Chickpea Competitiveness in India

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Chickpea's competitive position in India has changed during the last 20 years, resulting in a shift in the centre of chickpea production away from the traditional growing region in the north. This paper estimates national and regional trends in chickpea crop area, identifies factors underlying these trends, and assesses the demand and regional supply prospects to the year 2000.

I
Introduction

WHILE India remains the leading producer of chickpea, its share of world production is declining. More than 80 per cent of the world's total was produced by India 20 years ago; today it produces about 65 per cent. Chickpea production in India has remained virtually stagnant during the last two decades. Indeed, poor performance in chickpea production has raised concerns about India's ability to maintain minimum levels of per capita pulse consumption. Per capita pulse production has fallen from 51 grams to 44 grams per day since the early 70s. The quantity of pulse intake recommended by the Indian Council of Medical Research is about 70 grams per day [Gopalan 1987]. Stagnant growth in chickpea production is at the heart of this shortfall.

Earlier studies have examined changes in pulse area and production. A study by Chopra and Swamy (1975) was by far the most comprehensive, looking at area shifts under individual pulse crops in relation to competing crops. Their study also assessed the demand for total pulses and supply prospects of individual pulse crops in India up to the year 1980. Later, Sharma and Jodha (1982) examined changes in area and yield of pulse crops for different regions of India. They identified agro-climatic, socio-economic and biological constraints in the production of (mainly) chickpea and pigeonpea. Other state level analyses have examined growth rates in area, production, and yield of pulse crops and tried to identify factors affecting those trends [Choudhary et al 1990; Reddy 1991]. More recently, in a keynote paper given at the 1993 Annual Indian Society of Agricultural Economics Conference, Acharya (1993) addressed production performance of oilseeds and pulses in India. While oilseeds were examined in great detail, the analysis of pulses was restricted to estimation and discussion of growth rates only. Several other papers at the conference estimated trends in total area under pulses and their production or provided state-level analyses of specific pulse crops—usually simple estimates of rates of growth in production, area, and yield and their variability over time. Some offered suggestions about the future scope for pulse production in those states.[1] Because these studies emphasise several pulse crops, and are restricted largely to estimating growth rates, they fail to provide the depth and insight necessary to assess the changes—and factors responsible for those changes—in any specific crop over time.

Missing from the literature is an up to date and comprehensive analysis of shifts in chickpea area relative to competing crops in the major chickpea growing regions in India. The decline in chickpea area at the national level masks important changes occurring at the regional level, where in some cases area has actually increased. It is useful to identify factors underlying these shifts as they help explain changes in chickpea's competitive position over time.

There is currently no up to date analysis of—and thus little information about—supply and demand prospects for chickpea in India. Is chickpea production in India constrained more by supply or by demand factors? If by supply factors, as current thinking suggests, then what yield and area growth rates are required to meet projected future demand? If growth rates in yield and area are not likely to be high enough to meet domestic consumption requirements, as past trends indicate, the government faces the prospect of higher imports or higher domestic prices. A third alternative, perhaps more appealing, is to promote domestic production—raise chickpea productivity—through enhanced research and extension support.

In attempting to address these issues, this study examines national and regional trends in area, production, and yield for chickpea and its major competing crops. Where possible, data are disaggregated by cultivation under irrigated and rainfed conditions. An analysis of chickpea's performance provides the basis for assessing regional supply prospects for chickpea in India in the 1990s and beyond. Per capita consumption of chickpea and other major pulses are also examined. Chickpea imports to India have increased over time: trade-related issues and their importance to India are discussed. Demand for chickpea at the all-India level to the year 2000 is estimated based on projected income and population growth rates. These are compared with future domestic production of chickpea.

II
Trends in Production, Area, and Yield

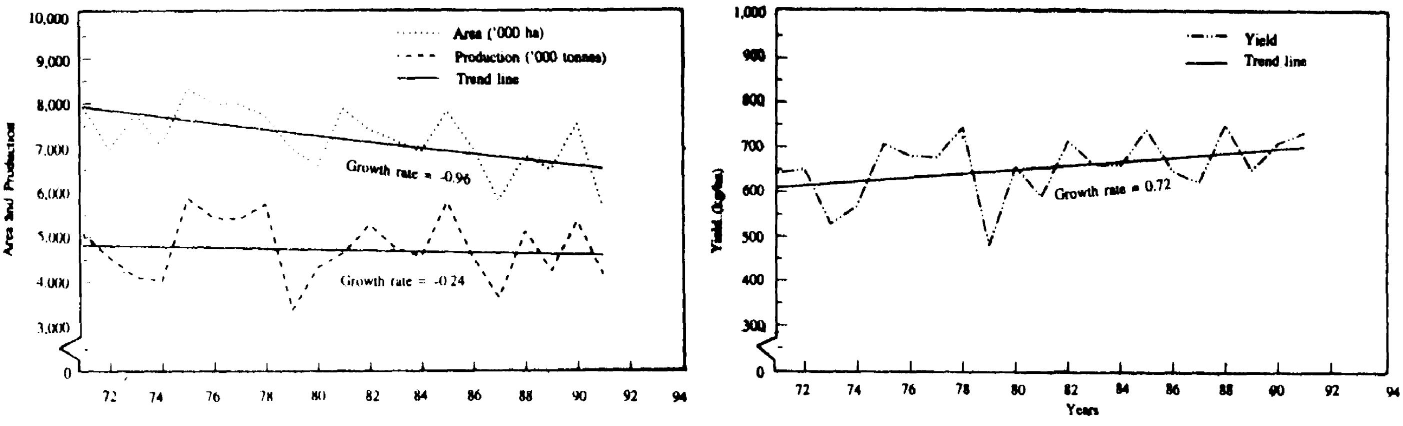
During the past two decades, pulse production in India rose from 10.3 to 13.0 million metric tons. Chickpea added nothing to growth in pulse production during this time. Rather, chickpea production stagnated, losing ground to other pulse crops. Whereas 20 years ago it accounted for 44 per cent of total pulse production, it now represents only 35 per cent.

Trends in chickpea production, area, and yield for India between 1971 and 1991 are shown in Figure 1. Stagnant growth—negative growth but not significant—and large year to year fluctuations in production are evident. As discussed below, the decline in area is largely responsible for the lack of growth in production. Variability in production is relatively high: the detrended coefficient of variation (CV) measured 15 per cent.[2] Yield variability (CV = 10 per cent) contributed slightly more to fluctuations in production than did area (CV = 8 per cent). Compared to other crops, chickpea in India is grown under less favourable conditions and exposed to greater production risks, e g, drought conditions in central/southern India and disease problems in northern India. In such environments, farmers are reluctant to apply significant amounts of inputs, like fertiliser and labour for weeding. This represents a major constraint to achieving higher yields.

Area under chickpea cultivation in India fell by almost 9,00,000 ha between 1971 and 1991 (Figure 1). The largest decline occurred more recently. However, there are regions where chickpea area actually increased. A detailed discussion of changes in crop area and chickpea competitiveness *vis-a-vis* other crops, particularly wheat and rape/mustard is taken up in Section III.

Though chickpea yields fluctuate dramatically, positive (though non-significant) growth rates are observed. Chickpea yields grew by 0.7 per cent per annum between 1971 and 1991. Productivity growth during this period may be related to

Figure 1: Chickpea Area, Production and Yield in India



Sources: Government of India, 1992, Agricultural Situation in India.
Government of India, 1992, Area and Production of Principal Crops

two factors: good monsoons and availability of improved technology—both more evident during the 1980s. From 1971 to 1981, productivity growth was actually negative. Only during the period 1981 to 1991 did yield growth rates become positive, growing by 1.0 per cent per annum in a period with just two 'unfavourable' monsoons. Indeed, the four years after the drought were very favourable, which partially explains the good performance of chickpea during that time. In addition, anecdotal evidence suggests that farmers in India are beginning to adopt improved, wilt resistant cultivars. Presently, yield levels are still well below other regions in the world. For example, average yields in Turkey are approaching 1.0 t/ha; yields in India are well below that (0.7 t/ha).

III
Crop Competitiveness and Cropping Pattern Changes

Perceptions of profitability drive crop choices. Farmers choose crops which offer the highest returns per unit of their scarcest resource—typically, land in India. Profits π, defined as gross returns (P_iY_i) minus variable (P_xX_i) and fixed (FC) costs, are maximised subject to a fixed input-output relationship $Y_i = f(X_i)$, in which crop i yield is function of level of inputs X. This can be expressed mathematically as:

$$\text{Max } \pi = \sum_{i=1}^{I} \sum_{j=1}^{J} (P_iY_i - P_xX_i - FC)\, A_i$$

Not specified here are socio-economic constraints facing farmers, e g, farmer know-how, credit availability, and risk considerations. The optimal solution identifies crop choices for specific land areas at specific levels of input use (A_i^*, X_i^*) for a given set of input and output prices (P_x, P_i). Thus, if per ha profits from chickpea exceed profits from wheat, $\pi_c > \pi_w$, the land will be allocated to chickpea.

