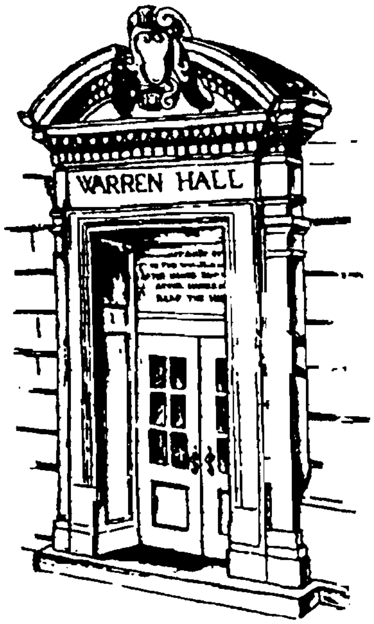

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EFFECTIVE INCENTIVES AND CHICKPEA COMPETITIVENESS IN INDIA

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Effective Incentives and Chickpea Competitiveness in India

Abstract

This paper attempts to measure the impact of government intervention in product and factor markets on chickpea competitiveness in India. This is done by estimating the nominal (NPC), effective (EPC) and effective subsidy (ESC) protection coefficients for chickpea and its main competing crops - wheat and mustard. Further, the Net Economic Benefit (NEB) in the production of these three crops is estimated to indicate where comparative advantage and production efficiency in production lie. In addition, this paper also analyses the production constraints affecting chickpea competitiveness. The analysis is confined to the states of Haryana, Uttar Pradesh, Madhya Pradesh and Rajasthan.

The protection coefficients indicate that the government's output price, subsidy and trade policies have discriminated against chickpea producers. These policies provided the greatest effective protection to mustard producers in all the four states studied. In Haryana wheat received greater protection than chickpea, though in both Madhya Pradesh and Rajasthan chickpea had greater protection than wheat. This result indicates a general policy bias against chickpea producers in the northern wheat growing belt of India. The Net Economic Benefit coefficients show that all states have a comparative advantage in wheat and chickpea production, while only Uttar Pradesh, Madhya Pradesh and Rajasthan have comparative advantage in mustard production also. However, across all states, wheat is the most efficient crop to produce. From a standpoint of economic efficiency, this result implies that India is better off allowing resources to flow into wheat production and importing its chickpea and mustard requirements.

Effective Incentives and Chickpea Competitiveness in India

1. Introduction

Pulses play a crucial part in India's food economy by providing cheap protein to a largely poor and vegetarian population. Their ability to rejuvenate the soil by fixing atmospheric nitrogen has made pulses figure prominently in crop rotations, while their hardiness has made them an ideal insurance crop for farmers against the vagaries of nature. Important as pulses are in the food economy, their cultivation has suffered in India. While other foodgrains like wheat and rice have made remarkable production increases, pulse production in India has remained stagnant between 10 to 13 million tons over the last forty years. One of the major reasons behind this stagnation is the negative growth in chickpea area and production in the post-Green Revolution period (Table 1).

This declining chickpea acreage and production has given rise to many areas of concern. First, there has been a consistent decline in the per capita pulse availability from 70 grams per day in 1960/61 to 45 grams per day in 1990/91. This is much below the 70 grams per day quantity of pulse intake recommended by the Indian Council of Medical Research (Kelly and Rao, A-89). The negative growth in chickpea area and production is a major contributor to this. Second, the adoption of the rice-wheat sequence in the northern wheat growing zones during the post-Green Revolution period directly resulted in the decline of the traditional intercropping or rotation of chickpea with wheat. The sustainability of the rice-wheat sequence has been seriously questioned and one solution suggested has been to introduce a pulse crop into this rotation. Third, falling chickpea production has resulted in India going from a net exporter of chickpea in 1970 to a net importer in 1995. By 1995, India's net imports of chickpea were 46,000 tons, valued at US$ 25.8 million. Clearly, these levels of imports are costing the government dearly in terms of foreign exchange, besides sacrificing self-sufficiency and food security.

This paper attempts to investigate chickpea's decline by examining its competitiveness relative to its main competing crops - wheat and mustard. First, factors such as technological constraints, profitability and risk are considered. Secondly, the role of India's agricultural price and trade policy and the pattern of incentives generated by government policy towards chickpea, mustard and wheat will be examined by estimating the following Coefficients of Protection; the Nominal Protection Coefficient (NPC), the Effective Protection Coefficient (EPC) and the Effective Subsidy Coefficient (ESC) for the three crops. This analysis will also attempt to identify which among chickpea, wheat and mustard is the most efficient to produce. This would require the estimation of Net Economic Benefit (NEB) of chickpea, wheat and mustard production. Geographically, the study focuses on the states of Haryana, Uttar Pradesh, Rajasthan and Madhya Pradesh. In the first three chickpea area declined in the post-Green Revolution period while in Madhya Pradesh it has been increasing.

Table 1 All-India Compound Growth Rates of Area, Production and Yield of Selected Crops

(Percent Per Annum)

CROP	1949/50 to 1992/93			1949/50 to 1964/65			1967/68 to 1980/81			1980/81 to 1992/93		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
All Cereals	0.60	3.00	2.04	1.30	3.24	1.68	0.39	2.70	1.78	-0.33	3.07	2.97
Wheat	2.38	5.69	3.23	2.68	3.99	1.27	2.94	5.64	2.61	0.44	3.55	3.09
Rice	0.81	2.63	1.81	1.33	3.49	2.13	0.76	2.22	1.46	0.51	3.46	2.94
Coarse Cereals	-0.32	1.19	1.38	0.90	2.23	1.29	-1.03	0.62	1.57	-1.70	0.79	2.33
All Pulses	0.26	0.50	0.38	1.90	1.39	-0.22	0.45	-0.39	-0.66	0.13	1.50	1.41
Chickpea	-0.73	-0.15	0.59	1.64	2.66	1.00	-0.55	-1.03	-0.52	-1.31	-0.61	0.70
Red gram	0.97	0.81	-0.16	0.57	-1.34	-1.90	0.38	0.56	0.16	2.11	1.11	0.98
Other Pulses	0.69	0.99	0.30	2.07	1.28	-0.77	1.06	-0.14	-1.18	0.39	3.34	2.93
Mustard/Rapeseed	2.00	4.02	1.98	2.97	3.36	0.37	1.26	1.50	0.22	4.20	8.46	4.08
Total Foodgrains	0.53	2.70	2.03	1.41	2.93	1.43	0.38	2.39	1.54	-0.23	2.94	3.75
Total Non-Foodgrains	0.97	2.74	1.35	2.52	3.54	0.93	0.98	2.36	1.20	0.79	3.82	2.66
Total Crops	0.62	2.71	1.87	1.61	3.13	1.30	0.54	2.38	1.43	0.06	3.22	3.58

Source : Government of India, Area and Production of Principal Crops in India : 1990-93, (New Delhi : Directorate of Economics and Statistics, Department of Agriculture and Co-operation, Ministry of Agriculture, 1993), 274-5.

2. Acreage Trends

This negative growth in chickpea in the post-Green Revolution period (Table 1) is largely due to its acreage declines in the Indo-Gangetic region, especially in the wheat growing states of Punjab, Haryana and Uttar Pradesh (Figures 1 and 2). During the same period there have been increases in chickpea acreage in central regions of India, especially in the states of Madhya Pradesh and Maharashtra (Figures 3 and 4). However, the comparatively small acreage increases in these states coupled with their low productivity has resulted in the overall decline of chickpea production in India. South India is not a major chickpea producing region. In addition, at the all-India level, there has been a decline in the share of chickpea acreage (especially irrigated shares) of large operational holdings (Table 2). The bulk of chickpea acreage has shifted to marginal, small and medium sized holdings, indicating a disinclination among commercial producers to cultivate chickpea. For a detailed description of these trends see Kelly and Rao (1994), Sharma (1986) and Rao (1998).

Turning to the geographical focus of this study, Figures 5, 6, 7 and 8 describe the acreage trends among chickpea, wheat and mustard in the states of Haryana, Uttar Pradesh, Rajasthan and Madhya Pradesh[1]. In Haryana (Figure 5), wheat acreage increased almost as rapidly as chickpea area declined, with mustard acreage rapidly increasing after 1980/81. With negligible increases in net cultivated area, most of the area gains by wheat and mustard were at the expense of chickpea. Indeed, between 1970/71 and 1992/92, chickpea area in Haryana declined by 65 per cent, while wheat and mustard acreage increased by 73 and 33 per cent respectfully. In Uttar Pradesh, chickpea acreage has fallen off in a less drastic fashion (Figure 6), losing 50 per cent of its area between 1970/71 and 1993/93. However, the area lost in absolute terms has been greater than in Haryana. Here, chickpea seems to have lost acreage only to wheat, which increased acreage by 53 per cent in the same period. Mustard also declined, losing 43 per cent of its area.

In the two main chickpea producing states of Rajasthan and Madhya Pradesh (Figures 7 and 8), the relative acreage trends are different from those of Haryana and Uttar Pradesh. These states did not experience any rapid increase in wheat area, and there was no corresponding rapid decline in chickpea area. In Rajasthan, wheat and chickpea seem to have had the same level of acreage till the early 1980's, after which chickpea acreage declined. Corresponding with chickpea's decline, mustard experienced a dramatic surge in acreage. Between 1970/71 and 1992/93, chickpea lost 19 per cent of its area, while wheat and mustard increased their acreage by 42 and 78 per cent respectfully. In Madhya Pradesh, chickpea, wheat and mustard all increased in area, with mustard joining in after 1980/81. This is the only state in which chickpea has gained acreage. Between 1970/71 and 1992/93, chickpea acreage increased by 46 per cent, while wheat and mustard increased by 1.5 and 19.5 per cent respectively.

[1] The area trends represent three year moving average values.

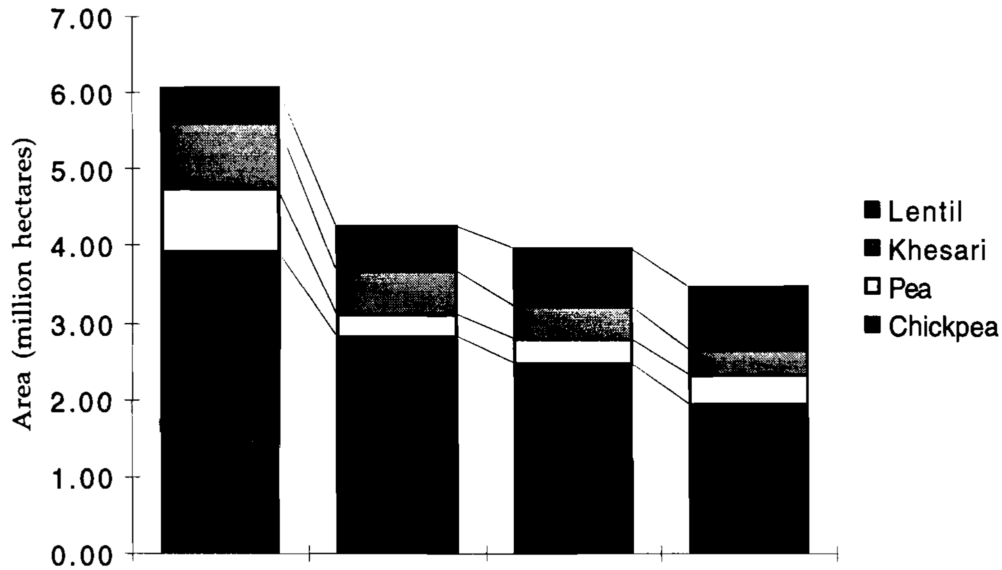

Figure 1 Major Rabi Pulses - Punjab, Haryana, Uttar Pradesh, Bihar and Bengal

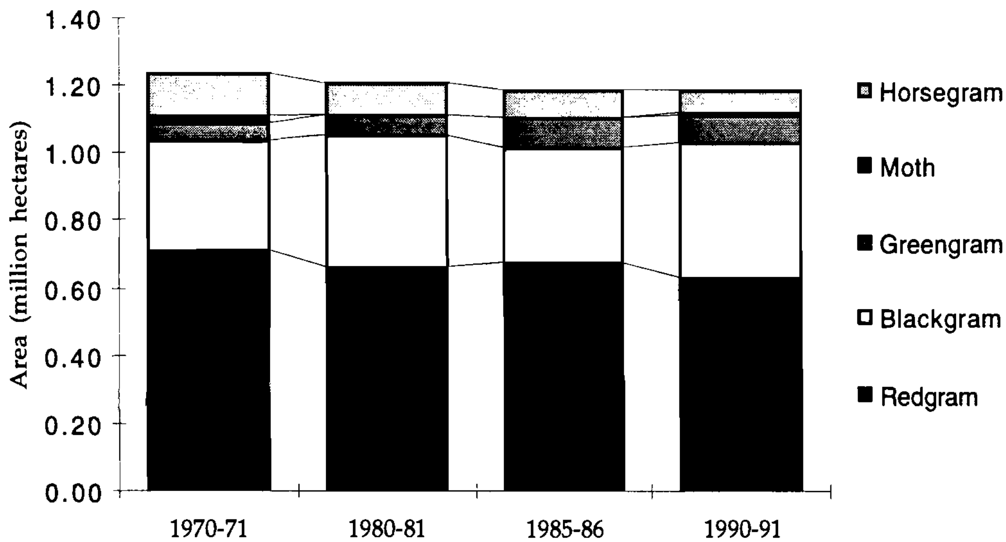

Figure 2 Major Kharif Pulses - Punjab, Haryana, Uttar Pradesh, Bihar and Bengal

Source : Government of India, Area and Production of Principal Crops in India, Various Issues, (New Delhi: Ministry of Agriculture)

Note : Area figures are three year averages.

