replacing the local varieties. In Andhra Pradesh, these varieties are spreading at a faster rate due to policy support in terms of favourable prices and technological change through availability of improved varieties. In Punjab, use of improved varieties for moong was found common but gram was found lagging behind. The proportion of pulse area under improved seeds and farm size are found positively related in Punjab as well as in Haryana. The extent of adoption of recommended package of practices by pulse growers was not found satisfactory. Sowing practices related to preparation of land, time and method were adopted by majority of the growers but seed practices, use of recommended doses of fertilizer, pesticides and weedicides were found deficient. The lower rung farmers were more particular in sowing practices but they missed in adopting practices related to fertilizer, pesticides and weedicides, which involved finance. In contrast, large farmers paid more attention to these practices. The main reasons advanced by the adopters for neglecting the recommended package of
practices were limited irrigation facilities at their disposal, high prices of fertilizer, pesticides, weedicides and uncertain yield of pulse crops.

Thus, the principal concern regarding technological change appears to be the poor adoption rate of improved seeds. It is further accentuated by less than recommended application of yield augmenting inputs. The micro-level studies highlight the experiences of producers regarding the factors hindering spread of full package of improved technology in pulse farming. The farmers rated lack of assured profitability as the most important factor in the adoption of technology, which requires investment in expensive inputs. The other constraints in popularizing technology reported by them included lack of information, inadequate availability of genuine improved seeds, pesticides, weedicides and insufficient extension support. Since, adoption of technology at the grass root level depends on these factors, they should be given top priority in policy.

The hypothesis that adoption of technology for pulse cultivation at the all India, state and farm size levels is slow due to low proportion of cropped area covered by improved seeds, fertilizer and pesticides is fully confirmed at the country level because less than half of the pulse area is covered by these inputs. But, some of the major pulse producing states showed more than 50 per cent of pulse area under improved seeds. This proportion was even higher for pulse area fertilized and tilled by tractor. The coverage of pesticides was extremely low in all the states. At the farm level, all categories of farmers except large farmers had sown less than 50 per cent of pulse area under improved seeds. The pulse area tilled by tractor was more than 50 per cent in marginal, medium and large farms. Thus, the aforesaid hypothesis was partially confirmed at the state as well as at the farm level.
Farm Size Variation

The macro variations in the area, production and yield of pulse crops arise due to differences at the farm size level, which play an important role in India, given the predominance of small and marginal farmers in number and of large farmers in area. Unfortunately, the all India evidences such as Agricultural Censuses, Input Surveys and Cultivation Practices in India did not give detailed information by farm size on pulse crops and neglected important aspects like productivity. However, these sources help in understanding the status of pulse farming across farm sizes over time. In 1980-81, percentage of GCA devoted to pulse crops was significant on all farm sizes. The irrigated and un-irrigated area differentials were found substantial. In the eighties and nineties, large farmers devoted higher percentage of GCA to pulses in comparison to small and marginal farmers. This phenomenon reversed in the recent period. Farmers especially those with fair amount of land have shown a declining preference to raise pulses due to emerging options in the form of alternative crops with higher yields and low risk. The percentage of GCA under pulses on large size farms declined in comparison to the eighties and nineties. On the other hand, small and marginal farmers who could not undertake risk by raising pulse crops on their tiny holdings have started devoting higher proportion of GCA in response to limited availability of improved seeds and remunerative prices.

The results of farm size evidence regarding proportion of GCA allocated to pulse crops from the two Indian states- Haryana and Madhya Pradesh, suggested that in advanced district of Ambala in Haryana, marginal and small farmers devoted higher proportion of GCA to pulse crops in comparison to large farmers. But, in the agriculturally backward and lesser-irrigated district of Bhiwani, large farmers allocated a very high share of GCA to pulse crops and they used improved seeds on 38.75 per cent of pulse area. In contrast, marginal farmers allocated 19.57 per cent
of GCA to pulse crops and applied improved seeds only on 4.44 per cent of pulse area during 1997-98.

In the leading pulse growing state of Madhya Pradesh, marginal farmers devoted more than 40 per cent of GCA to pulse crops in Durg, Jhabua and Narsingpur districts. Large farmers however, allocated less than 30 per cent of GCA in Jhabua and Narsingpur and more than 30 per cent in Durg district during 1996-97. Thus, a positive relationship between farm size and area allocated to pulse crops observed in irrigated areas was not confirmed in un-irrigated areas. The adoption rate of improved seeds was zero and 55.56 per cent of pulse area.