Over time, the choice of crop may change as individual plots of land shift to their best use in response to a changed relationship between profits of different crops. This implies, from the crop perspective, competition for land among crops. Thus, when a crop 'attracts' area, it attracts land out of other crops for which, given the set of relative prices and productivity ratios, its use is less remunerative. In theory, the number of crops which compete for a given plot of land are numerous. In reality, given the specific agro-climatic conditions, plot characteristics, farmer know-how and relevant set of prices, only a few crops effectively compete for the same plot of land.[3] It is this shift over time in individual crop areas—both absolute and relative—which is used in this study as a measure of crop competitiveness.

The analysis below rests on the proposition that changes in per unit production costs—

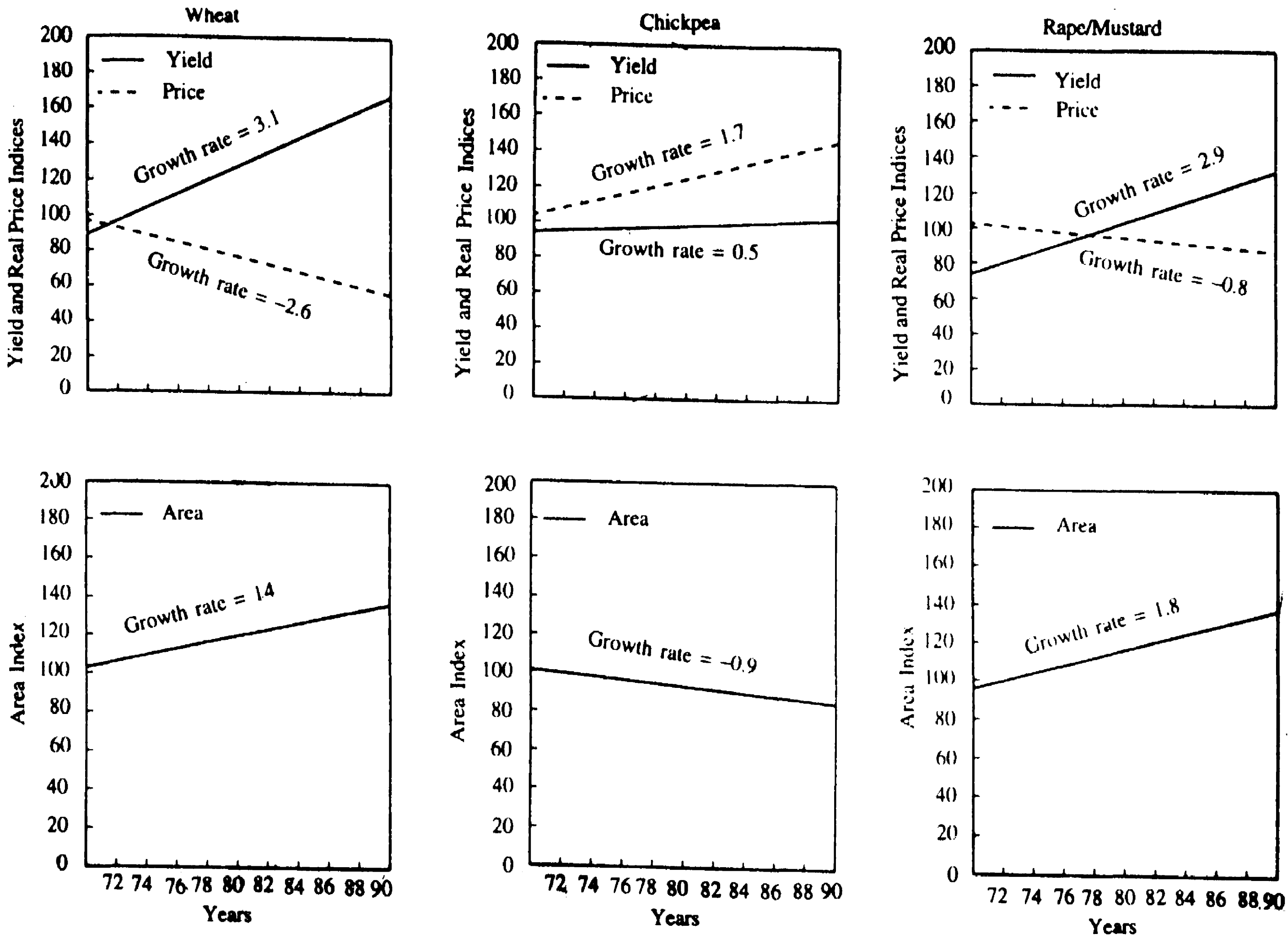
Table 1: Area and Yield for Selected Crops in North, Central and South India

Crop	Region	Area ('000 ha) Average of 1971-73	1988-90	Absolute Change	Yield (kg/ha) Average of 1971-73	1988-90	Absolute Change
Chickpea	North[1]	5022	3491	-1531	624	760	136
	Central[2]	1771	2370	599	647	698	51
	South[3]	568	936	368	317	505	188
	All-India	7547	6942	605	606	707	101
Wheat	North	12907	17442	4535	1454	2526	1072
	Central	3894	4198	304	887	1451	564
	South	1226	1105	-121	490	990	500
	All-India	19062	23911	4849	1275	2215	940
Rape/mustard	North	2812	3389	577	479	923	444
	Central	272	815	543	454	980	526
	All-India	3463	5200	1737	476	880	404
Groundnut[4] (post-rainy)	South	278	868	590	1241	1507	266
	All-India	643	1416	773	1391	1461	70
Sunflower[4]	South	61	1214	1153	541	371	-170
	All-India	157	1263	1106	682	381	301
Cotton	Central	2497	1633	-864	148	197	49
	South	3724	3945	212	84	151	67
	All-India	7684	7477	-207	140	227	87
Pigeonpea	Central	606	834	228	723	957	234
	South	1003	1775	772	434	464	30
	All-India	2472	3555	1083	677	737	60
Soyabean	Central	17	1807	1790	824	910	86
	All-India	38	2143	2105	711	912	201
Sorghum (post-rainy)	Central	163	132	-31	761	842	81
	South	5688	5625	-63	371	559	188
	All-India	6088	5842	-246	390	577	187

Notes: 1 North includes: Rajasthan, Bihar, Punjab, Haryana and Uttar Pradesh.
2 Central includes: Madhya Pradesh and Gujarat.
3 South includes: Andhra Pradesh, Karnataka and Maharashtra.
4 1988-89 average data used; 1990 data not available.

Source: Government of India (various years), Area and Production of Principal Crops.

Figure 2: Trends in Crop Price, Yield and Area Indices in India, 1970-89 (Base 1970=100)



Sources: Government of India, 1991, Bulletin on Food Statistics.
Government of India (various years), Area and Production of Principal Crops.

through changes in crop technology and relative prices—determine a crop's relative profitability and, hence, its 'competitiveness' over time.[4] Absolute and relative changes in the area of chickpea and its competing crops are examined in relation to changes in productivity, yield variability, and prices.

Several crops compete with chickpea for area in India. The analysis here examines changes in chickpea area with reference to its principal competing crops only—wheat and rape/mustard. By definition, crops which substitute for or are replaced by chickpea compete with this crop. It is much easier to establish which crops compete for land *ex post*. One of the objectives in this exercise, however, is to predict *ex ante* the impact of further price and productivity changes on farmers' choices and hence on shifts in crop areas and changes in production.

Crop Area Shifts: All-India Analysis

At the national level, area under chickpea cultivation declined by almost 9,00,000 ha since 1971. In the aggregate, chickpea seems to be losing ground to other crops, particularly in the more favourably endowed areas. An analysis of growth rates in trends of yield, as a proxy for technical change, and product prices provides insight into shifts in area under chickpea and competing crops.