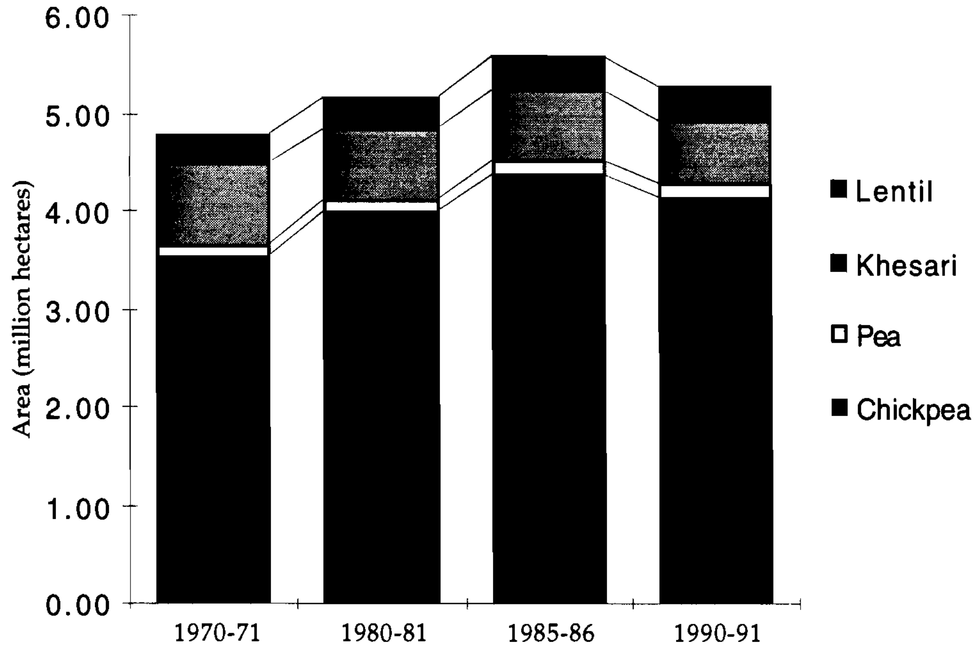

Figure 3 Major Rabi Pulses - Rajasthan, Madhya Pradesh, Maharashtra and Orissa.

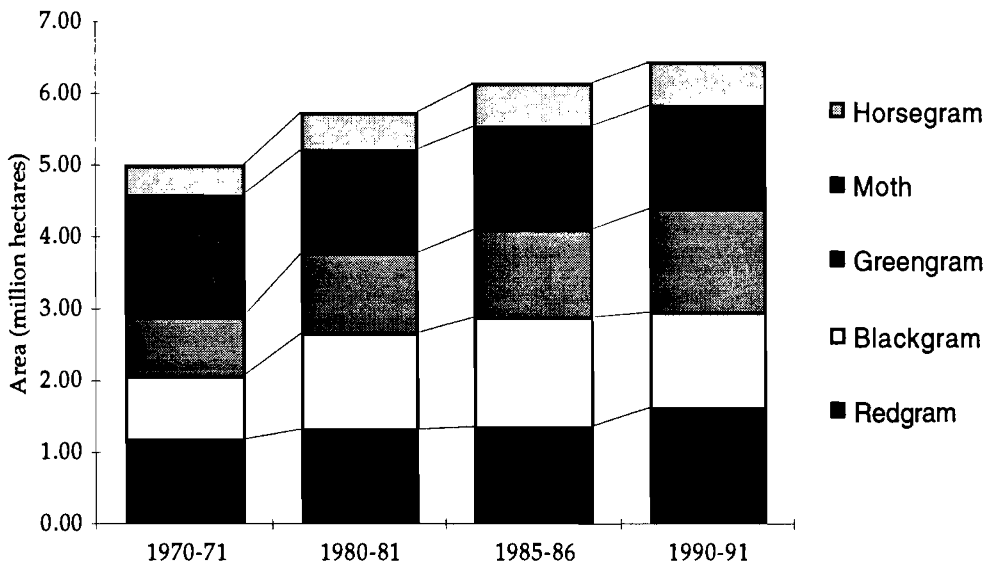

Figure 4 Major Kharif Pulses - Rajasthan, Madhya Pradesh, Maharashtra and Orissa.

Source: Government of India, Area and Production of Principal Crops, Various Issues, (New Delhi: Ministry of Agriculture).

Table 2 All India - Cultivation of Chickpea by Size-Groups of Holdings

Year	Marginal	Small	Semi - Medium	Medium	Large	All Classes
Total Chickpea Area						
1970/71	7.7	10.5	18.3	31.5	32.0	100
1976/77	7.8	10.6	19.1	34.6	28.0	100
1980/81	9.0	10.9	19.6	33.5	27.1	100
1985/86	9.5	12.0	21.0	33.2	24.2	100
Irrigated Chickpea Area						
1970/71	7.7	10.3	18.3	33.0	30.9	100
1976/77	8.8	11.4	19.9	36.4	23.4	100
1980/81	7.6	10.4	19.9	36.6	25.5	100
1985/86	8.4	15.2	23.4	34.0	19.0	100
Unirrigated Chickpea Area						
1970/71	7.7	10.6	18.4	31.2	32.2	100
1976/77	7.6	10.5	18.9	34.3	28.7	100
1980/81	9.3	11.1	19.5	32.6	27.5	100
1985/86	9.8	11.3	20.5	33.1	25.4	100

Source : Government of India, All India Report on Agricultural Census, Various Issues, (New Delhi : Ministry of Agriculture).

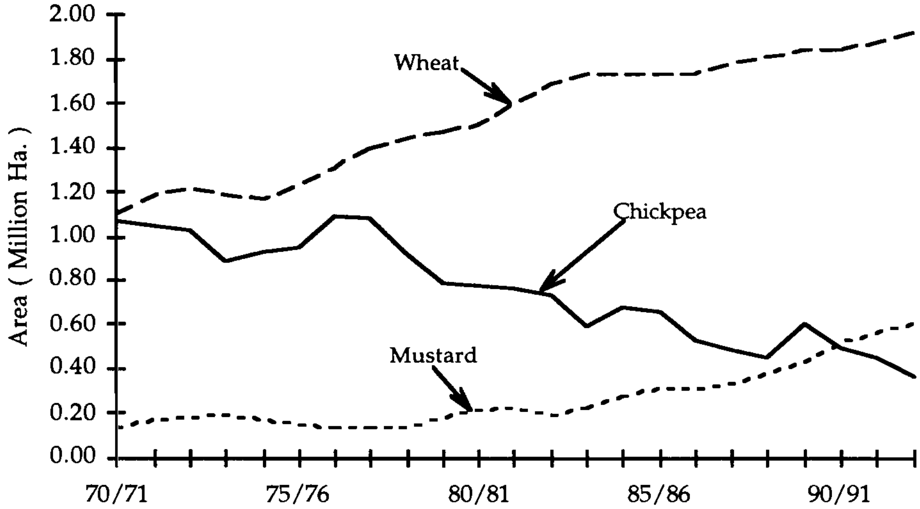

Figure 5 Haryana - Area Trends in Chickpea, Wheat and Mustard.

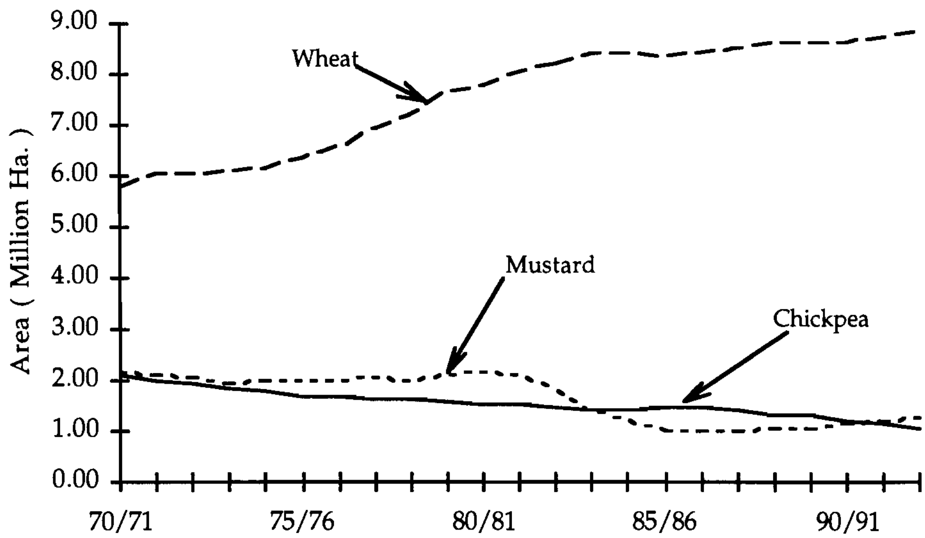

Figure 6 Uttar Pradesh - Area Trends in Chickpea, Wheat and Mustard.

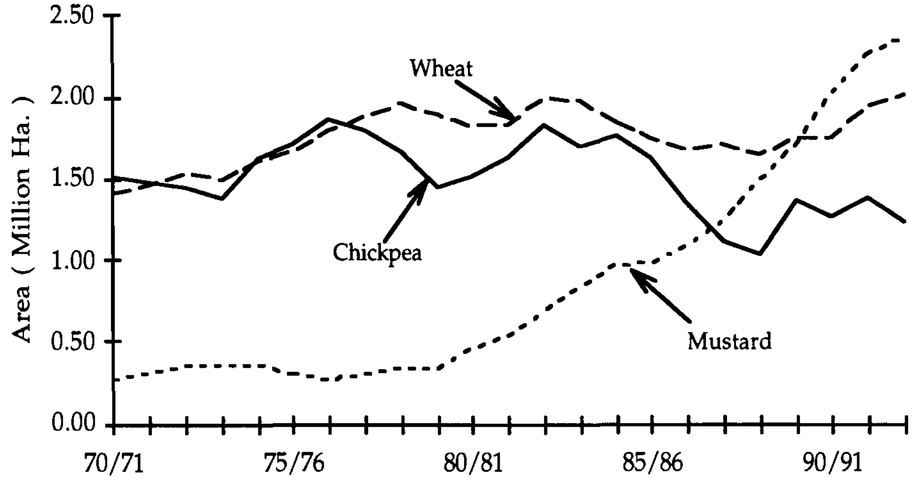

Figure 7 Rajasthan - Area Trends in Chickpea, Wheat and Mustard.

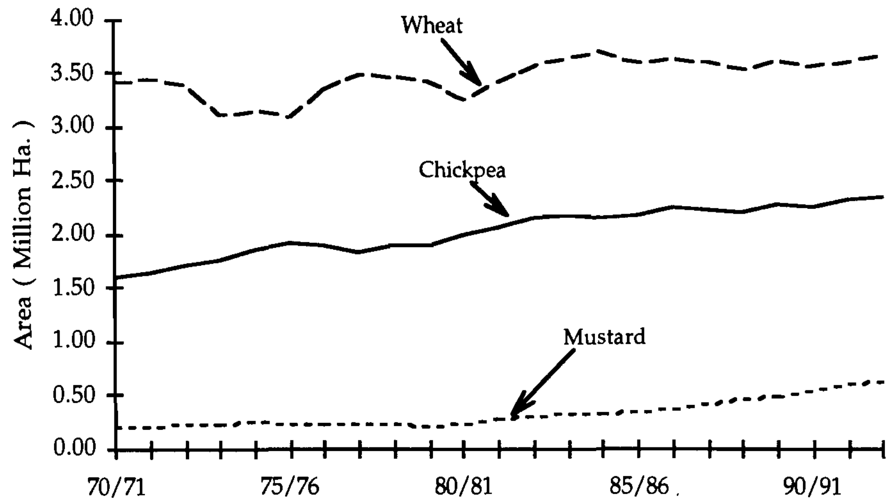

Figure 8 Madhya Pradesh - Area Trends in Chickpea, Wheat and Mustard.