Determinants of Acreage and Yield

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 estimates of elasticities of lagged area, lagged relative price, lagged relative yield, price risk, yield risk and pre-sowing rainfall 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. It implies that farmers are significantly responsive to commercial stimuli in addition to non-price factors like lagged acreage. 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. The low and insignificant elasticity coefficient of relative price for kharif pulses in most of the referred states suggests dominance of non-price factors over price factors in area allocation to these crops. It appears quite logical because alternate options for kharif pulses are limited to coarse cereals, which are inferior to pulses in profitability.
The lagged relative yield, price risk and yield risk though theoretically important, turned out to be insignificant for rabi as well as kharif pulses in most of the analysed states. This suggests that farmers do not attach higher weightage to these factors in acreage allocation under pulses.

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 revealed 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.

The hypothesis related to the greater responsiveness of the non-price factors in comparison to relative price in acreage allocation to pulse crops was fully confirmed for the total pulses at the all India level. But, it was partially substantiated at the state level as relative prices affected area allocation in the states of Andhra Pradesh, Karnataka and Maharashtra. Among selected pulses, it was partially accepted for gram and massar since relative price influenced farmers' decisions in area allocation at the national level and in some of the analysed states. However, this hypothesis was by and large confirmed for kharif pulses barring the two states, namely Maharashtra and Rajasthan where relative prices were found significant in case of arhar and moong.

The results of the Cobb-Douglas yield function of gram in Madhya Pradesh indicated that seed was the most responsive input followed by rainfall during the past two decades. The response of fertilizer was not significant and this can be attributed to the fact that gram in Madhya Pradesh is generally grown under rainfed conditions whereas; response of fertilizer is higher under irrigated conditions. Thus, the belief regarding the influence of expenditure on seed, fertilizer and magnitude of rainfall on the
productivity of pulse crops was partially confirmed because fertilizer response was not found significant on the productivity of gram in Madhya Pradesh.

The results of acreage and yield functions of gram, arhar, moong, urad, massar and total pulses in major growing states based on district level data showed that farm harvest price and rainfall have explained low variance in the area allocation under these crops in the referred states. The best function was obtained for Gujarat which explained 59 per cent variations in the area allocation under total pulses.

The single factor used in the yield model was rainfall. It has shown strong, positive and significant impact on the yield of gram in Uttar Pradesh, Rajasthan and Karnataka; for arhar in Uttar Pradesh, Maharashtra and Karnataka; for massar in West Bengal and for total pulses in Rajasthan and Karnataka. The coefficient of rainfall was above one in six cases. The rainfall explained above 50 per cent variations in the yield of pulse crops in eleven cases out of thirty-four analysed cases. The overall results are on the expected lines because yield of pulses largely depends on water availability from rainfall in the absence of assured irrigation facilities.

The available district level data on price and non-price factors were limited to price and rainfall in case of gram and arhar while for minor pulses (moong, urad and massar) price data were not available. Therefore, the set hypothesis regarding the role of price and non-price factors in area allocation under pulse crops at the district level could not be fully tested. But, the limited results suggest that this hypothesis was rejected since price as well as rainfall did not show significant impact in majority of the analysed states. The findings regarding influence of rainfall on yield also did not fully substantiate the hypothesis because some of the analysed states did not show significant impact of rainfall on the yield of pulse crops.
Output Response of Pulse Prices

The findings emanating from the analysis of the behaviour of prices of pulses in the study period are summarized below.

All types of prices of selected pulse crops increased significantly during the study period but the rate of increase had been different for different pulses and also varied between different periods. The rise in the wholesale price and retail price was higher, as supply could not cope up with the demand due to growth of population and stagnant production of pulses in the country. Even, higher imports in recent years could not bring stability in price.

The semi-log equations successfully explained the price behaviour of pulses. The regression coefficients of time were found positive and significant in most of the cases. In addition, $R^2$ turned out to be more than 0.90 in majority of equations. It suggests that time is an important element in explaining variations in prices of pulses. The results of coefficient of variations of prices of pulses over the study period are indicative of very high variability, which increased more in the reforms period.

The year-to-year percentage change in prices of pulses was generally positive but negative changes were also observed in the wholesale, farm harvest and retail prices in the first as well as in the second sub-periods. The minimum support prices of individual pulses have been rising through out the study period but the rate of increase varied from year to year.