Time series data from 1970 to 1990 on area, yield, and real prices for wheat, rape/mustard and chickpea in India are used to examine the impact of yield and relative prices on area changes in these post-rainy season crops.[5] In Figure 2 linear trends estimated from index values (1970 = 100) are shown for each of the variables: yield, real prices, and area. In the case of wheat,

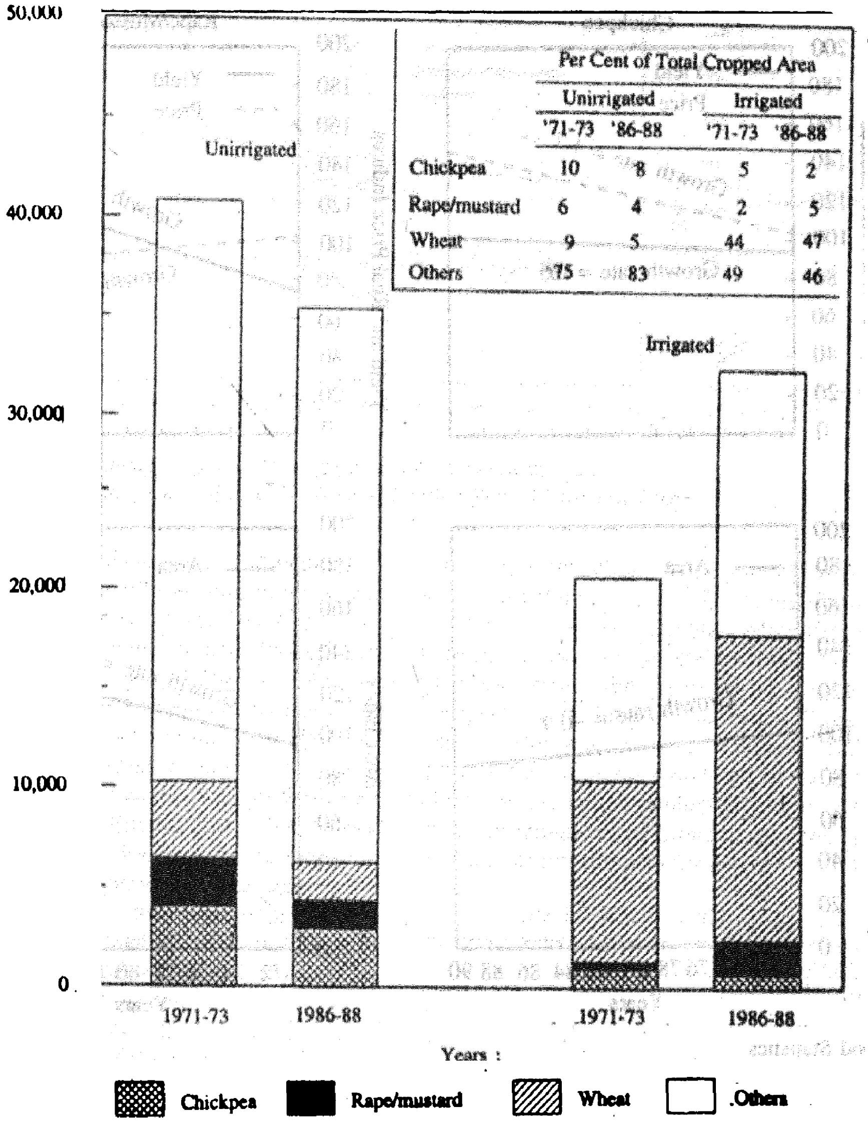
Table 2: Change in Yield between 1971-73 and 1986-88 and Variability in Yields in Irrigated and Dryland Cropped Area of North and Central India

Region	Crop	Irrigated			Dryland		
		Change in Irrigated Yield (Kg/ha)	CV (Per Cent)	Change in Gross Returns (Rs/ha)	Change in Dryland Yield (Kg/ha)	CV (Per Cent)	Change in Gross Returns (Rs/ha)
North	Chickpea	154 (20)[1]	19.1	2997	131 (23)	22.9	2333
	Wheat	1170 (74)	7.7	3724	696 (87)	13.9	2074
	Rape/mustard[2]	466 (73)	11.2	3818	343 (69)	25.7	2869
Central	Chickpea	28 (4)	12.1	2331	-9 (-1)	15.8	1838
	Wheat	797 (62)	12.0	3142	70 (10)	10.3	984
	Rape/mustard	521 (90)	18.7	4517	68 (16)	24.7	1218

Notes: 1 Figures in parenthesis are per cent change in yield.
2 For rape/mustard irrigated and unirrigated yields are based on 1974/76 average since yield data for 1971-73 are not available.

Sources: Government of India (various years), Area and Production of Principal Crops.
Fertiliser Association of India, 1992, Fertiliser Statistics.
Government of India (various years), Farm Harvest Prices in India.

Figure 3: Changes in Unirrigated and Irrigated Crop Area in North India, 1971-73 to 1986-88



Sources: Government of India (various years), Indian Agricultural Statistics.
Government of India (various years), Area and Production of Principal Crops.
Fertiliser Association of India, 1992, Fertiliser Statistics.

a high growth rate in yield (3.1 per cent per annum) more than offset a declining trend in real prices (-2.6 per cent per annum), translating into a 1.4 per cent growth rate in area planted to wheat. Chickpea, despite a positive trend in real prices, dropped in area (-0.9 per cent per annum), largely because growth in yield lagged significantly behind that of other crops. Rape/mustard witnessed the fastest growth in area—1.8 per cent per annum—due to high growth rate in yield accompanied by only a modest decline in real prices.

Trend analyses at the national level are incomplete at best and generally tend to obscure important changes occurring at regional levels. Below cropping pattern changes for three regions in India are examined.

Crop Area Shifts: Regional Analysis

Between 1971-73 and 1988-90, 1.66 million ha of chickpea went out of production in the traditional chickpea growing states of northern India: Haryana, Punjab Rajasthan, Uttar Pradesh, and Bihar (Table 1). This greatly exceeds the all-India total decline in chickpea area (8,95,000 ha during the same period). The gainers were the central states of Madhya Pradesh and Gujarat, which added 5,21,000 ha, and the southern states of Maharashtra, Andhra Pradesh and Karnataka, which added 3,40,000 ha. The latter three states represent relatively new production environments for chickpea. These changes imply a significant shift in the centre of production. As recently as 20 years ago, 70 per cent of India's chickpea area was concentrated in the five northern states. Today, chickpea area in the central and southern states is nearly equal to that in the north.

Cropping pattern changes should be studied in the context of dryland and irrigated crop area changes. Effects are difficult to interpret when area changes, yields, and yield variability are not examined separately. For example, it is well known that irrigation expanded significantly in the north during the last two decades. What impact has this had on relative shifts in crop area under irrigated conditions, and under dryland conditions?

(a) *Northern India*

With the expansion of irrigation in the north, favouring high input crop technology,

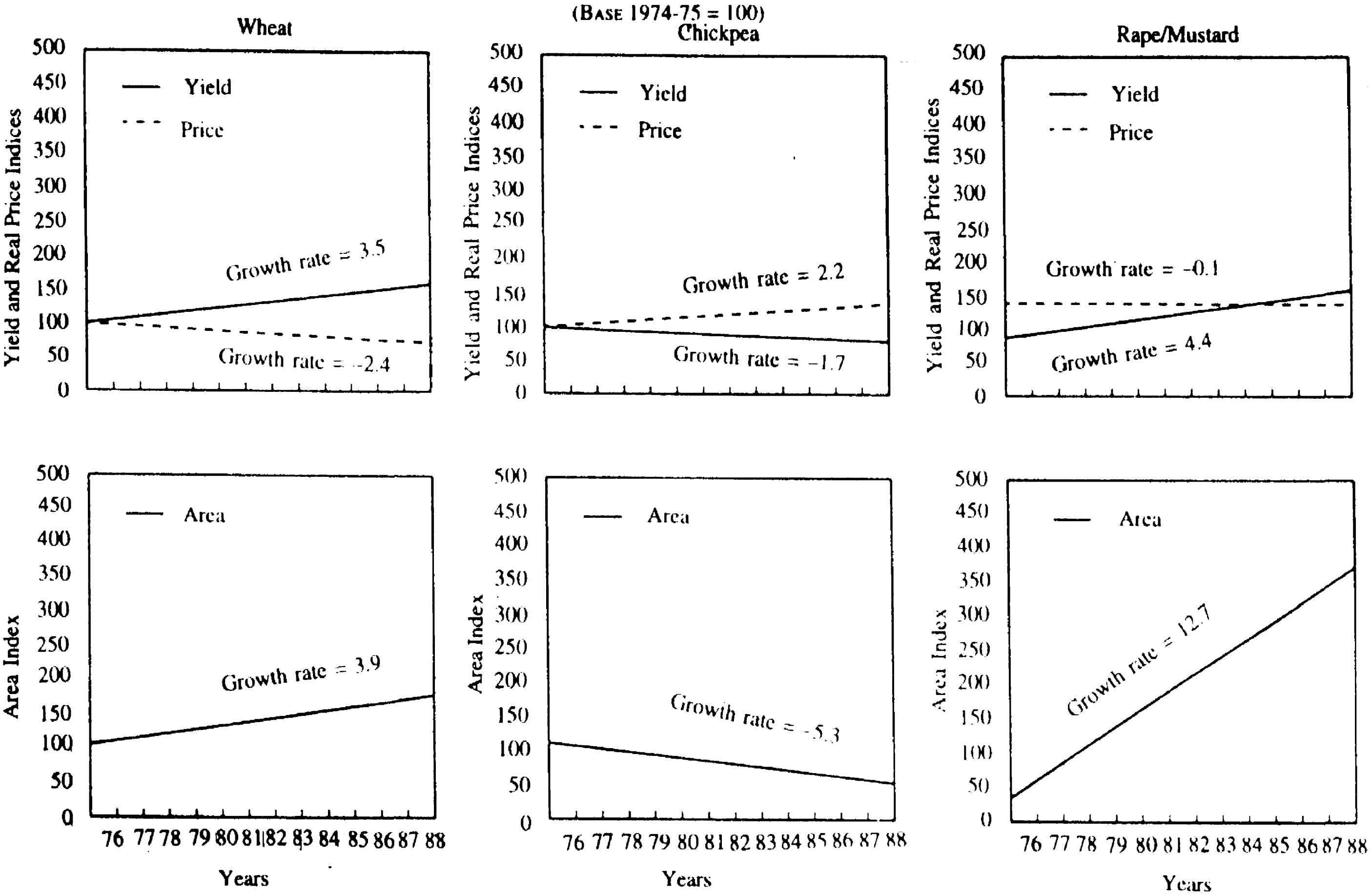
Table 3: Production, Per Capita Availability and Price Index for Major Pulses in India