3. Factors Affecting Chickpea Competitiveness

The Green Revolution and Modern Wheat Varieties

In the previous section it was seen that post-Green Revolution declines in chickpea acreage occurred more extensively in Haryana and Uttar Pradesh (to a lesser extent) than in Madhya Pradesh and Rajasthan. Much of this had to do with the technology involving the cultivation of modern wheat varieties, which were introduced as part of the Green Revolution in the former two states. Table 3 brings out the connection between the level of infrastructure available, the adoption of the new seed varieties and the resulting changes in the cropping pattern. The interconnectedness between the various elements of the Green Revolution and their impact on chickpea cultivation is clearly visible in this Punjab village example. As this village moved from traditional to modern farming methods, indicated by increased irrigation, fertilizer and mechanization, the cropping patterns also changed with rice and wheat becoming dominant crops at the expense of chickpea and non-foodgrain crops.

It is striking that in just over a decade after the new seed varieties were introduced, wheat-chickpea inter-cropping fell from 24 percent of the cropped area to zero. This indicates that the HYV technology was such that it required HYV wheat to be planted as a monoculture. This affected the traditional mixed cropping of chickpea with wheat in the northern wheat growing zones (e.g., Haryana, Western Uttar Pradesh), leading to a further decline in chickpea acreage. In addition, the shift to modern agricultural methods (like the use of tube-well irrigation, chemical fertilizer and mechanization), increased the cropping intensity and changed the crop calendar. The short duration HYV varieties made this possible and as they replaced the longer duration traditional varieties, pulses like chickpea and redgram, which no longer fit the rotation, fell out. As HYV wheat began to displace chickpea from the from irrigated areas, chickpea began to be cultivated on marginal lands.

Irrigation

The spread of irrigation affected chickpea cultivation in a variety of ways. In the states of Haryana and western Uttar Pradesh, the availability of proper irrigation facilities (e.g. tube-wells, canals), led to the rapid adoption of modern wheat varieties and the consequent decline of chickpea. Further, the irrigation levels required by HYV wheat are detrimental to chickpea cultivation as it encourages excessive vegetative growth and disease spread (Kelly and Rao 1994, A-93). Indeed, some of the Haryana farmers reported that high levels of irrigation and fertilizer caused the chickpea plants to grow rapidly and then lodge. In this sense, the mixed cropping of chickpea and wheat is not suitable. In addition to this, the returns from irrigated wheat were much higher than that of chickpea (discussed later), which further encouraged the elimination of chickpea from irrigated regions.

Table 3 : Cropping Pattern Change In The Punjab, 1965 - 78

A : Punjab State

	1965	1978	% increase
Wheat yield	1.24 t/ha	2.73 t/ha	120%
Rice yield	1.00 t/ha	2.55 t/ha	155%

B : Punjab Village Study

1. Irrigation

Percentage of cropped land irrigated

1955	1965	1978
60%	80%	100%

Power sources

1955 : 23 animal powered wells

1965 : 24 animal powered wells + 2 motor drived tube wells

1978 : 28 tubewells; mechanical pumps added to 22 of 24 older wells

2. Fertilizer

Fertilizer use increased by 300 %

Area used for composting increased four fold

3. Mechanization (tractors)

1965 : None

1978 : 3 large (50 hp) and 1 small

1986 : 9 tractors in village and no remaining bullocks

4. Cropping Pattern Changes (as % of cropped area)

Kharif crops	1965	1978	Rabi crops	1965	1978
Maize	21	40	Wheat	21	69
Sugarcane	31	27	Wheat + Chickpeas	24	0
Fodder	12	14	Sugarcane	31	26
Rice	0	10	Fodder	10	1
Cotton	17	1	Chickpeas	6	1

Adapted from : Goldman, Abe and Joyotee Smith, "Agricultural Transformations in India and Northern Nigeria: Exploring the Nature of the Green Revolutions," World Development, 1993, Vol. 23, No.2 : 245.

The effect of irrigation on the cultivation of chickpea acreage can be seen from Table 4. States like Haryana and Uttar Pradesh which witnessed the greatest increase in irrigation experienced the biggest declines in chickpea acreage. The increase in gross cropped area under irrigation has led to a decline in irrigated chickpea cultivation across all the northern states. Clearly, as irrigation spread the proportion of irrigated wheat increased, resulting in the elimination of competing crops like chickpea. In the central states irrigated chickpea actually increased acreage in Madhya Pradesh but slightly declined in Rajasthan, one of the major chickpea producing states.

Surprisingly, there has also been a general decline in unirrigated chickpea acreage, indicating that chickpea has lost ground even in dryland agriculture. The crop that seems to be replacing unirrigated chickpea is mustard (except in Uttar Pradesh).

Relative Profitability

One of the main reasons for the decline in chickpea production was its lower profitability in relation to its competing crops. Surveying the profitability values in Table 5, one can see that in Haryana prior to 1985/86 wheat was the most profitable of the three while after this period mustard became more profitable. Indeed, chickpea was the least profitable of the three. In Uttar Pradesh, the data indicates that chickpea cultivation is more profitable than wheat. However, this conclusion may be misleading due to the data being aggregated over the vastly different eastern and western regions of the state[2]. If area trends are any indication (Figure 7), then wheat should certainly be more profitable than chickpea and mustard, both of which seem to be decreasing in area. In the two main chickpea producing states the profitability trends are different from those in the northern states. In Rajasthan mustard has been consistently more profitable than wheat and chickpea at least since the beginning of 1980/81, and chickpea more profitable than wheat. However, after 1985/86, wheat has increased profitability over chickpea, making chickpea the least profitable of the three. In Madhya Pradesh, chickpea has been consistently more profitable than wheat cultivation (data for mustard are not available). However, given the profitability levels of mustard in the other states (especially Rajasthan), it would be reasonable to assume that in Madhya Pradesh too, mustard is more profitable than chickpea. A comparison of these profitability trends with their respective acreage trends (Figures 5 to 8) indicate that farmer's planting decisions are responsive and consistent to relative profits (except Uttar Pradesh).

One of the major drawbacks in inferring acreage behavior and profitability from the above estimates is that the lack of data does not allow differentiation

[2] Western Uttar Pradesh, which is well endowed with good infrastructure, is closer to Haryana and Punjab in its agriculture. Eastern Uttar Pradesh, which is not so well endowed is similar to the rest of the eastern Indo-Gangetic region.

Table 4 Changes in Irrigated and Non-irrigated Cropped Area

		Percent Irrigated		Percent Unirrigated	
		1970 /71	1991/92	1970 /71	1991/92
	Gross Cropped Area	45.0	77.9	55.0	22.1
	Chickpea	4.8	1.6	16.3	3.9
Haryana	Wheat	18.4	31.8	4.3	0.6
	Mustard	0.9	7.7	1.7	3.8
	Other	20.9	36.8	32.7	13.8
	Gross Cropped Area	36.0	57.2	64.0	42.8
	Chickpea	1.9	0.9	7.1	3.4
Uttar	Wheat	17.2	29.7	8.2	3.7
Pradesh	Mustard	0.3	1.8	9.0	3.2
	Other	16.6	24.8	39.7	32.5
	Gross Cropped Area	7.4	20.6	92.6	79.4
	Chickpea	0.5	2.6	7.4	6.6
Madhya	Wheat	2.5	8.8	14.0	6.6
Pradesh	Mustard	0.1	1.2	0.9	6.5
	Other	4.3	7.9	70.3	59.6
	Gross Cropped Area	14.7	29.1	85.3	70.9
	Chickpea	1.7	1.3	8.0	4.4
Rajasthan	Wheat	6.0	9.3	2.8	0.6
	Mustard	0.4	8.7	1.1	4.5
	Other	6.6	9.8	73.4	61.4

Note : All crops are percentage of gross cropped area.

Source : Fertilizer Association of India, Fertilizer Statistics, Various Issues, (New Delhi : Fertilizer Association of India.)

Table 5 Relative Profit of Chickpea, Wheat and Mustard (Rs/Ha)

State	Crop	1975/76	1980/81	1985/86	1990/91
	Chickpea	603	994	1902	3716
Haryana	Wheat	955	1683	2180	5199
	Mustard	-	1827	3407	8115
	Chickpea	-	1117	1856	2435
Uttar Pradesh	Wheat	26	677	693	1938
	Mustard	-	982	2013	-
	Chickpea	352	848	1465	2189
Madhya Pradesh	Wheat	361	760	1033	1682
	Chickpea	644	1330	1863	2761
Rajasthan	Wheat	381	902	1733	5085
	Mustard	-	2310	3147	5972

Source : Government of India, Cost of Cultivation of Principal Crops in India, Various Issues, (New Delhi : Ministry of Agricultutre).

Government of India, Area and Production of Principal Crops in India, Various Issues, (New Delhi: Ministry of Agriculture).

between irrigated and unirrigated agriculture. An attempt to capture this has been made by taking the irrigated and unirrigated gross revenues of these crops as indicative of their relative profitability.

Figures 9 to 16 describe the trends in gross revenue per hectare for irrigated and unirrigated varieties of chickpea, wheat and mustard. In irrigated agriculture, chickpea does not seem at all competitive with either wheat or mustard. In Haryana, wheat had the highest revenue till the mid-1980's, after which mustard takes the lead. Similar trends are apparent in Uttar Pradesh and Rajasthan. The lower revenues of chickpea are consistent with their falling share of irrigated area (Table 4). The only exception to this trend is Madhya Pradesh, where revenues of irrigated chickpea and wheat seem to be the same. Again this is consistent with the increasing irrigated chickpea acreage in this state. However, given the profitability levels of mustard in other states it would be reasonable to assume that in Madhya Pradesh irrigated mustard has greater profitability than irrigated chickpea and wheat.

In dryland agriculture, the story is somewhat different. In Haryana chickpea has lower gross revenues than both wheat and mustard. This would explain the falling share of dryland chickpea area in this state (Table 4). In Uttar Pradesh it seems that chickpea and wheat have similar gross revenues. In Madhya Pradesh, dryland chickpea seems to have a considerable advantage over wheat since 1983. Comparing these trends to Table 4, it is clear that dryland chickpea share has fallen only slightly in comparison to wheat, indicating its greater competitiveness in unirrigated agriculture. However, the jump in mustard's area share is indicative of it's greater competitiveness and profitability than either wheat or chickpea under unirrigated conditions. Rajasthan too displays trends similar to those in Madhya Pradesh. The increase in unirrigated mustard share is reflective of mustard's higher gross revenue, which would also explain the falling dryland chickpea and wheat area in the state.

From the above analysis, it is clear that chickpea has lower gross returns per hectare than either wheat or mustard under irrigated conditions. The only exception to this is Madhya Pradesh, where irrigated chickpea has higher revenues than wheat. However, it would seem from mustard's acreage trends and revenue levels (in other states) that in Madhya Pradesh mustard has higher returns. One can therefore conclude that under the criterion of gross returns, chickpea is not competitive in irrigated agriculture. In unirrigated agriculture, chickpea seems to be competitive in comparison to wheat in all the states except Haryana. However, the recent increases in mustard's gross revenue seem to have offset chickpeas' competitiveness in unirrigated agriculture too. In sum, chickpea is not competitive in either irrigated or unirrigated agriculture.

Yields and Yield Variability

Relative yields and yield variability significantly influence the

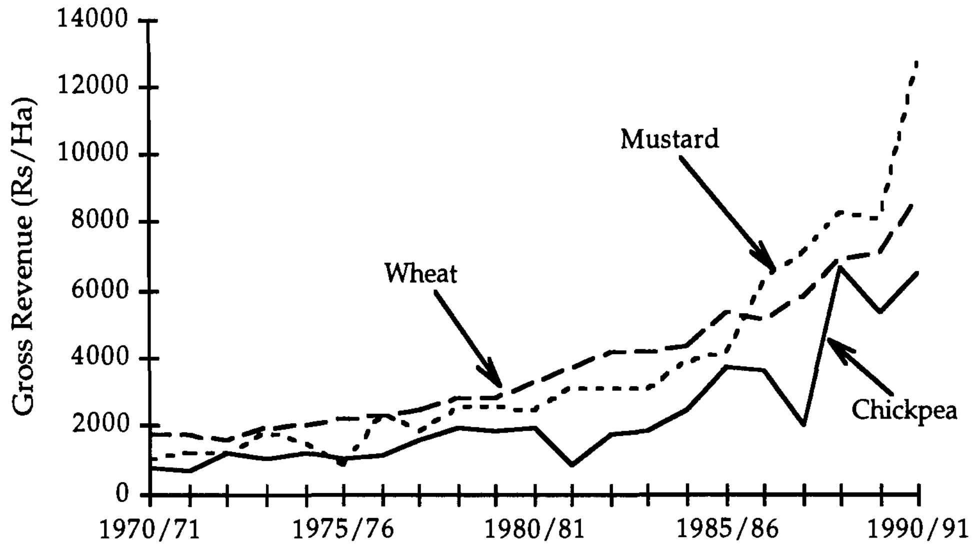

Figure 9 Haryana - Gross Revenue Per Hectare for Irrigated Chickpea, Wheat and Mustard.