Seasonal price variations in wholesale price of pulses is a common phenomenon in the major markets of core states, However, coefficient of variation was found the highest for gram, arhar and massar in 2001. But, it was the maximum for moong and urad in 1981.

The overall price behaviour of pulses indicates preponderance of the demand factor over that of supply. Recently, imports have made some
impact by increasing supply, which appeared to have slowed down the growth in prices of pulses.

Output response of prices of pulses was found low at all India level but moderate and high in some of the major growing states. It was particularly high in Andhra Pradesh, Maharashtra, Karnataka, Tamil Nadu and Madhya Pradesh. But production could not increase to desired level because of low negative response in some other states. These results partially substantiate the hypothesis that pulse production is responsive to output/input prices. It is rejected at the all India level for gram, arhar, moong and total pulses but accepted for urad and massar. It is partially accepted at the state level in view of around 70 per cent positive and significant elasticity coefficients of output/input price found for the analysed pulse crops.

**Domestic Competitiveness of Pulse Crops**

The domestic competitiveness of gram, arhar, moong, urad and massar in terms of relative profitability was examined in the core states for the early eighties, early nineties and the recent period. The analysis of data revealed that profitability of gram vis-à-vis its competing crops namely, wheat and mustard has improved over the study period. Especially, domestic competitiveness of gram in Madhya Pradesh and Uttar Pradesh during the recent period could be well established because yield advantage of wheat is gradually getting off set by growing yield and higher per unit price of gram in states like Uttar Pradesh where it has emerged as the faster growing crop in terms of profitability than the alternate crops.

The analysis of gross returns, costs and net returns per hectare of arhar and its competing crops (bajra and jowar) in Madhya Pradesh and Uttar Pradesh during the referred three points of time has established the superiority of arhar over the alternate crops. The profitability of arhar in
Madhya Pradesh has risen from Rs. 1806 per hectare in 1981-82 to Rs. 6055 in 1999-00 at the operational cost. The similar increase was noticed in Uttar Pradesh as well.

The estimates of profitability of moong and its two competing crops (jowar and bajra) in Andhra Pradesh, Maharashtra and Madhya Pradesh in the early eighties, early nineties and recent period provided mixed results. It was competitive in Andhra Pradesh and Madhya Pradesh barring Maharashtra where jowar was most profitable during the early eighties. The scenario did not change in the early nineties as well rather it became non-competitive in Andhra Pradesh and Maharashtra both. However, the recent estimates of profitability of moong vis-à-vis its competing crops in Andhra Pradesh and Maharashtra were observed to be favourable for moong.

An examination of domestic competitiveness of urad in Andhra Pradesh and Madhya Pradesh showed positive results, as the crop was found profitable over jowar in the early eighties, nineties and in the recent period.

The findings of massar on relative profitability in Uttar Pradesh and Madhya Pradesh during the recent period did not establish the superiority of this crop over its three competing crops gram, wheat and mustard in Uttar Pradesh but results were better for Madhya Pradesh where it was found profitable over gram and wheat.

A gradual increase in the proportion of expenditure on technology enhancing inputs (seed, fertilizer, pesticides and irrigation) in the operational cost was noticed for gram, arhar, moong and urad in all the analysed states.

The results emerging from testing of the set hypotheses are as follows The first hypothesis that domestic competitiveness of pulse crops is low was fully valid for gram in Madhya Pradesh, Uttar Pradesh and Rajasthan for the early 1980s but partially acceptable for the early 1990s and the recent period. It happened because gram’s performance in
Central India (in states like Madhya Pradesh and Uttar Pradesh) appeared to be improved because higher prices and rising yield of gram has more than offset the comparative yield differentials. The hypothesis is fully discarded for arhar in all the analysed states at the referred three points of time. Since, results for moong are mixed in the early 1980s and 1990s, this hypothesis is partially accepted but fully rejected for the recent period. The same hypothesis is fully discarded for urad except one case that was of Madhya Pradesh in the early 1990s when urad was not found competitive to jowar. The same hypothesis for massar in the latest period was accepted for Uttar Pradesh but partially rejected for Madhya Pradesh. The hypothesis relating to gradual increase in the share of technology enhancing inputs (seed, fertilizer, pesticides and irrigation) in the operational cost is supported to a large extent for gram, arhar, moong and urad for all the analyzed states. The hypothesis about the increasing share of machine labour and decreasing shares of human and animal labour is fully accepted for selected pulse crops in all the analyzed states.