	Production			Per Capita Availability (g/day)				Real Price Indices (1970 = 100)			
	1971-73	1988-90	Per Cent Change	1971-73	1988-90	Per Cent Change	Growth Rate (1971-90)	1971-73	1988-90	Per Cent Change	Growth Rate (1971-90)
	('000 mt)			(g/day)				(indices)			
Chickpea	4572	4852	6	22.5	15.9	-29	2.3**	113	173	53	1.9**
Pigeonpea	1673	2625	56	8.3	8.6	4	0.4	101	125	23	1.1**
Green gram[1]	627	1336	113	3.1	4.4	42	2.4**	127	150	19	0.9*
Black gram[1]	631	1553	146	3.1	5.1	64	3.3**	133	127	0	0.0
Lentil gram[1]	360	718	99	1.8	2.4	33	1.8**	128	156	22	0.8*
Total pulses	10336	13509	31	50.9	44.3	-13	-1.0*[1]	115	157	37	1.5**

Notes: 1 1988-89 (2-year average only).
* Significant at .10 P level.
** Significant at .05 P level.

Sources: Government of India (various years), Area and Production of Principal Crops.
Government of India, 1992, Bulletin on Food Statistics.
FAO (various years), Production Yearbook.

Figure 4: Trends in Crop Price, Irrigated Yields and Area Indices in Haryana, 1975-88
(Base 1974-75 = 100)



Sources: Government of India (various years), Farm Harvest Prices.
Government of India (various years), Area and Production of Principal Crops.

and the impressive research-led productivity advances in wheat, chickpea's competitive position has weakened. Progress has been slow in developing high yielding, input (fertiliser and water) responsive cultivars of chickpea. Indeed, irrigation sometimes lowers yield in chickpea, by promoting excessive vegetative growth and facilitating disease spread [S C Sethi, ICRISAT, personal communication]. Wheat has replaced chickpea in many of the more favourable areas in the north. Between 1971 and 1989, area under irrigated wheat cultivation jumped from 9.1 to 15.4 million ha (Figure 3). Other crops expanded too. Rape/mustard, the major post-rainy season oilseed crop, increased its area under irrigation by 1.3 million ha (360 per cent). Total irrigated crop area rose from 21 to 33 million ha. Chickpea was one of the few crops which broke the trend. Its cultivated area under irrigation shrunk by 2,64,000 ha (26 per cent). Chickpea's relative decline is even more pronounced. The share of chickpea under gross irrigated area declined from 5 per cent to 2 per cent during this period (Figure 3).

Yield growth and yield variability explain much of the shift in cropping patterns in the north. As shown in Table 2, wheat yields under irrigation rose by 1,170 kg/ha, a 74 per cent increase over the base 1971-73 period; rape/mustard yields rose by 470 kg/ha, a 73 per cent increase; chickpea yields, however, rose by only 150 kg/ha, a 20 per cent increase. While the rise in chickpea prices compensated to some extent, the change in gross returns—which integrates both yield and price changes—clearly moved in favour of wheat and rape/mustard during this period (Table 2). Another important factor driving area changes has been yield stability. Chickpea yields in the north are more variable compared to wheat and rape/mustard under irrigated conditions. The detrended CV of chickpea yields over this period is 19 per cent, compared to 8 per cent for wheat and 11 per cent for rape/mustard, implying higher production risks for chickpea growers.[6]

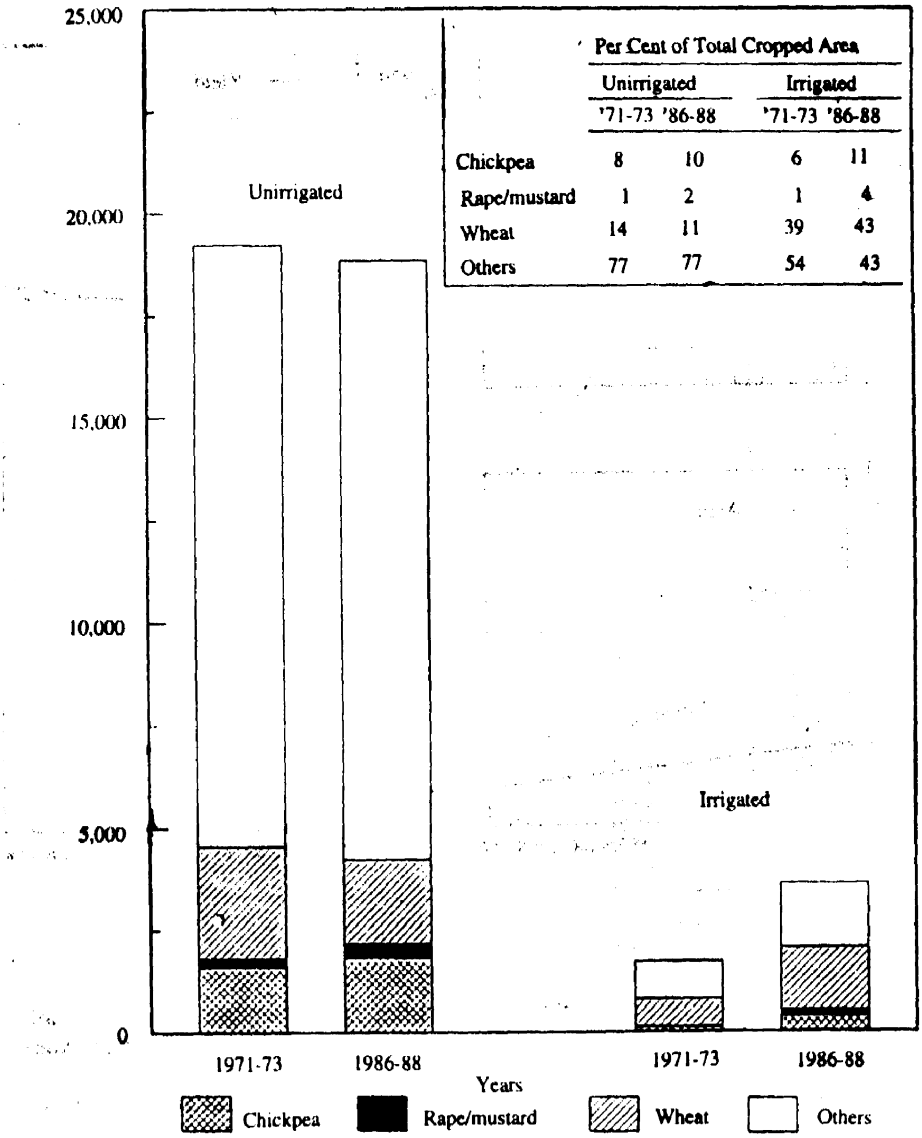
The story for dryland chickpea in the north is similar. In these relatively less favourable environments chickpea has not remained competitive either, as its share of the total dryland area declined from 10 to 8 per cent (Figure 3). In absolute terms, this amounted to 1.1 million ha reduction. Area under wheat and rape/mustard, too, fell by almost three million ha. Due to expansion of irrigation, total dryland crop area in the north declined from 41 million ha to 35 million ha. Interestingly, wheat, rape/

Table 4: Regionwise Chickpea Area, Yield, Production and Consumption in India, Present (1988-90) and Projected (2000) Levels

Region	North		Central		South		Others[1]		All-India[2]	
	88-90	2000[1]	88-90	2000	88-90	2000	88-90	2000	88-90	2000
Area ('000ha)	3508	2663	2370	2858	936	1211	90	60	6904	6792
Yield (kg/ha)	760	828	698	763	505	639	645	675	703	765
Production[3] ('000 t)	2667	2205	1654	2180	473	774	58	41	4852	5200
Consumption ('000 t)	—[4]	—	—	—	—	—	—	—	4952	6466
Deficit ('000 t)	—	—	—	—	—	—	—	—	100	1266

Notes: 1 Others include all other areas in India where chickpea is grown.
2 The sum of north, central, south and others equals to All-India
3 Projections to 2000 based on observed growth rates in area and yield from 1971 to 1990.
4 Regionwise consumption figures are not available.