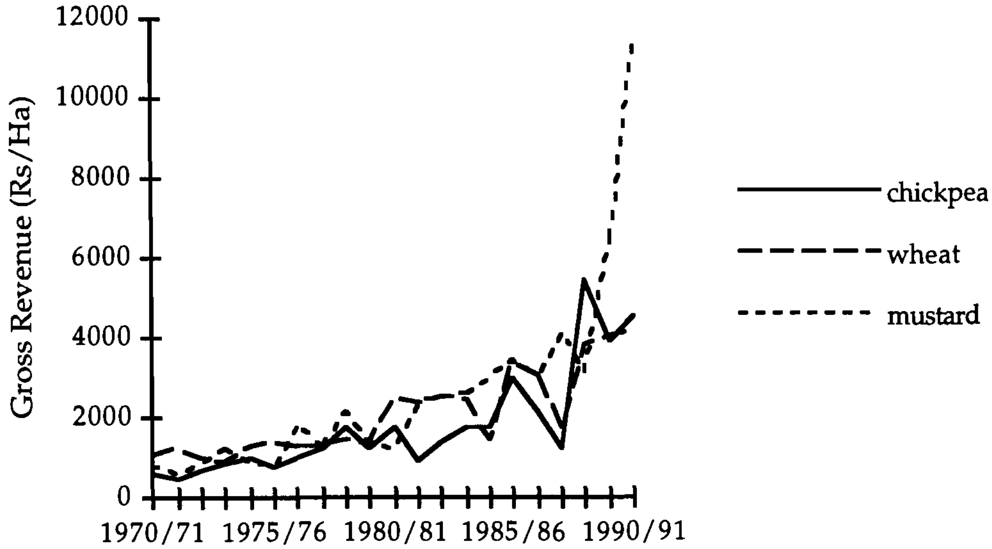

Figure 10 Haryana - Gross Revenue Per Hectare for Unirrigated Chickpea, Wheat and Mustard.

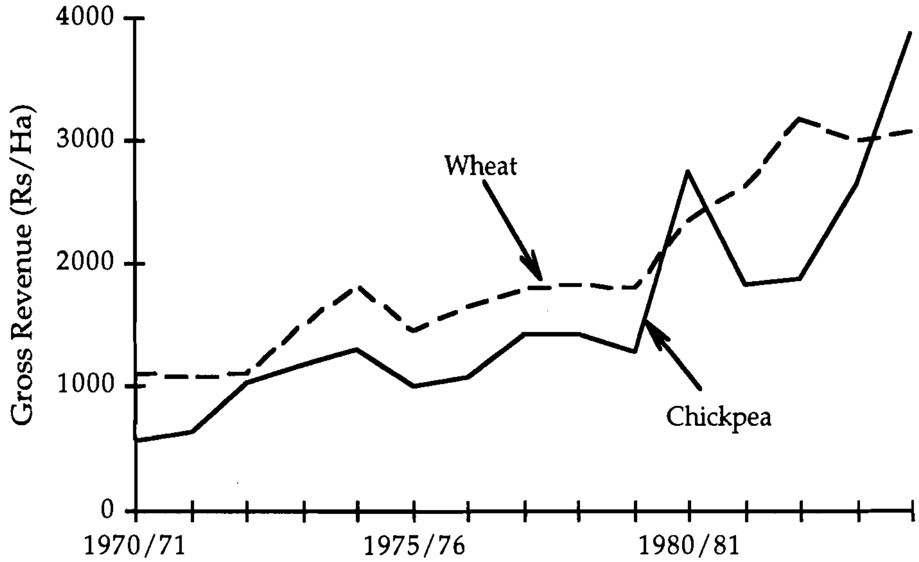

Figure 11 Uttar Pradesh - Gross Revenue Per Hectare for Irrigated Chickpea and Wheat.

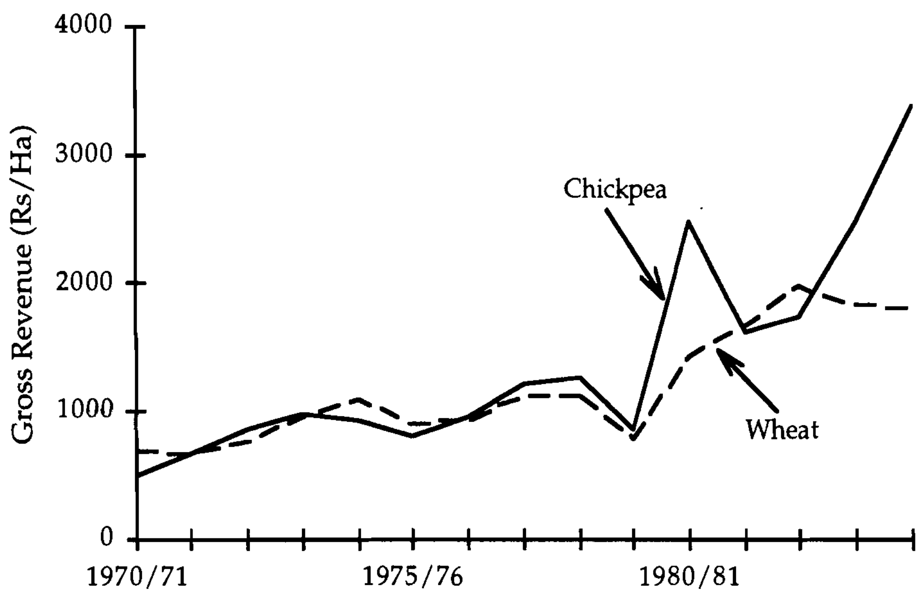

Figure 12 Uttar Pradesh - Gross Revenue Per Hectare for Irrigated Chickpea and Wheat.

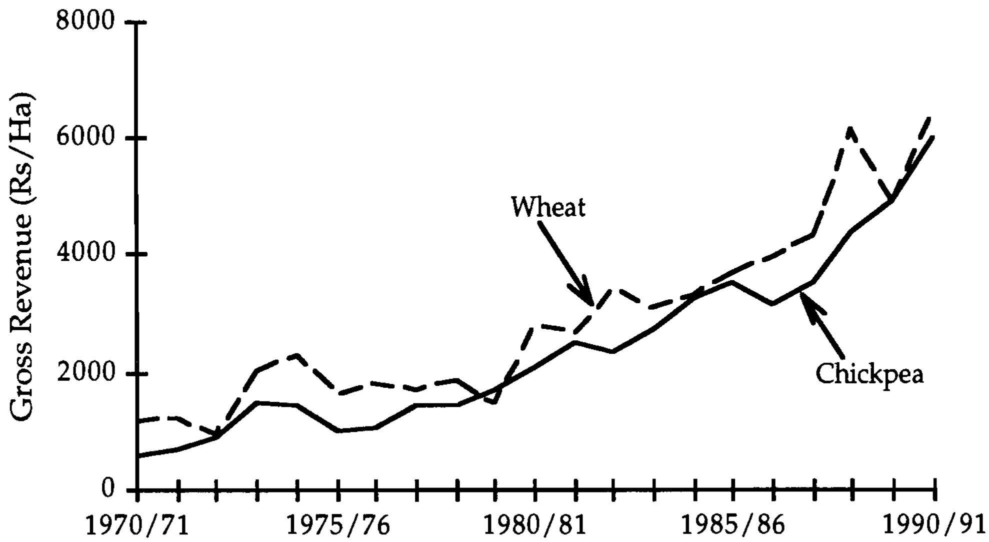

Figure 13 Madhya Pradesh - Gross Revenue Per Hectare for Irrigated Chickpea and Wheat.

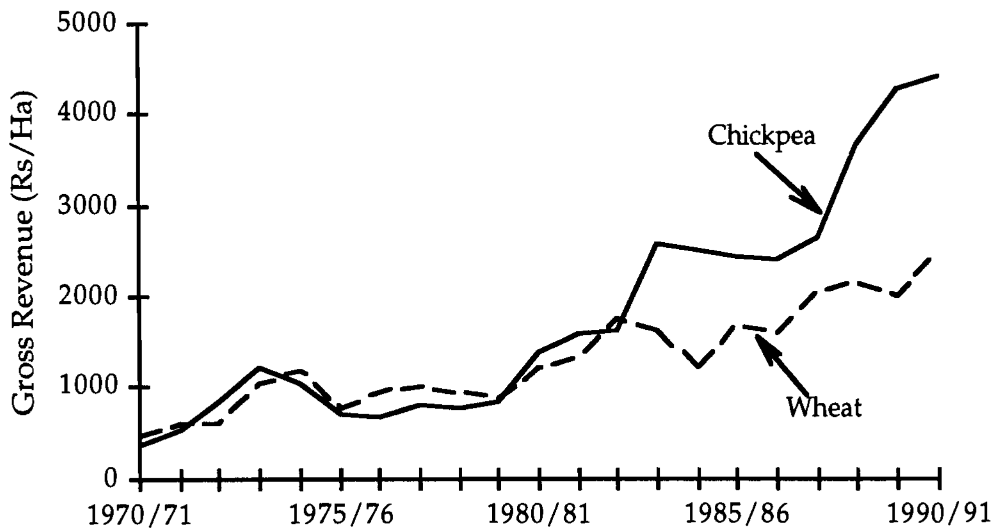

Figure 14 Madhya Pradesh - Gross Revenue Per Hectare for Unirrigated Chickpea and Wheat.

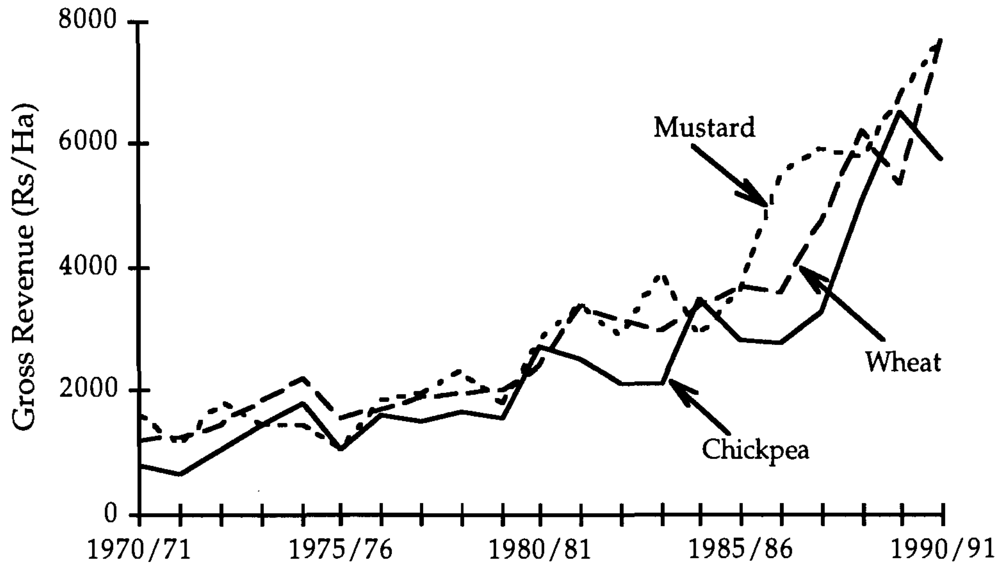

Figure 15 Rajasthan - Gross Revenue Per Hectare for Irrigated Chickpea, Wheat and Mustard.

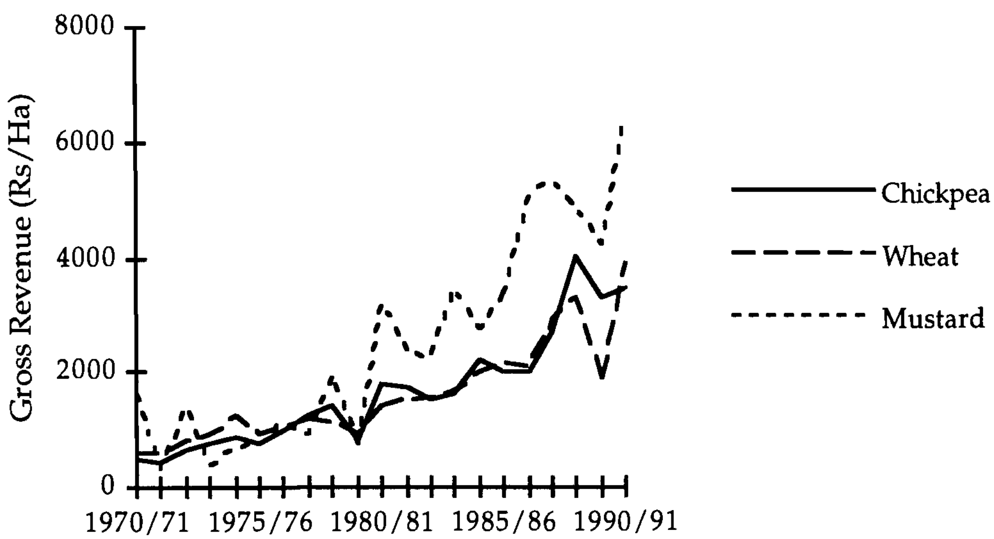

Figure 16 Rajasthan - Gross Revenue Per Hectare for Unirrigated Chickpea, Wheat and Mustard.

competitiveness of crops. Figures 17 to 24 describe the relative yields of chickpea, wheat and mustard in irrigated and dryland agriculture. If one assumes that all irrigated wheat is planted to high yielding varieties, one can clearly see the differences in the yield levels that the Green Revolution created. Clearly, the higher wheat yields were a major factor behind the increased competitiveness of wheat relative to chickpea. These figures also reveal that the unirrigated yields of chickpea and its competing crops have much wider fluctuations than their irrigated varieties. Variability of crop yields play a crucial role in farmer's decision as it makes the future uncertain. Yield variability directly translates into profit variability, something that risk averse farmers would like to do without.