International Competitiveness of Indian Pulses

The overall perspective of the international competitiveness of pulses was examined by including trade related issues like status of India in global pulse production, international trade in pulses, major destinations of pulse exports and imports and recent changes in trade policy. The major findings are as under.

Pulses occupied 68.32 million hectares of area and contributed 57.51 million tonnes to the world food basket during 2000. India has been the largest producer of pulses in the world accounting for 37.27 per cent of area and 25.51 per cent of global production in triennium ending 1981. These shares dropped to 31.54 per cent and 23.84 per cent in triennium ending 2001. On the other hand, shares of Canada, France, Australia and Mynamar in global pulse production improved over the past two decades.
The yield growth is primarily responsible for their success. The leading country is France, which produced 4559 kgs/ha against 610 kgs/ha by India during the triennium ending year 2001.

International trade in pulses constituted 12.46 per cent of global production during 2002. The major exporting countries included Canada, Mynamar, Australia, France and China with corresponding shares of 16.27 per cent, 12.67 per cent, 12.24 per cent, 11.35 per cent and 9.90 per cent respectively in the world exports of pulses. India’s share is marginal (1.74 per cent) despite being the leading producer of pulses. This is basically due to stagnation in pulse production and higher domestic demand, which converted India into the biggest importer of pulses in the world. Its share was as high as around 25 per cent during 2002. The other importing countries comprised Pakistan, Egypt, USA, Belgium, Spain, China and Netherlands.

India exports as well as imports a large variety of pulses. Massar among the exports and pea among the imports accounted for the largest share. A significant variation was noticed in the unit value of the Indian exports and imports of pulses. The export prices were higher than the import prices in all individual cases. This may be attributed to yield advantage, which reduced cost in major exporting countries. In addition, high export subsidies might have also played an important role. Therefore, countries like France can afford to sell pulses at the low prices. Second, India grows a large variety of pulses. Most of the importing countries buy for non-resident Indian population settled in these countries. India has an added advantage because some of the pulses are grown only in India due to agro-climatic diversity.

India exports pulses to several countries. The leading importers included USA, UK, UAE, Iraq, Kuwait, Saudi Arabia, Sri Lanka and Bangladesh. On the other hand, India imports pulses in huge quantity from Mynamar, Canada, Tanzania, Iran, Australia and France. Mynamar accounting for 55.41 per cent share has been the single largest exporter of
gram to India. Similarly, Iran with its two fifth share in total Indian imports of gram dal happened to be the largest exporter.

The international competitiveness of the Indian pulses judged on the basis of conventional indices such as Nominal Protection Coefficients (NPCs), Effective Protection Coefficients (EPCs) and Effective Subsidy Coefficients (ESCs) revealed that export competitiveness of the Indian pulses is high while import competitiveness is low. The overall strength of international competitiveness the Indian pulses has improved between 1981 and 2000.

A further examination of the international competitiveness of the Indian pulses on the basis of Domestic Resource Cost Ratios (DRCRs) highlighted that these are import competitive and therefore, country should go ahead in enhancing domestic pulse production.

India had followed protective trade policies for pulse trade before the initiation of economic reforms in 1991. The trade of these items was regulated through quantitative restrictions, canalization, licenses, quotas and high tariff rates. But, now it is almost liberalized. The quantitative restrictions on imports are removed since April 2000. The rate of custom duty as on 1.3.2003 for pulses other than pea was 10 per cent but the bound duty rate as on 1.1.2003 was 104 per cent. This was an effort to provide some protection to pulse growers despite huge imports.

It was hypothesized that the international competitiveness of the Indian pulses is low in terms of conventional as well as alternate indices. The findings of this study show that the Indian pulses are export competitive but not import competitive in terms of conventional indices. The results of international competitiveness of the Indian pulses based on alternate indices calculated as DCRR ratios revealed that Indian pulses are import competitive. Therefore, the set hypothesis regarding the international competitiveness of the Indian pulses was partially confirmed.
Policy Implications