FIGURE 5: CHANGES IN UNIRRIGATED AND IRRIGATED CROP AREA IN MADHYA PRADESH, 1971-73 TO 1986-88



Sources: Government of India (various years), Indian Agricultural Statistics.
Government of India (various years), Area and Production of Principal Crops.
Fertiliser Association of India, 1992, Fertiliser statistics.

mustard, and chickpea all had proportionately larger reductions in area than other dryland crops. Their combined share in the total dryland cropping declined from 27 to 17 per cent, indicating that other dryland crops were more competitive. These declines occurred despite significant gains in yield growth, particularly for wheat and rape/mustard (Table 2). However, wheat, which suffered the largest relative decline in its share of total dryland cropped area (Figure 3), also had the smallest change in gross returns (Table 2). The dryland crop which appears to have gained the most, relative to the trend, was paddy.

Data are not available for a complete northern India analysis of crop yield, area and price data, disaggregated by dryland and irrigated area. Data do exist, however, for some selected states.[7] Data for Haryana have been used to estimate linear trends in yield, real prices and area indices for irrigated wheat, chickpea, and rape/mustard[8] (Figure 4). The pattern is consistent with that observed at the all-India level: area growth rates corresponding positively with yield growth rates. Rape/mustard had the highest rate of growth in area (12.7 per cent per annum), triggered by an impressive growth rate in yield (4.4 per cent) and stable real prices. Again, while chickpea maintained a strong, positive trend in prices, its yield growth rate was negative and area declined by 5.3 per cent per annum.

A more thorough analysis is necessary for examining the relative impact of yield and prices on area, but even this cursory glance suggests that chickpea is losing its competitive position in the north because of inadequate gains in productivity growth. A more rigorous analysis of the effect of yield and price changes on chickpea area[9] is provided in the Appendix.

(b) *Central India*

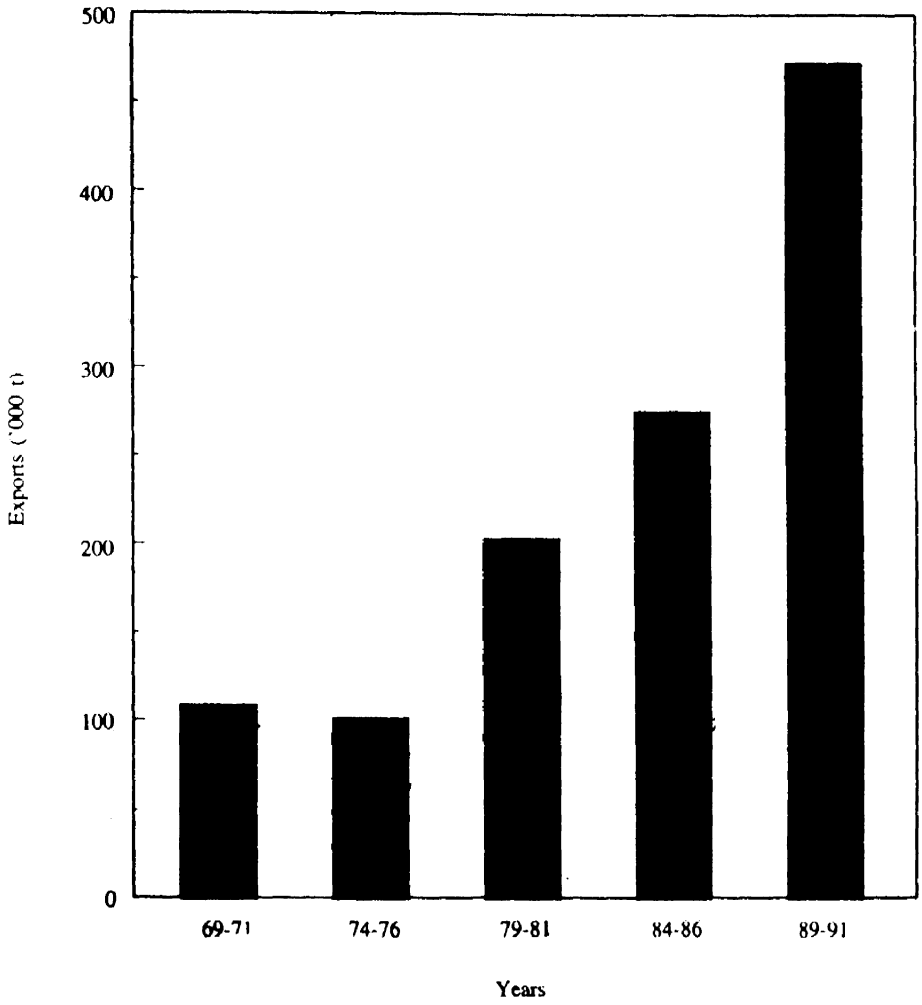
The chickpea story changes as one moves south. In the central state of Madhya Pradesh,[10] chickpea area has expanded relative to other crops under both irrigated and dryland conditions. While all three crops, chickpea, wheat, and rape/mustard, increased their cultivated area under irrigation,[11] chickpea increased from 1,10,000 to 3,85,000 ha, a 250 per cent jump. Also, its share of the total irrigated area increased from 6 per cent to 11 per cent (Figure 5). This compares with wheat and rape/mustard whose share rose from 39 per cent to 43 per cent and from 1 per cent to 4 per cent, respectively. Yield growth alone cannot explain the high rate of growth observed in irrigated chickpea area in central India. Chickpea yields went up by an almost insignificant 4 per cent, compared to wheat yields which rose by 62 per cent and rape/mustard which rose by 90 per cent (Table 2). Yield variability, however,

TABLE 5: HYPOTHETICAL YIELD GROWTH RATES TO MEET DOMESTIC CONSUMPTION REQUIREMENTS IN 2000

Region	Yields, Yield Growth Rates and Projections to 2000[1]			Yield Growth Rate Required to Meet 50 Per Cent of the Deficit in Production 2000[2]		Yield Growth Rate Required to Meet the Full Demand in 2000[3]	
	Yield 1988-89 (Kg/ha)	Yield Growth Rate 1971-90	Yield in 2000 (Kg/ha)	Yield Growth Rate (Per Cent)	Yield in 2000 (Kg/ha)	Yield Growth Rate (Per Cent)	Yield in 2000 (Kg/ha)
North	760	0.78	828	2.0	945	3.0	1052
Central	698	0.82	763	2.0	868	3.0	966
South	505	2.20	639	2.5	663	3.0	699
Others	645	0.40	675	0.4	675	0.4[4]	675
All-India	706	0.93	786	2.0	888	3.0	983

Notes:
1 Yields in 2000 based on historical growth rates in yield between 1971 and 1990.
2 Yield growth rates required to meet 50 per cent of the deficit in production in 2000 assuming no change in area growth rates.
3 Yield growth rates required to meet the deficit in production in 2000 assuming no change in area growth rates.
4 No change in yield growth rates assumed for 'others' since it is not a major chickpea growing region.

Figure 6: World Chickpea Exports, Annual Three-Year Averages



Source: FAO, 1992, Trade Tapes.

was relatively low for both wheat and chickpea (CV = 12 per cent) in comparison to rape/mustard (CV = 19 per cent). More importantly, it appears that the strong price trend in chickpea more than offset the relatively smaller yield gain observed in chickpea. Farm harvest prices for chickpea in Madhya Pradesh rose by 425 per cent over the period; wheat prices by 270 per cent. Another factor to consider is that the base from which area changes were measured were much lower for chickpea than for wheat. The absolute increase in irrigated area was considerably higher for wheat, which added 8,70,000 ha, than for chickpea which added only 2,75,000 ha. This is a difference of almost 6,00,000 ha. While irrigated chickpea's performance looks impressive in relative terms, changes in absolute figures suggest that wheat was indeed more competitive. The significantly larger change in gross returns under irrigation from wheat attests to this (Table 2). Finally, there is some evidence to suggest that chickpea has some advantage over wheat under scarce irrigation conditions [Gill 1992]. There are no data on the quality of irrigation by which these crop areas could be separated out.

Dryland chickpea area increased from 1.61 million ha to 1.84 million ha as its share of total dryland cropped area increased from 8 per cent to 10 per cent. In contrast, dryland wheat area declined by 6,90,000 ha. Wheat yields were relatively stagnant during this period (Table 2). Chickpea yields were stagnant too but its area rose due to the strong price advantage. The change in gross returns for chickpea was nearly twice that for wheat and significantly higher than for rape/mustard.[12] This points to a strengthening of chickpea's competitive position in dryland agriculture in Madhya Pradesh. The only other major dryland crop to have increased its cultivated area in both absolute and relative terms during this period is soyabeans.