Tables 6 and 7 attempt to quantify the relative yield variability of chickpea and its competing crops by estimating the coefficient of variation (CV) of their yields. In general, one can see that the CV's of irrigated crops are lower than their unirrigated counterparts as irrigation removes the dependence on the vagaries of rainfall. A comparison of irrigated and unirrigated CV's, shows that in Haryana and Uttar Pradesh, chickpea has the highest CV's in both irrigated and unirrigated agriculture. Clearly, chickpea cultivation is very risky in these states. In Rajasthan, irrigated chickpea has higher CV's than wheat and mustard, while in Madhya Pradesh irrigated wheat has higher CV's than chickpea. Unirrigated CV's show that wheat has higher yield variation in Madhya Pradesh, though there does not seem to be any consistent trend in Rajasthan.

Summarizing the Factors

From the previous analysis two different patterns in chickpea agriculture emerge - one of the northern wheat growing states of Haryana and Uttar Pradesh, the other of the central states of Madhya Pradesh and Rajasthan.

In Haryana and Uttar Pradesh, it was seen that the introduction of modern wheat varieties and the high input technique of cultivation associated with it are perhaps the most significant factors behind chickpea's decline. The cultivation of modern wheat varieties was not compatible with the traditional mixed or sequential cropping of chickpea. The higher wheat yields translated into higher profits over its competing crops, and with the growth in infrastructure like irrigation to exploit wheat's yield potential, increasing amounts of land were sown to HYV wheat. Added to this, the higher risk associated with chickpea cultivation in Haryana and Uttar Pradesh further hindered its competitiveness. Besides this, chickpea had lower revenues compared to irrigated mustard. In dryland agriculture, chickpea's situation does not change as it continued to have lower revenues and greater yield risk in comparison to wheat and mustard.

With all these factors retarding chickpea's competitiveness, lands once sown to both chickpea and wheat, were sown solely to wheat. As more land was brought under irrigation, chickpea lost acreage in the most productive regions of the Indo-

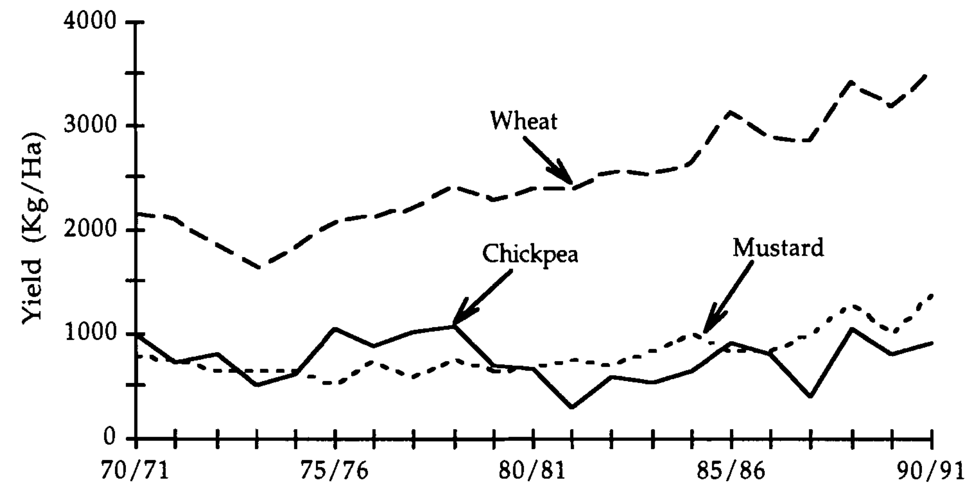

Figure 17 Haryana - Irrigated Chickpea, Wheat and Mustard Yields.

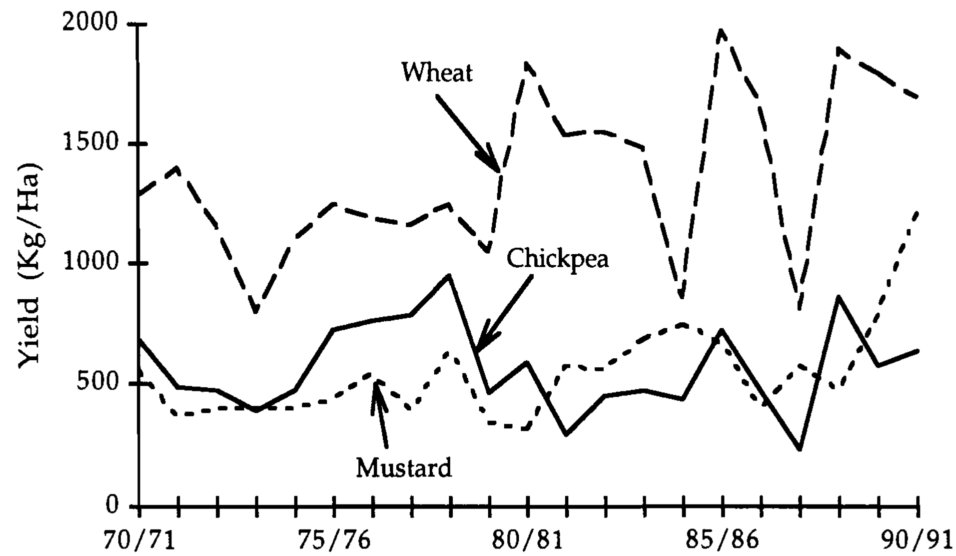

Figure 18 Haryana - Unirrigated Chickpea, Wheat and Mustard Yields.

Source : Government of India, Area and Production of Principal Crops in India, Various Issues, (New Delhi: Ministry of Agriculture).

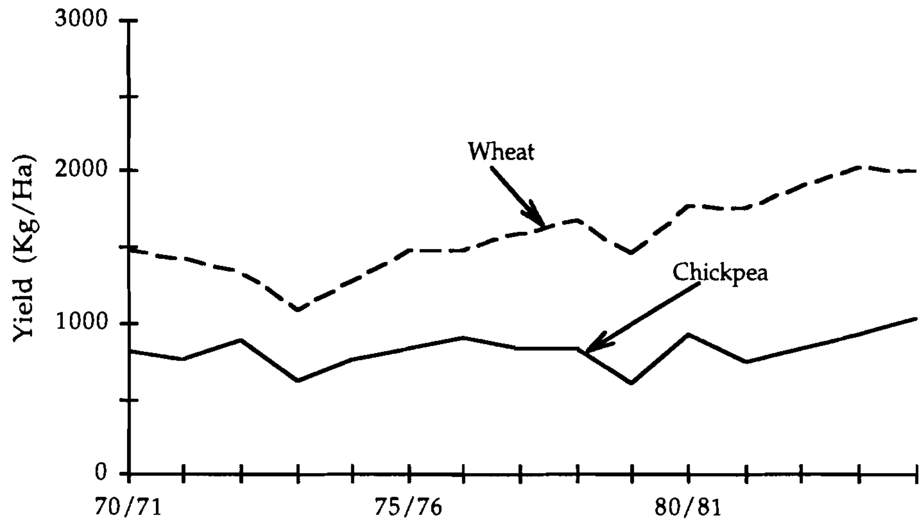

Figure 19 Uttar Pradesh - Irrigated Chickpea and Wheat Yields.

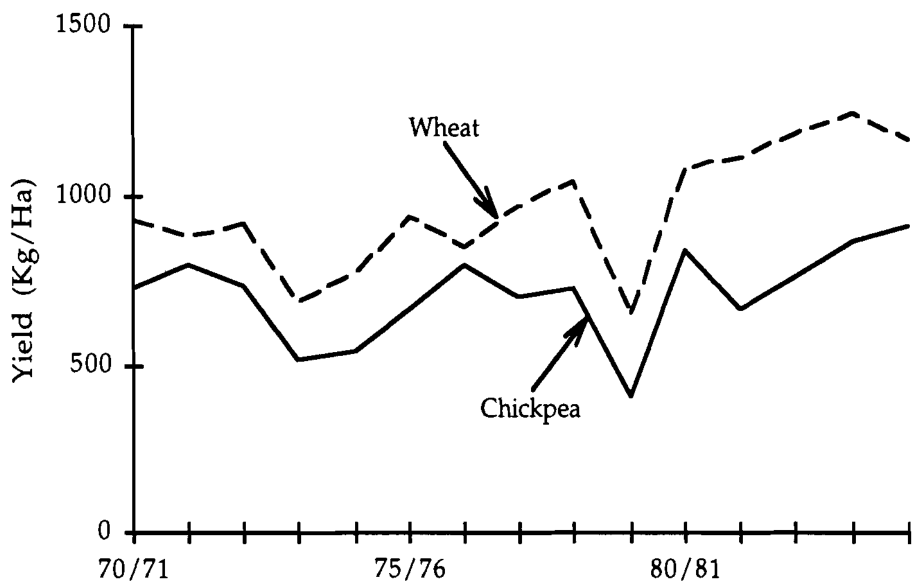

Figure 20 Uttar Pradesh - Unirrigated Chickpea and Wheat Yields.

Note : Data not available afte 1985/86.

Source : Government of India, Area and Production of Principal Crops in India, Various Issues, (New Delhi: Ministry of Agriculture).

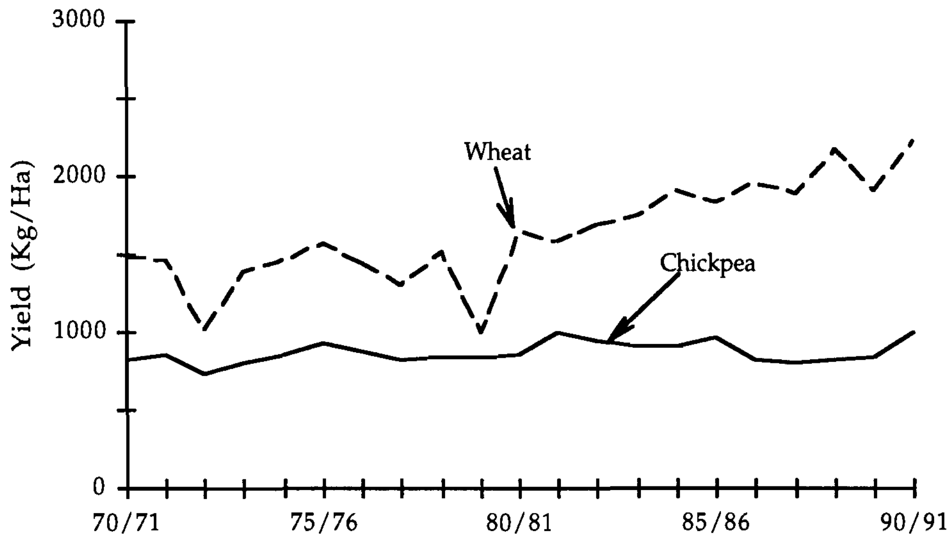

Figure 21 Madhya Pradesh - Irrigated Chickpea and Wheat Yields.

Figure 22 Madhya Pradesh - Unirrigated Chickpea and Wheat Yields.

Source : Government of India, Area and Production of Principal Crops in India, Various Issues, (New Delhi: Ministry of Agriculture).

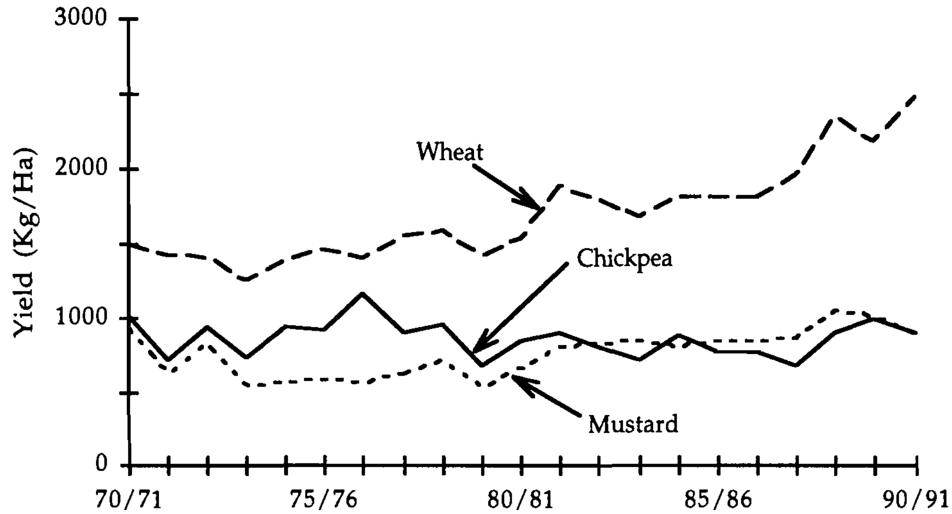

Figure 23 Rajasthan - Irrigated Chickpea, Wheat and Mustard Yields.