The pulse production performance in India over the past two decades has been extremely poor. More than a decade after the economic reforms and liberalization, instead of experiencing boom in growth, there has been a deceleration in the rate of growth of pulse output as compared with the same achieved during the decade immediately before the outset of reforms. It has fallen from 1.9 per cent per annum in the eighties to negative growth of -0.3 per cent per year in the nineties. There has also been a sharp decline in the yield growth rate from 1.7 per cent per annum to 0.6 per cent per annum during this period. This situation has resulted in a demand and supply gap of more than 3 million tonnes per year. So far, country has been bridging this gap through huge imports, which have become a regular feature in the recent years. This reflects declining self-reliance and increasing import dependence. The current per capita availability of pulses in India is much below the nutritional minimum and this is going to fall further with rising population and growth in income. The deficit in future has to be filled either through imports or through increase in domestic production. In the context of first option, limited availability of pulses in terms of quantity and variety and the price competitiveness in the international market are great constraints. Even, if the situation improves in future, problem of pulse growers in rainfed areas in the form of threat to their livelihoods from large-scale imports need to be addressed. This also merits attention regarding policy prescription related to the minimum level of self-sufficiency that the country should adhere to over the years with respect to pulses. The anticipated situation demands a careful scrutiny of policies given the importance of pulses in the Indian human and animal nutrition and their role in farming.

In the era of globalization and increasing market access, comparative advantage in the production has become an important factor to be reviewed before embarking upon a policy framework to improve
production of agricultural commodities. The broad conclusions emerging from the analysis of the international competitiveness of the Indian pulse crops suggest that country is price competitive in exports but not in imports. However, analysis of price competitiveness of pulses in an integral manner by analyzing pulse system as a whole suggested that India seemed to be quite comfortable in terms of opportunity cost of domestic production. Besides, domestic competitiveness was also found favourable in some of the major growing states. This implies that India should increase pulse production and can promote pulse exports after looking the domestic needs. But, export thrust is not possible without increasing the productivity of Indian pulses, which face tough competition in the world. For this purpose the real emphasis should be on improving yields, reducing costs and improving quality of the produce.

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 large part of pulses is grown on un-irrigated lands in rainfed areas. The farmers here face challenges on yield, marketing and prices. For removing these bottlenecks, there is a strong case for further policy initiatives in terms of research and development. As such, past policies did not succeed in improving the pulse production. The inclusion of pulses in the Technology Mission in 1990 demanded a high priority to supply of improved seeds and complementary inputs. Owing to the strategic importance of these critical inputs in improving pulse production through increased productivity, the onus fell on the government to ensure that improved seeds, fertilizer and pesticides were available, accessible and affordable. The positive contribution of the TMOP has been in bringing around 47 per cent of pulse area under improved seeds in 1999. But, unfortunately targets of yield-enhancing inputs remained elusive or
partially achieved. For the success of the TMOP, its percolation to grass root levels in all pulse growing states is of utmost importance. It was found high in Gujarat, Tamil Nadu and Andhra Pradesh but the major growing states of Madhya Pradesh and Uttar Pradesh showed an adoption rate of 30.91 and 34.19 per cent respectively. Further, the adoption rate of small and marginal farmers has been much lower than the mean level. In case of these farmers, the critical issue is to induce them to adopt improved seeds through a support mechanism. For others, making their use viable by adopting associated practices is extremely important. The adoption of complementary package of practices has so far received little attention and there are evidences of deficiencies on this front. For correcting these shortcomings, vigorous extension system is an urgent need. This calls for strengthening the already existing programmes in terms of coverage, input delivery system, evaluation and regular monitoring of the key components along with in time sanction of funds.

Although, the NAFED provides this support by procuring a small quantity of pulses at the minimum support prices under price support and commercial purchases, the price and marketing support to pulse growers is still inadequate. But looking at the area covered and number of farmers involved in pulse cultivation in the country, interventions of the NAFED were found marginal and hence made hardly any difference to overall situation. This could be one of the reasons that pulse production could not pick up despite increasing the market and minimum support prices in comparison to other agricultural commodities. Farmers did not respond enthusiastically to price signals due to yield disadvantage and price uncertainty involved in pulse farming and low effectiveness of the MSP in the absence of procurement system. Therefore, procurement of pulses from the farmers during the peak season at the MSP and canalizing the produce through the Public Distribution System (PDS) will be the right step to protect farmers. In addition, changes in trade policy according to circumstances may further strengthen the support system.
To sum up, growth in pulse production in India has to be induced primarily through widespread adoption of technology. There is an urgent need to increase the supply of inputs that lead to yield improvements. But, transfer of technology may be impeded or thwarted by unfavourable price regime. Hence, a favourable price support to pulse growers is an utmost need to incentivise farmers in stepping up the rate of adoption of technology and to induce them to use yields augmenting inputs, which may usher in enhanced overall profitability. It is sanguinely hoped that these measures will lead to growth as well as stability in the production of pulses in India.