(c) *Southern India*

In the southern states where wheat and rape/mustard are of minor importance, a significant increase in chickpea area of 3,30,000 ha is attributed to an expansion in post-rainy season cultivation (i e, higher cropping intensity), strong prices, and high productivity growth. However, besides chickpea, area under groundnut, sunflower, cotton, and pigeonpea also rose (Table 1). Indeed, sunflower, groundnut, and pigeonpea (in that order) had higher rates of growth in area than chickpea. These crops do not necessarily compete with chickpea in space as they are mainly rainy-season crops, but to the extent that choices are made by farmers between rainy and post-rainy season cropping, they do compete. Area under tobacco, jute and mesta and other more minor crops declined the most.

Chickpea yields during this period increased by 62 per cent.[13] This and the price advantage were the driving forces behind the increasing area. The trend of increasing chickpea area in the southern states seems likely to continue as new *desi* and *kabuli* cultivars—shorter duration varieties better adapted to drought-prone environments—and improved management practices—earlier planting—are made available to farmers [Jagdish Kumar, ICRISAT, personal communication].

IV
Consumption Analysis

With chickpea production virtually stagnant during the last two decades, imports negligible (except very recently), and population expanding at the rate of 2.1 per cent per annum [World Bank 1991], it is not surprising that per capita availability of chickpea in India has declined.[14] Table 3 shows per capita availability of the five major pulses for two points in time. Per capita availability of pulses has declined by about 1.2 per cent per year since 1970. This decline is almost exclusively because of chickpea, which registered a dramatic 29 per cent fall in per capita availability, from 23 to 16 g/day.

The decline in production and per capita availability of chickpea accounts for the significant rise in its price. Real prices of chickpea increased at the rate of 1.9 per cent per year throughout the 20-year period. Real prices of pigeonpea, mungbean, and lentil, however, also rose, though not as sharply. This is significant because these pulse crops maintained production levels high enough to increase, or at least sustain, per capita availability over the level of 1970—and still register significant increases in real prices. This suggests two things. First, demand for chickpea has not been strong enough to push prices higher, or at least not sufficient to induce suppliers to produce enough chickpea to maintain per capita consumption at 1970 levels. Rather, as chickpea prices have risen in response to production shortfalls, consumers have shifted away from chickpea to other pulses and to other commodities. And the once fairly common practice of mixing chickpea flour with wheat flour to make softer, tastier chappatis, is no longer so common. As consumers have made this shift, prices have adjusted downwards somewhat, resulting in a price increase in chickpea which is still higher—but not radically so—than other pulses.

Second, there is probably greater scope to increase supplies of pulses through rainy season production of pigeonpea, greengram, and blackgram (through area increases primarily) than through post-rainy season production of chickpea. This is due to strong competition from wheat and mustard/rape where expansion in irrigation and rapid technical change have favoured the latter crops. Pigeonpea faces much less competition from low yielding and low value rainy season crops, e g, sorghum and pearl millet—though there are other high value kharif crops (sunflower, castor) which increasingly compete for land with pigeonpea.

Expenditure and price elasticities of demand for chickpea and other pulses provide additional information on preferences. These elasticities provide information on the change in the quantity demanded of a particular commodity as its price and the income of consumers change. Murty (1983) found that expenditure elasticities for other pulses are higher than for chickpea in every expenditure group in both rural and urban areas of India, indicating that as incomes go up, consumers spend a higher share of their income on pulses other than chickpea. For price elasticities in most expenditure groups, higher negative price elasticities are observed for chickpea. This indicates that consumers reduce their purchases of chickpea proportionately more than they do for other pulses for equivalent increases in price.

It must be remembered that this data applies to all-India. There are regions where demand for chickpea is very strong, and will remain so. To substantiate this, data on per capita consumption of chickpea over time at the regional or state level are required. Such data, though available now, were not available in the 70s.

V
Trade

The world market for chickpea is relatively thin. Less than 0.5 million metric tons are traded annually, which is about 6.5 per cent of the total chickpea produced. This is low compared to all other pulses, where exports represent about 11 per cent of world production [Oram and Agcaoli 1992]. Nevertheless, an increasing trend in world trade is observed for chickpea (Figure 6). Since 1975-77, the market volume has expanded by a factor of three.[15]

India is now the largest importer of chickpea. Chickpea imports to India rose significantly in the last five years. The severe drought of 1987 during which production of chickpea declined by almost 2 million metric tons (30 per cent below previous year's production) was largely responsible for the dramatic increase in chickpea imports in 1987/88. Imports increased from 8,000 mt to 2,23,000 mt in a single year. Imports have come down slightly thereafter as domestic production recovered. Nevertheless, imports remained high in 1990 (1,60,000 mt), probably due to the government's decision to reduce the import duty on foodgrain pulses. The *ad valorem* tax was reduced from 35 per cent to 10 per cent in 1989, but this probably had less effect than hoped on lowering pulse prices in India. Imports fell again in 1991 to 1,00,000 mt, probably in response to a mid-year devaluation of the rupee that made all imported pulses more expensive.

World trade in chickpea is likely to increase as production shifts to areas of greater comparative advantage, particularly as agricultural commodity markets are increasingly liberalised [von Oppen 1990]. There are some indications of this happening already, e g, domestic production declines in India with simultaneous increases in imports from Australia. Higher levels of chickpea imports to India during the last five years reflect the inability of domestic production to satisfy demand at current (domestic) prices. This is not necessarily a bad thing, particularly if domestic resources are utilised more efficiently elsewhere. This advocates for a policy of self-reliance, rather than self-sufficiency. For some countries, utilising domestic resources for crops of greater comparative advantage—and relying on imports to meet domestic requirements, for example chickpea in the case of India—may be the most efficient course. If such a pattern takes hold, it would result in higher aggregate production and consumption of chickpea worldwide. This point is discussed further by von Oppen (1990).

VI
Supply and Demand Projections

What are the prospects for the future? Projections of future supply of and demand for chickpea provide some answers. Assuming past performance in area and yield serves as a good basis for predicting future trends, estimates of chickpea production to the year 2000 can be reasonably projected.[16] This estimate is calculated using growth rates based on historical area and yield trends (1971-90), according to the following compound growth rate equation:

$$Y_t = Y_0 (1+r)^t$$

or in natural log form,

$$\ln Y_t = a + bt + e_t$$

where Y_t is chickpea area (or yield) at time t, a = ln Y_0, b = ln (1+r), r = compound growth rate, and e is the error term. These growth rates in area and yield are used in projecting future area and yield in chickpea and to derive production to the year 2000. These estimates are calculated for each of the major chickpea growing regions in India and summed to get all-India production.

Projections of population and income growth, weighted by expenditure elasticity of demand, are used to predict future demand at the all-India level. Expenditure elasticity of demand for chickpea is taken as 0.42, based on an earlier analysis by Murty (1983). Population (1.7 per cent) and income (1.8 per cent) growth rates during 1989-2000 for India are taken from the *World Development Report* [World Bank 1991]. The following equation is used in projecting demand.

$$D_t = D_0 (1+d)^t$$
$$\text{and } d = p + i*n$$

where D_t is chickpea demand at future time t, D_0 is chickpea consumption at the 1989-91 level, d is the compound growth rate, p is the population growth rate, i is the income growth rate, and n is the income elasticity of demand.[17]

The area projections indicate that at the all-India level chickpea area will decline marginally, from 6.9 to 6.8 million ha, by the year 2000. However, a steep decline in chickpea area (8,50,000 ha) is projected for the northern region. This will be offset by a nearly comparable increase in chickpea area in the central and southern regions (Table 4). Thus, the centre of chickpea cultivation will continue to move southward.

Chickpea yields, in contrast, are expected to grow in all three regions. The largest absolute and relative yield increases are expected in the south, from a fairly low base of 505 kg/ha to 640 kg/ha. In north and central India, yields are expected to rise by about 70 kg/ha to the year 2000. Based on these area and yield projections for each region, en estimate of chickpea production to the year 2000 is derived.[18]

In north India, chickpea production is projected to be 2.2 million mt, down from 2.7 million mt currently. Yield growth will not be large enough to offset the decline in production due to reduced area under cultivation. On the other hand, chickpea production in central and south India is expected to rise, since both area and yields are increasing. Production increases in these two regions will more than offset production shortfalls in the north. Taken together, chickpea production is expected to rise marginally, from its current level of 4.85 million mt to 5.20 million mt.

These projections must be viewed against rising demand for chickpea in India, well above predicted production levels. Demand for chickpea is projected to rise from its current 4.95 million mt to 6.47 million mt in the year 2000. This leaves a 1.3 million mt deficit and will necessitate dramatic increases in imports to satisfy demand in India—a favourable prospect for exporters like Australia and Turkey. Without these imports, chickpea prices in India will rise—as they have in the past—thus discouraging demand and ultimately reducing per capita consumption. To maintain the present low levels of per capita availability of chickpea to the year 2000, at least 50 per cent of the deficit of 1.3 million mt will have to be met either through imports or increased production.