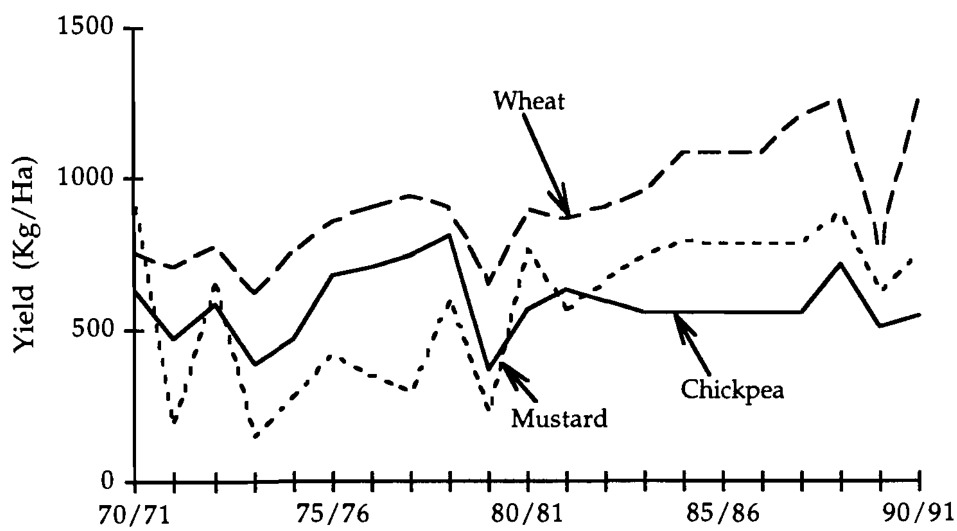

Figure 24 Rajasthan - Unirrigated Chickpea, Wheat and Mustard Yields.

Source : Government of India, Area and Production of Principal Crops in India, Various Issues, (New Delhi: Ministry of Agriculture).

Table 6 Estimates of Coefficient of Variation of Irrigated Yields

State	Crop	1970-74	1975-79	1980-84	1985-89
Haryana	Chickpea	22.6	14.8	24.7	28.1
	Wheat	9.6	5.5	4.0	7.0
	Mustard	8.9	13.2	14.7	16.7
Uttar Pradesh	Chickpea	11.6	12.6	11.5	-
	Wheat	10.4	5.3	5.9	-
Madhya Pradesh	Chickpea	5.4	4.3	5.5	6.6
	Wheat	12.9	15.1	6.5	6.1
Rajasthan	Chickpea	13.8	16.4	7.9	13.8
	Wheat	5.6	4.7	7.0	10.5
	Mustard	22.2	10.1	7.9	9.6

Table 7 Estimates of Coefficient of Variation of Non-irrigated Yields

State	Crop	1970-74	1975-79	1980-84	1985-89
Haryana	Chickpea	19.1	21.2	20.6	37.2
	Wheat	17.5	6.0	22.1	25.7
	Mustard	16.0	22.7	25.4	24.0
Uttar Pradesh	Chickpea	17.1	20.2	10.9	-
	Wheat	11.2	15.5	4.9	-
Madhya Pradesh	Chickpea	8.4	14.8	14.4	6.9
	Wheat	8.9	9.4	10.7	6.3
Rajasthan	Chickpea	17.3	23.4	4.7	12.2
	Wheat	8.2	12.5	8.0	16.0
	Mustard	70.5	33.8	12.0	11.0

Gangetic area, especially on large commercial farms (see Table 2). With chickpea steadily losing its importance in the region, its cultivation was relegated to marginal lands.

In the main chickpea producing states of Madhya Pradesh and Rajasthan, the trends in chickpea production are different from that of the north. This region, characterized by poor irrigation and other infrastructure, restricted the rapid adoption of HYV wheat. With wheat not having its yield advantage, chickpea remained profitable compared to irrigated wheat in Madhya Pradesh and Rajasthan. In addition, its lower yield risk in Madhya Pradesh clearly puts it at an advantage in this state. However, given the profitability and revenue levels of mustard in other states[3], it would seem that irrigated mustard is more competitive than irrigated chickpea in Madhya Pradesh. In Rajasthan too, irrigated mustard has higher returns per hectare making it more competitive than irrigated chickpea. Under dryland conditions in Madhya Pradesh and Rajasthan, chickpea, with higher returns than wheat and lower yield risk, is certainly more competitive. However, as in Rajasthan, where unirrigated mustard has higher returns, it is possible that in Madhya Pradesh too dryland mustard is more profitable. Therefore it seems that chickpea is not competitive in any of these states under both irrigated and unirrigated conditions.

The fact that mustard is more competitive than chickpea serves to highlight the role of prices in influencing competitiveness among crops. The price of mustard, like those of chickpea and wheat, has been influenced by the Government of India's agricultural price and trade policy. Not only this, but the prices of inputs to a large extent are also regulated by government policy. The effect of such policies on the competitiveness between crops will be discussed in the next section.

4. Government Intervention In Agricultural Markets

This section briefly describes the various methods with which the government of India intervenes in and manipulates the wheat, chickpea and mustard markets. Further, the distortion in the factor and product prices resulting from this intervention is estimated. In the next section, the effect of this policy environment on the relative competitiveness of chickpea, wheat and mustard will be quantified.

Nature of Government Intervention

The Government of India's agricultural policy influences every aspect of the country's agricultural sector. This intervention, by manipulating input and output prices, affects the incentive structure that farmers face. In product markets, this takes

[3] Mustard data for Madhya Pradesh not available. Rajasthan would serve as a reasonable indication of mustard's profitability and gross revenue levels in Madhya Pradesh.

the form of setting support prices for crops, procuring marketed surplus to maintain government buffer stocks, controlling the movement of foodgrains within the country and last but not least, distributing food commodities through its vast public distribution network. In addition to this, domestic crop prices and producers are shielded from foreign competition by various trade restrictions imposed by the government. Similarly, input markets are also subject to intervention. Inputs such as fertilizer, irrigation water, electricity and credit are supplied to farmers at subsidized rates. The distribution of inputs like fertilizers is also controlled by the government. In addition, to protect domestic subsidies, trade in these inputs (e.g. fertilizer) is channeled through government agencies. Clearly, government intervention in the agricultural sector is pervasive.

The rationale behind this interventionist policy is a concern about domestic prices. A large proportion of India's agricultural exports and imports enter into domestic consumption and changes in the prices of these commodities would significantly impact domestic prices. Therefore, agricultural imports and exports have been regulated to prevent the domestic prices of tradeable commodities from rising to levels they would have otherwise achieved. In addition to this, concerns regarding the balance of payments, terms of trade and a policy to protect domestic agriculture have supported trade regulations. In general, the trade and output price policy has "sought to maintain domestic prices at absolute levels that are commensurate with average income levels. For another, the trade policy regime has sought to impart a stability to domestic prices in the interest of both producers and consumers." (Nayyar and Sen 1994, 1188).

Input subsidies are implemented to promote the use of new inputs, influence production of specific crops and as income transfers to the agricultural sector. In India, inputs such as irrigation, fertilizer, seed, electricity and credit are provided at below market prices. However, non-tradable inputs such as irrigation and electricity are often supplied below cost. Though input subsidies were implemented to encourage production and input use, of late, subsidizing agriculture has become a political tool to win the favor of the farming community.

Intervention in Output Markets for Wheat, Chickpea and Mustard.

Of these three crops, wheat is subject to the most significant intervention. It is purchased by the Food Corporation of India (FCI) to supply the country's public distribution system (PDS) and to maintain buffer stocks in case of droughts. The FCI strives to keep the market price of wheat stable. It purchases wheat from the open market at pre-announced procurement prices, allowing simultaneous purchases by private traders. However, if the open market price in surplus states (Punjab, Haryana) equals the procurement price, then the FCI can bar private traders from purchasing wheat.[4] In this way it prevents the producer price of wheat from falling

[4] See Gulati and Sharma (1991)

below a desired level. On the other hand if the price of wheat is too high, the FCI's buffer stocks are used to maintain price stability in the open market. Further, trade in wheat is not free. Wheat imports are funneled through the FCI, while exports are also subject to quota restrictions and are handled by the Agricultural and Processed Food Products Exports Development Authority (APEDA).

Chickpea and other pulses are also subject to support prices fixed by the government. However the open market price of chickpea is higher than the procurement price, making the latter redundant. The National Agricultural Cooperative Federation (NAFED) is in charge of procuring chickpeas and other pulses for the PDS. Exports of chickpea are banned by the government, except in the case of consignments imported for re-exportation after processing. Thus, none of the domestically produced chickpea can be exported. On the other hand, there are no restrictions on imports except for an import duty of around ten per cent (1989 figure)[5].

Mustard, like other oilseeds, is subject to government support prices. However, the open market price has always been higher, making the official price redundant. Export of mustard is banned, with few imports taking place. The government of India has followed a series of measures to boost oilseed production within India. These programs, which were initiated in 1984/85 , included, among other things, the setting of support prices for mustard. Currently, mustard and other oilseeds are subject to a 'price band', wherein the procurement price of mustard is fixed at least 40 per cent above the levels recommended by the Prices Commission (Gulati 1990).

The effect of the government's output price policy on chickpea, wheat and mustard is evident from Figures 25 to 30. In the absence of trade restrictions and crop price controls farmers would have faced world prices. Hence, the divergence between the world and domestic price is a measure of the distortion created in domestic crop prices due to government intervention. In these figures two sets of domestic prices have been used - procurement and farm harvest prices. Procurement prices are pre-announced government prices. They are usually lower than the open market price and so do not affect farmer decisions. However, they do reflect the policy intentions of the government towards specific crops. Farm harvest prices are open market prices that farmers face at the farm gate. The international prices for wheat and mustard are price quotations at major centers of world trade adjusted for transportation and insurance costs to Indian ports (c.i.f. prices). All prices in these figures have been deflated by appropriate deflators.

On the basis of the comparisons illustrated in these figures, domestic prices of wheat and chickpea have been lower than world prices. This is particularly true when procurement prices are considered (Figures 25 to 28). The clear exception to this is mustard, whose procurement price is only slightly lower than its

[5] ibid.

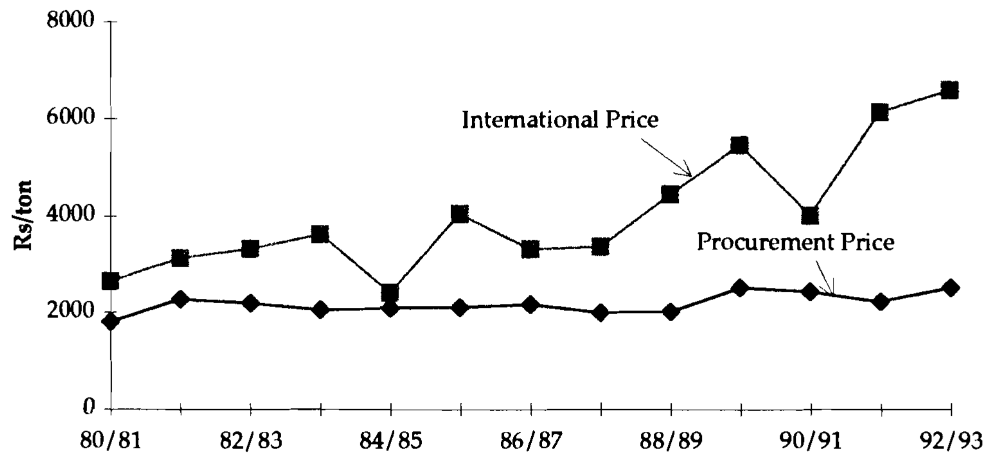

Figure 25 Chickpea - International and Domestic Price

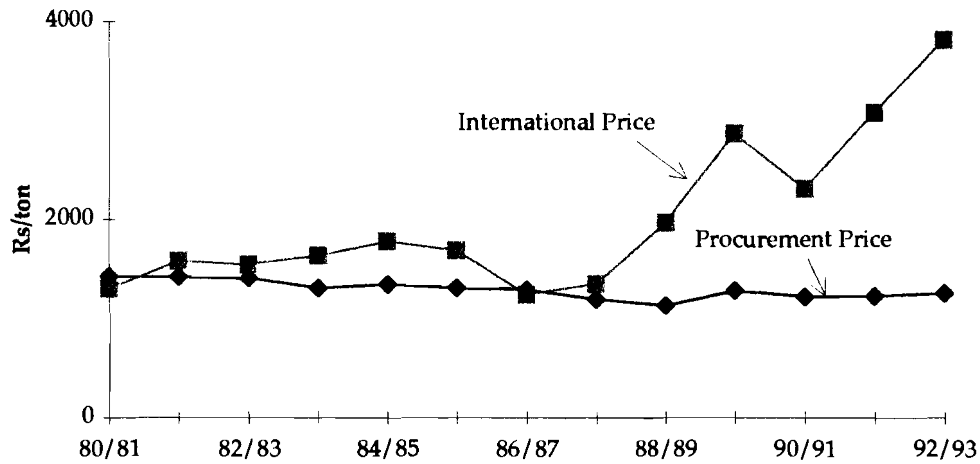

Figure 26 Wheat - International and Domestic Price

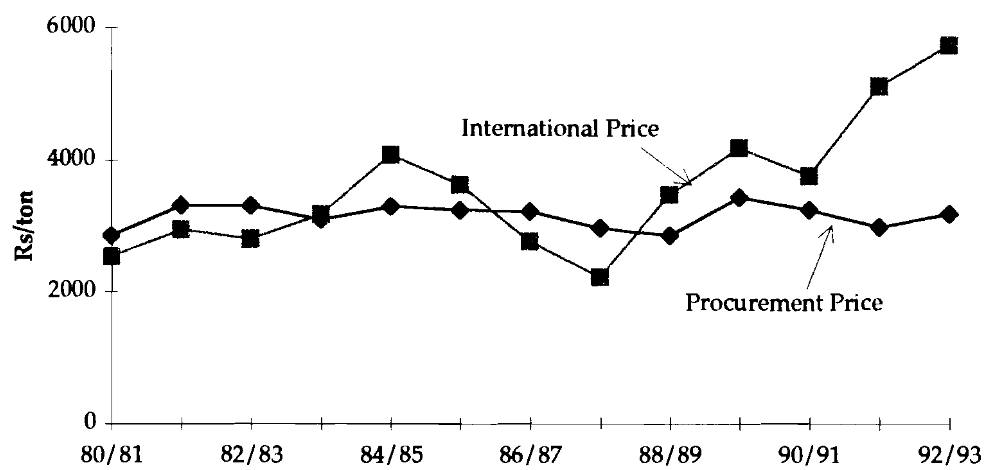

Figure 27 Mustard - International and Domestic Price

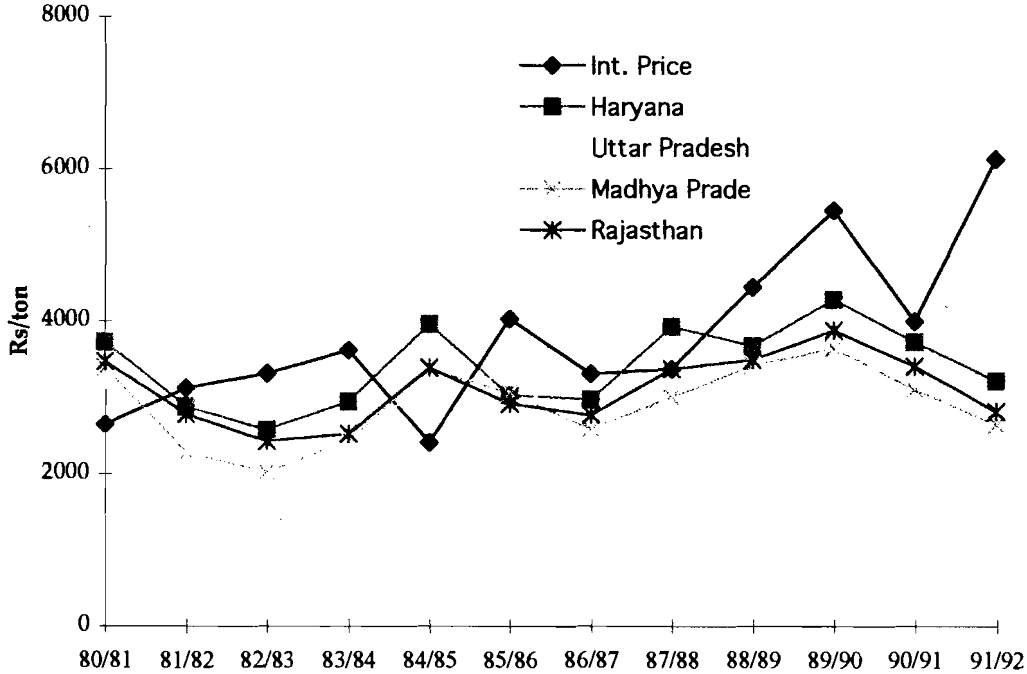

Figure 28 Chickpea - International and Farm Harvest Price

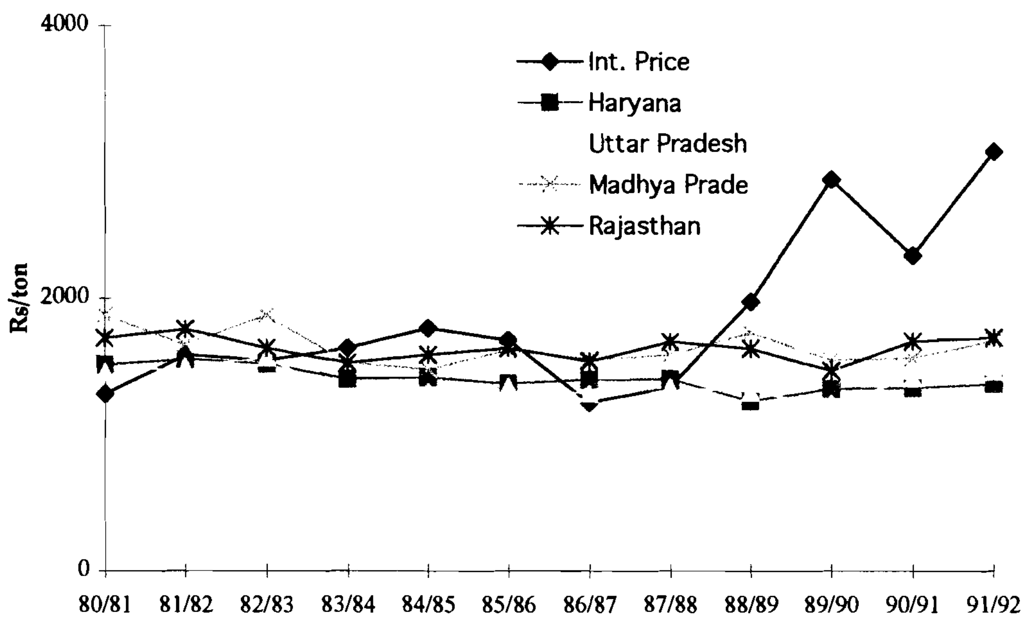

Figure 29 Wheat - International and Farm Harvest Price

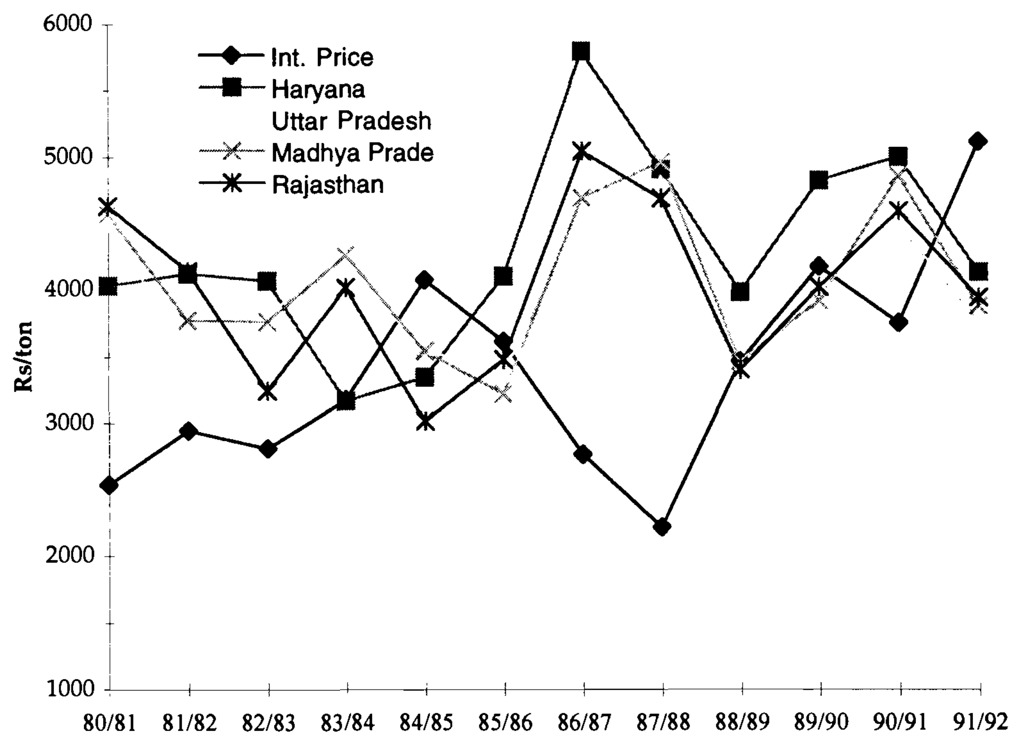

Figure 30 Mustard - International and Farm Harvest Price

international price, while its farm harvest price is at par with world prices. In addition, the procurement prices of chickpea, wheat and mustard have not kept up with their international prices. This clearly reflects the government's policy of offering low output prices to agriculture. However, the movements in the farm harvest prices seem to be positively correlated with the international prices. Further, the sudden increase in the world prices of chickpea, wheat and mustard after the mid-1980's is reflective of the devaluation in the rupee, which has continued into the 1990's. This has had the effect of making the domestic prices of these crops lower than world prices. With the ongoing process of economic liberalization taking place in India, further devaluation of the rupee is expected, which in turn would increase the gap between the domestic and world prices.

Government Intervention Through Input Subsidies

All major agricultural inputs - fertilizer, irrigation, electricity, credit - are subsidized by the government. Accessibility and use of these inputs would increase productivity, a major concern for the government. The amount of subsidy for non-traded inputs like irrigation water and electricity are particularly large and the prices charged for them often do not even cover the costs of production.

Irrigation Subsidy : Irrigation subsidies have significantly affected farmer incentives. Subsidies on irrigation and electricity used to pump water have caused distortions in the cropping pattern in favor of water intensive crops. One study concluded that the "subsidy on irrigation through electricity and canal water causes distortion in the cropping pattern in favor of water-intensive crops like paddy in Punjab and sugarcane in Maharashtra. An ex-post survey of ten major projects in the country showed that the cropping pattern that finally emerged in the command areas of these projects were significantly different from the ex-ante expectations of the project authorities, and that they were tilted heavily in favor of water-intensive crops like paddy and sugarcane."(Gulati and Sharma 1991, 227). In addition to this, canal water pricing in India is not volumetric, resulting in water-intensive crops being subsidized more than others. Among wheat, chickpea and mustard - wheat receives the largest irrigation subsidy due to its considerably higher water requirements.

This analysis estimates the net subsidy in irrigating a hectare of chickpea, wheat and mustard. For comparison purposes, the actual cost of setting and running a deep tube well at the true cost of electricity and credit was used. From this value the official water rate[6] charged by the respective states was subtracted to arrive at the total subsidy on a unit of water. The total subsidy on a hectare of a given crop is then calculated by multiplying this value by the total volume of water required for the crop's irrigation. The details of this procedure are described in Appendix A5.

[6] The official water rates refer to canal water charges.

Table 8 gives the irrigation subsidy computed for chickpea, wheat and mustard. Across all the states, the level of subsidies have progressively increased. Wheat has received the highest subsidies primarily because it is more water intensive than the other two crops. Chickpea received higher irrigation subsidies than mustard in all states except Haryana.

Fertilizer Subsidy: As would be expected, fertilizer subsidies have resulted in excessive fertilizer use. "In areas where productivity is sagging farmers tend to compensate by applying higher doses of fertilizer rather than managing fertilizer and other inputs more efficiently. This substitution of 'management' by higher and higher doses of cheap fertilizer can be stopped through widespread extension and more judicious pricing." (Gulati and Sharma 1991, 227). Though fertilizers were heavily subsidized in the recent past the government has been cutting down on fertilizer subsidies.

To calculate the fertilizer subsidy the cost of importing NPK fertilizer has been estimated by computing the import value of Urea (46% N), Diammonium-Phosphate (DAP, 18-46-0), and Muriate of Potash (60% K_2O) fertilizer at the national level with their relative consumption levels acting as weights. The import value has been adjusted for port handling charges and dealer margins. The domestic cost of NPK fertilizer has been estimated using domestic prices but with the same weights. The details of the estimation are given in Appendix A6.

Figure 31 illustrates the domestic price of NPK fertilizer in comparison to its international price. The difference between the two prices reflects the extent to which the domestic fertilizer price has been distorted by government policy. The jump in international prices after 1987/88 is due to the devaluation of the rupee. However, it seems that after a lag of a few years, domestic prices are catching up with international ones. This is due to the government reduction in fertilizer subsidies.