The questions might well be asked: How reasonable are these supply projections? Are past trends indicative of future supply trends? And what are the prospects for achieving higher growth in domestic production via new yield-enhancing technologies in chickpea? Assuming such technologies are available (or in the pipeline) and adoptable, what yield growth rates would be required to narrow the projected supply-demand gap in India?

Assuming projected chickpea area remains constant, yield growth rates required to meet (a) 50 per cent and (b) 100 per cent of the projected deficit are given in Table 5. At the all-India level, yield growth rates would have to rise from their current levels of less than 1 per cent per annum to 2 per cent per annum just to meet 50 per cent of the projected domestic shortfall, and to 3 per cent to meet 100 per cent of the projected demand. What are the regional implications? Of course, many possible scenarios exist; these projections are only meant to be illustrative. Increasing domestic production enough to meet just 50 per cent of the import gap would require yield growth rates in north and central India—where 90 per cent of chickpea production takes place—to rise significantly. In the scenario presented in Table 5, it would mean raising growth rates from 0.8 per cent (current levels) to 2 per cent per annum in the north and central regions, and from 2.2 per cent (current level) to 2.5 per cent per annum in the south. This implies raising yields to 945 kg/ha in the north, 870 kg/ha in the central region, and 665 kg/ha in the south. To raise domestic production enough to completely close the projected supply-demand gap, yield growth rates of 3 per cent per annum are required in each of the three regions. This would effectively raise yields in each of the northern, central, and southern regions to 1050 kg/ha, 970 kg/ha, and 700 kg/ha from their current levels. Again, this assumes area under chickpea in each region remains unchanged from its projected value. One would, of course, expect an area response from improved yields.

While it is possible to construct several other scenarios, the above scenarios provide some idea of yield targets which need to be met by 2000 to satisfy consumer demand. Failing to meet these targets will undoubtedly result in some, but not necessarily dramatic, increases in imports. Recall that the world market for chickpea is thin. Supplies from outside may simply not be available, or may be available at low enough prices, to meet this demand—at least in the short run. World and domestic prices of chickpea will rise as a result. While this will have a positive effect on production, it will discourage consumption and encourage the shift away from chickpea to other pulses.

VII
Conclusions and Implications

Relative to competing crops, chickpea's performance in India during the last 20 years has been poor. Stagnant growth in production has resulted from lagging productivity and declining area. This was most evident in the north, the traditional chickpea growing region in India, where competing crops had higher rates of growth in yield and area compared to chickpea. With the expansion of irrigation in the north—favouring high input crop technologies—and the impressive research-led productivity advances in wheat, chickpea's competitive position weakened considerably. Indeed, the decline in chickpea area in India can be attributed entirely to the decline in area in the north: 1.7 million ha went out of production in this region. The secular decline in chickpea area in the north is likely to continue as the driving force behind these changes is crop substitution by more profitable post-rainy season crops like wheat and rape/mustard under irrigation, which corresponds to a general decline in dryland crop area as irrigation expands. Barring any major breakthrough in chickpea productivity to enhance its competitiveness, the overall declining trend in chickpea area will likely continue.

At the same time, chickpea's competitiveness in the central and southern regions appears to have improved. In the central region, higher prices of chickpea more than offset smaller yield differentials between chickpea and its competing crops. In the south, yield increases and higher prices contributed to chickpea's better performance. Chickpea area in the central and southern regions grew by 8,60,000 ha during the last two decades. Chickpea cultivation in India appears to be moving southward.

With population growing by nearly 2 per cent per annum, per capita availability of chickpea has declined sharply. Since chickpea is the most important of the pulses, this has led to an overall decline in the availability of total pulses in India. As a consequence real chickpea prices have risen sharply during the 70s and 80s inducing consumers to shift to cheaper substitutes. This explains the gradual shift from chickpea to other pulses which generally have higher expenditure and lower price elasticities. Vegetables and livestock products are also replacing chickpea among consumers whose incomes have risen, suggesting a demand constraint for high-income groups in the long run. In the short run, demand for chickpea will continue to grow as population and incomes rise for low-income groups. With chickpea production projected to grow only marginally during the 90s, imports will have to increase significantly (by 1.3 million mt) from present levels to meet the demand in 2000. Imports are not likely to close this gap entirely as the world market for chickpea is relatively small. Rather, prices of chickpea are expected to rise thereby reducing demand from projected levels. Relative price changes among pulses will determine how much demand for chickpea is reduced.

In the future, as world trade in chickpea expands, production is expected to shift to regions of greater comparative advantage. In such a situation, it should not be necessary for India to meet its consumption requirements entirely through domestic production, unless it can do so in a cost efficient manner. Otherwise, it should utilise its domestic resources to produce crops for which it has a comparative advantage and rely on imports for commodities for which it does not. But comparative advantage can change over time due to technological change.

Expanding chickpea production in the short run—sufficient to satisfy future demand in India—without resorting to substantial imports depends primarily on the rigidity of supply constraints. Is there a possibility for significantly reducing per unit costs of production in chickpea—primarily by raising yields—which would make it more competitive with wheat and rape/mustard in the north and central regions, and with sunflower, cotton, pigeonpea, and sorghum in the central and southern regions? Improved technologies are already available to at least double chickpea yields in many areas [Jagdish Kumar, ICRISAT, personal communication]. Crop improvement scientists can focus on either the relatively better endowed dryland chickpea growing regions in the north where presently *Aschochyta blight* and *Botrytis grey mould* limit yield potential (and the amount of inputs producers are willing to risk on the crop), or on the drier, more marginal environments of peninsular India. Here, drought and root diseases (*Fusarium wilt* and *Root rot*) are the most serious constraints to higher yields. Work on the latter has been reasonably successful with recent releases of resistant cultivars.

Much, however, still needs to be done in ascertaining which on-farm constraints are limiting the adoption of new productivity-enhancing technologies in these specific regions. 'Improved' technologies may fail to find acceptance if competing crop technologies are superior, or if they are too complex or risky, or if necessary inputs are simply not available. Chickpea improvement scientists must assess the relative importance of each of these constraints and then design research strategies to address them. Yield gap analysis must go beyond simple determination of potential yield minus actual yield. The potential for closing these gaps through new research and extension efforts must be assessed.

New production technology in chickpea, if adopted, has the potential to realise significant gains in productivity, lower per unit production costs, and ultimately, ensure relatively lower prices on the market. This would improve chickpea's competitiveness, expand the consumption of traditional chickpea foods, and encourage chickpea substitution for other commodities in new uses. Without such gains in productivity, India will have to rely on imports to satisfy domestic consumption.

Appendix

Econometric analysis was used to estimate the impact of changes in relative gross returns (equation 1) and, subsequently, relative yield and prices (equation 2) on chickpea area in Haryana and Madhya Pradesh.[1] Yield, price, and area time series data from 1971 to 1988 for Haryana and 1960 to 1991 for Madhya Pradesh was used in the analysis. The Nerlovian partial adjustment model was fitted with chickpea area as the dependent variable.[2] The model was specified as follows:

$$(1)\ l_n A_t = l_n \beta_0 + \beta_1 l_n (GR_c/GR_w)_{t-1} + l_n \beta_2 A_{t-1} + u_t$$

$$(2)\ l_n A_t = l_n \beta_0 + \beta_1 l_n (Y_c/Y_w)_{t-1} + \beta_2 l_n (P_c/P_w)_{t-1} + \beta_3 l_n A_{t-1} + u_t$$

where, A_t = irrigated chickpea area in time t for Haryana, and total chickpea area in time t for Madhya Pradesh; $(GR_c/GR_w)_{t-1}$ = chickpea/wheat gross returns ratio in time t-1; A_{t-1} = irrigated chickpea area in time t-1 for Haryana, and total chickpea area in time t-1 for Madhya Pradesh; $(Y_c/Y_w)_{t-1}$ = chickpea/wheat yield ratio in time t-1; $(P_c/P_w)_{t-1}$ = chickpea/wheat farm harvest price ratio in time t-1; U_t = error term.

Relative net returns—rather than gross returns—is the preferred independent variable when the ratio of input costs change over time. Cost of cultivation data were not readily available and hence the analysis here is restricted to gross returns. This assumption is not as restrictive as it may appear. Wheat and chickpea had relatively similar growth rates in costs of cultivation during the last two decades [Mruthyunjaya and Kumar 1989].

In the partial adjustment model, the lagged dependent variable captures the effects from all previous lagged gross returns, i e, $(GR_c/GR_w)_{t-2}$, $(GR_c/GR_w)_{t-3}$,..., in equation (1). Initial adjustment is captured in the variable $(GR_c/GR_w)_{t-1}$ where the coefficient estimate is equivalent to the short-run elasticity.

In equation (2), $(Y_c/Y_w)_{t-1}$ and $(P_c/P_w)_{t-1}$ are included to measure the impacts of relative changes in productivity and prices separately. Economic theory suggests a positive sign for each of these coefficients.

The results for Haryana are presented in Table A1. In equation (1) the decline in $(GR_c/GR_w)_{t-1}$ explains a significant amount of the change in irrigated chickpea area. This coefficient estimate (0.435) measures the percentage change in chickpea area expected for a given percentage change (measured at the mean) in the chickpea/wheat gross returns ratio. Chickpea area would decline by 4.35 per cent, or by about 10,000 ha, in the first year in response to a 10 per cent decline in that ratio. As specified in the model, the complete adjustment occurs over a longer time. This seems reasonable because pulses for various agronomic reasons are subject to technical constraints in area decisions. Thus, actual area under pulses may differ from the desired level as dictated by yield and price considerations [Chopra and Swamy 1975]. Over the long run, a 10 per cent decline in (GR_c/GR_w) results in a 14.7 per cent decline in irrigated chickpea area.

Turning to equation (2), changes in relative yields were found to be positively associated with irrigated chickpea area. i e, a fall in the Y_c/Y_w ratio is associated with a fall in chickpea area. The coefficient estimate (0.432) is nearly identical to that observed for relative gross returns in equation (1), suggesting that the most of the influence of relative profitability came through the yield variable. The coefficient estimate for the relative price ratio (P_c/P_w) is also positive, as expected, but not quite significant at $p = 0.10$. The interpretation of the yield ratio coefficient is similar to that above for gross returns. The long-run elasticity estimate (1.57) is similar to that in equation (1).

Equations (1) and (2) were also fitted to data for Madhya Pradesh. The dependent variable here was total chickpea area as continuous time-series data for irrigated and dryland chickpea area were not available.[3] Estimation results are shown in Table A2. In equation (1), $(GR_c/GR_w)_{t-1}$ is

TABLE A1: CHICKPEA (IRRIGATED) AREA RESPONSE MODEL RESULTS FOR HARYANA, 1971-88

Variables	Equation I	Equation II	ε_s	ε_l	Mean
Intercept	1.833	1.686	—	—	—
	(1.91)[1]	(1.24)			
$(GR_c/GR_w)_{t-1}$	0.435		0.43	1.47	0.569
	(2.91)				
$(Y_c/Y_w)_{t-1}$	—	0.432	0.43	1.58	0.314
		(2.76)			
$(P_c/P_w)_{t-1}$		0.472	0.47	1.72	1.91
		(1.70)			
A_{t-1}	0.704	0.726	—		238,300
	(4.01)	(3.17)			
Adj R^2	0.58	0.55	—	—	—
DW	2.48	2.47	—	—	—
h	1.43	3.02	—	—	
DF	14	13	—	—	—

Note: 1 Figures in parentheses are t-values.

TABLE A2: CHICKPEA AREA-RESPONSE MODEL RESULTS FOR MADHYA PRADESH, 1960-91

Variables	Equation I	Equation II	ε_s	ε_L	Mean
Intercept	2.403	3.765	—	—	—
	(3.47)[1]	(3.29)			
$(GR_c/GR_w)_{t-1}$	0.283	—	0.28	0.90	0.9008
	(3.85)				
$(Y_c/Y_w)_{t-1}$	—	0.097	0.01	0.19	0.7136
		(0.67)			
$(P_c/P_w)_{t-1}$	—	0.288	0.29	0.57	1.3254
		(4.00)			
A_{t-1}	0.687	0.496	—	—	1857,240
	(7.49)	(3.16)			
Adj R^2	0.78	0.79	—	—	—
DW	2.48	2.44	—	—	—
h	1.57	2.76	—	—	—
DF	28	27	—	—	—

Note: 1 Figures in parentheses are t-values.

able to explain a significant portion of variability associated with total chickpea area. The coefficient estimate, 0.283, indicates that with a 10 per cent increase in relative gross returns from chickpea a 2.8 per cent increase in chickpea area would be realised the following year. Calculated from the mean this translates into an additional 53,000 ha.

Results from equation (2) estimation generally confirm the earlier analysis which indicated that the farm harvest price ratio, rather than the yield ratio, governed changes in chickpea area. Similar to that observed for Haryana, a nearly identical coefficient estimate (0.289) is obtained for the price ratio variable in equation (2) as for the gross returns variable in equation (1), suggesting that prices, via its influence through relative gross returns, had the largest impact on chickpea area. Thus, for Madhya Pradesh, changes in relative yields had no apparent effect on chickpea area. This too was consistent with results obtained in Section III.

Notes to Appendix

1 It may be argued that differences in gross returns, yields and prices between competing crops are more appropriate variables for explaining shifts in crop area than ratios of gross returns, yields and prices. Using the former is somewhat restrictive as negative values preclude the use of the log functional form. Nevertheless, linear functions were also specified and estimated using differences in gross returns, yield and price variables: results were not substantially different from the model using ratios of the same variables.

2 Only irrigated chickpea area was considered in the analysis for Haryana since 95 per cent of the wheat grown there is irrigated, i e, dryland wheat does not effectively compete with dryland chickpea.

3 For Madhya Pradesh, where wheat competes with chickpea under both dryland and irrigated conditions, total chickpea area was used as the dependent variable. In any case only 15 per cent of chickpea area in Madhya Pradesh is under irrigation.

Notes

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1 Singh et al (1993) for Bihar, Bahura and Ray (1993) for Orissa, Patil (1993) for Karnataka, Chhikara et al (1993) for Haryana, and Upadhyay and Sharma (1993) for Uttar Pradesh, among others.

2 CVs were calculated around the trend line, i e, using the residuals of the linear estimation, i e, $CV = (\sqrt{[Y_i - \hat{Y})^2 / (n-2)]})/\bar{Y}$.

3 See Narain (1965) for an illuminating treatise on the concept of competing crops. This discussion draws liberally from that seminal piece.

4 Data on costs of production over time are difficult to come by. In lieu of that, gross returns per ha (yield x price) are used as a proxy for profits in this study. This assumption is not as restrictive as it may appear. Wheat and chickpea had relatively similar growth rates in costs of cultivation during the last two decades [Mruthyunjaya and Kumar 1989].

5 Ideally, changes in yields, output prices and production costs should be considered together in their effect on changing crop area, i e, profitability differentials are what matter. Detailed cost of cultivation time series data for the relevant crops were not available for a sufficient number of years to permit such an analysis.

6 For the northern states a weighted, detrended CV was obtained using state area under the crop as weights.

7 Gaps in yield data for irrigated and dryland crops from 1971 to 1988 exist for many of the northern states. Data for Haryana are relatively more complete.

8 Only irrigated chickpea area was considered in the analysis for Haryana since 95 per cent of the wheat grown there is irrigated, i e, dryland wheat does not effectively compete with dryland chickpea.

9 Econometric analysis was used to estimate more rigorously the impact of changes in relative yield and prices on chickpea area. This was done using data for both Haryana (representing the north) and Madhya Pradesh (representing the central region). Results are presented and discussed in the Appendix. The analysis in general supported regional-level trends presented in this and the following section.

10 Gujarat state is not included since data on cropwise irrigated area from 1986 onwards are not yet published.

11 In Madhya Pradesh only 15 per cent of the cropped area is under irrigation compared to 45 per cent in north India.

12 Once again, econometric analysis was used to confirm these tentative findings. See the Appendix for a further exposition.

13 Data on chickpea production and yields are not available in disaggregated form (irrigated and dryland) for the southern states. Hence, a more disaggregated analysis was not attempted here.

14 In the past, NSS consumption data for pulses were not disaggregated. Only recently has the NSS begun reporting data on chickpea consumption. In lieu of unavailability of direct estimates of consumption, production plus imports minus exports have been used in estimating total availability, our proxy for consumption. Carryover stocks of chickpea are assumed to be negligible, and seed, feed and wastage are assumed relatively constant over the period.

15 In contrast to international trade, chickpea trade within India is significant. This is due to a widely distributed demand and regional concentration of production [von Oppen and Rao 1987]. Earlier work by Raju and von Oppen (1980) estimated the marketable surplus of chickpea in India at 45 per cent. The Bulletin on Food Statistics [Government of India 1980] which formerly kept such data had somewhat lower estimates (35 per cent), but showed a consistently increasing trend in the marketable surplus over time. This challenges much of the conventional thought about chickpea production in India as largely subsistence-oriented.

16 Ideally, supply projections should consider the impact of future prices and yields (own and competing crops) on crop area. It was beyond the scope of this paper to estimate those effects. Instead, we rely on historical trends.

17 This demand equation ignores changes in relative prices of substitutes over time. Again, these considerations were outside the scope of this paper.

18 It must be emphasised again that these projections are not based on future technical considerations, i e, yield gaps and readily available and adoptable technologies. This analysis assumes that past trends are a reasonable indication of future yields and area.

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