By encouraging the excessive use of inputs, input subsidies have also caused environmental degradation. Excessive irrigation has resulted in salinity, water-logging and the depletion of groundwater. Similarly, excessive fertilizer use has contaminated the water, in addition to having adverse effects on the soil. Besides this, the fiscal strain of providing such heavy subsidies is tremendous. In 1989-90 the fertilizer subsidy amounted to Rs 4,601[7] crore[8] ($2.8 billion[9]) while losses to state electricity boards in supplying subsidized electricity to the agricultural sector exceeded Rs. 3,000 crore ($1.8 billion). The total investment in irrigation projects (major and medium) was Rs. 61, 513 crore ($36.9 billion) at 1988-89 prices, with revenues from these projects inadequate to cover even recurring expenses. The implications of the Indian government's input and output pricing on chickpea competitiveness will be considered in the next section.

[7] See Gulati and Sharma (1991)

[8] 1 crore = 10,000,000.

[9] At 1989/90 exchange rate.

Table 8 Irrigation Subsidy (Rs/Ha)

State	Crop	1980/81	1985/86	1992/93
Haryana	Chickpea	110	258	712
	Wheat	448	919	2365
	Mustard	373	779	2027
Uttar Pradesh	Chickpea	276	664	1855
	Wheat	376	857	2331
	Mustard	27	184	666
Madhya Pradesh	Chickpea	448	900	2290
	Wheat	568	1150	2936
	Mustard	195	417	1097
Rajasthan	Chickpea	418	871	2260
	Wheat	556	1137	2924
	Mustard	183	405	1085

Source : See Appendix A5

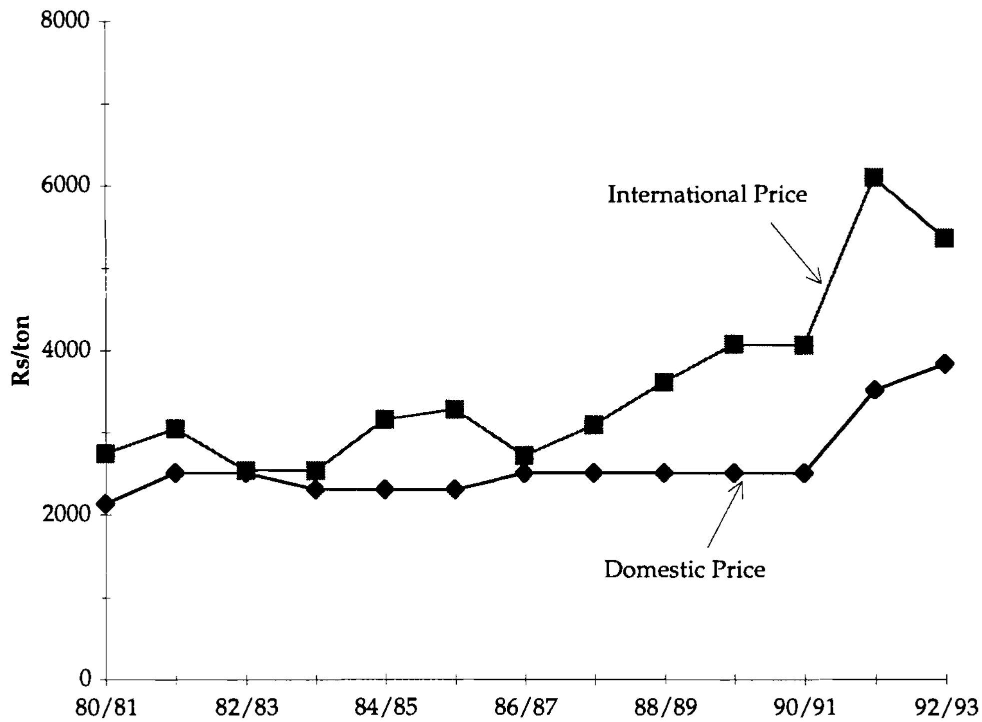

Figure 31 NPK Fertilizer - International and Domestic Price

5. Agricultural Price Policy and Chickpea Competitiveness

The aim of this section is to evaluate the effect of the distortion in product and factor prices discussed in the previous section on chickpea competitiveness. First, the pattern of incentives generated by government policy towards chickpea, wheat and mustard producers will be examined. This involves estimating the following Coefficients of Protection; Nominal Protection Coefficient (NPC), the Effective Protection Coefficient (EPC) and the Effective Subsidy Coefficient (ESC). Second, it will attempt to identify which among chickpea, wheat and mustard is the most efficient to produce, indicating comparative advantage. This requires the estimation of Net Economic Benefit (NEB) of chickpea, wheat and mustard production. All the estimation procedures mentioned are as described in Tsakok (1990).

Theoretical Framework : The Role of Prices and Opportunity Cost

The product and input prices that farmers face indicate two things. First, relative product and input prices reflect relative incentives for crop production and input use. Whether these incentives actually affect production and consumption decisions will depend on their respective price elasticities. Nonetheless, lower input prices induce increased use of inputs, while increased output prices would be an incentive to increase production. Secondly, prices which reflect the scarcity value of resources are necessary for the efficient allocation of resources in the economy.

Opportunity cost pricing involves pricing a resource or commodity at its 'true' value to the economy. It provides a benchmark price to which the prices faced by farmers can be evaluated. Prices which consistently diverge from opportunity costs are said to be distorted[10]. Comparing a price of a commodity with its opportunity cost reveals the following. First, it will show the extent of tax or subsidy on the good. Secondly, prices which consistently diverge from opportunity costs entail inefficient resource use and consequently constitute an inefficient price structure.

In assessing the opportunity cost of a commodity, it first needs to be identified as a tradable or non-tradable good. The opportunity cost of a tradable commodity is given by its border price, which is simply the world price (i.e. import or export parity price) of the commodity in question converted into the domestic currency at an appropriate exchange rate. The border price represents the opportunity cost of producing a tradable good, since the alternative to domestic production is importation. If an export, the border price is the domestic price at the point of export (port, airport), free on board the carrier (the f.o.b. price). If an import, the border price

[10] Government policy need not be the only cause of price distortion. Such distortions can exist due to lack of competitive markets (monopolistic elements etc.). Indeed, government policy might help correct the distortion in prices.

is the international price (in domestic currency) of the commodity at the national border and includes cost, insurance and freight (the c.i.f. price).

A tradeable commodity can have two sets of border prices; one under the importable hypothesis and the other under exportable hypothesis. The former uses the import parity price and the latter the export parity price. However, since India's domestic production of chickpea and mustard are insufficient to meet domestic demand, while wheat production just manages to satisfy domestic consumption, border prices of these crops have been estimated under the importable hypothesis. In addition, India is not a frequent exporter of these commodities.

The opportunity cost of nontradeable commodities is given by the domestic shadow price. This is the value of the resource or commodity in its next best alternative use. For instance, land is not a tradable commodity and its shadow price is evaluated by the value of its contribution to its best alternative use. If there is no alternative use, the shadow price is zero. If the contribution of the nontradable in the alternative use has a higher value, then the shadow price is positive and is greater than its actual observed price.

Prices and Exchange Rate Used

Two sets of producer prices have been used in this analysis. The first is the procurement price set by the government. The use of procurement prices are important for the following reasons. First, in Indian data, the procurement price takes into account the quality of output which is not the case with published open market prices (e.g. farm harvest prices). Thus, the price offered by the government for fair and average quality (FAQ) produce, makes it comparable to the imported quality of grain. Secondly, the government set prices reflect the policy (i.e. intentions) towards producers of particular crop.

The second set of producer prices used are the farm harvest prices. These represent the open market prices that farmers actually face at the farm gate. However, these prices are published without reference to the quality of the commodities they represent and so create problems in comparing them with international prices. However, they are closer to the prices that farmers face.

The coefficients of protection and comparative advantage are estimated on the import hypothesis, and the international prices used are the c.i.f. prices of the respective commodities published by the United Nation's Food and Agriculture Organization (FAO).

For estimating the NPC, EPC and ESC the official exchange rate is used. However, for the NEB estimations both the official exchange rate and the black-market rate has been used. In addition, the rupee has been undergoing gradual devaluation through the 1980's with a major devaluation occurring in mid-1991 as part of the economic liberalization agenda. The time series used in the present analysis covers the period before and after the rupee devaluation in mid 1991.

Coefficients of Protection

Coefficients of Protection indicate the relative incentives for a specific crop by determining the implied structure of taxation or subsidy on it. The three main coefficients of protection being considered in this analysis are (a) Nominal Protection Coefficient (NPC), (b) Effective Protection Coefficient (EPC), and (c) Effective Subsidy Coefficient (ESC). This section will describe the method of estimating the various protection coefficients and then give the actual estimates.

Nominal Protection Coefficient (NPC)

The nominal protection coefficient, the simplest of the protection coefficients, is the ratio of the domestic price of a crop/commodity to its border price.

$$NPC_i = \frac{P_i^d}{P_i^b}$$

where,

P_i^d = domestic (procurement) price of commodity i.

P_i^b = border price of commodity i - Foreign price x Exchange rate.

The NPC can have a range of values. An NPC > 1, indicates that domestic prices of the commodity are greater than the border price and is indicative of positive protection. It means that domestic producers are receiving a higher price due to government policy than they would have without it. The opposite holds true for NPC < 1. When NPC =1, the structure of protection is neutral and producers are facing border prices. The greater the divergence of the NPC from unity, the greater the effect of government policy on the incentive structure for production or consumption of the commodity. However, the most important thing for the purpose of this study is not the absolute level of divergence, but the relative divergence among crops. The relative divergence will reveal the relative incentives for production over time. To make the NPCs reflective of the protective structure of government policy, the domestic and border prices must represent prices which producers actually face. This usually involves adjustment in the border price. Appendix A7 describe the adjustments made in arriving at the NPC estimates.

NPC Estimates - Table 9 and 9A state the Nominal Protection Coefficients of chickpea, wheat and mustard. The NPC values in Table 9A are generally higher than Table 9 due to the former using farm harvest prices which are higher than the procurement prices used in Table 9.

A survey of the NPC values of these three crops across the states reveals the following :

1) Across all regions, mustard has had higher NPCs than wheat and chickpea. This is true of both the procurement price (Table 9) and the open market (Table 9A) estimates. This indicates that relative to wheat and chickpea, mustard producers were given a higher degree of protection. In addition, government policy was focused on providing greater protection to mustard producers.

2) Most of mustard's NPCs are greater than unity indicating that mustard farmers in India received higher prices due to government intervention than they would have without.

3) Wheat and chickpea generally had NPCs less than unity across all states, indicating that producers of these crops received lower prices than they would have in the absence of government intervention. This if true of both the open market (Table 9A) and the government price (Table 9) estimates. Thus, in terms of output prices, producers of wheat and chickpea producers were disprotected (taxed).

4) Some significant regional trends appear in comparing the NPCs of wheat and chickpea. In the wheat producing state of Haryana, the NPCs of wheat are slightly higher than chickpea till the late 1980's, after which chickpea has higher values. Moving eastward into Uttar Pradesh, wheat seems to have received slightly more protection than chickpea as far as the procurement price estimates are concerned (Table 9). However, the open market estimates (Table 9A) indicate that chickpea received slightly greater protection. In the major chickpea producing states of Madhya Pradesh and Rajasthan, the NPCs of chickpea and wheat reverse their trend. The NPC values of chickpea are higher. This is true for both the procurement and open market price estimates.

5) Across all crops and regions, the NPC values tend to decline, especially after 1989/90. This is due to the process of economic liberalization which included the devaluation of the Indian rupee. This raised the international price in comparison to the domestic price, making these crops disprotected.

From the above results it is clear that in the major wheat producing states of Haryana and Uttar Pradesh (to a lesser extent) wheat cultivators, till the late 1980's, received greater protection than chickpea producers. This is especially true when the government set procurement prices are considered, indicating an intentional price bias towards wheat and against chickpea. Further, in the major chickpea producing

Table 9 Nominal Protection Coefficients (NPC) - Procurement Price Estimates.

State	Crop	1980-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93
Haryana	Chickpea	0.61	0.66	0.59	0.51	0.72	0.47	0.56	0.51	0.40	0.41	0.52	0.32	0.34
	Wheat	0.88	0.77	0.85	0.73	0.65	0.69	0.91	0.82	0.47	0.39	0.44	0.32	0.27
	Mustard	1.22	1.23	1.31	1.06	0.84	0.97	1.29	1.57	0.90	0.91	0.96	0.63	0.59
Uttar Pradesh	Chickpea	0.62	0.66	0.60	0.52	0.73	0.47	0.57	0.52	0.40	0.41	0.52	0.33	0.34
	Wheat	0.72	0.63	0.66	0.58	0.53	0.54	0.65	0.58	0.37	0.32	0.35	0.27	0.23
	Mustard	1.21	1.22	1.30	1.05	0.84	0.96	1.27	1.53	0.88	0.89	0.95	0.62	0.58
Madhya Pradesh	Chickpea	0.70	0.76	0.69	0.59	0.88	0.54	0.68	0.63	0.47	0.49	0.66	0.38	0.40
	Wheat	0.73	0.64	0.68	0.59	0.54	0.55	0.68	0.60	0.38	0.33	0.36	0.28	0.24
	Mustard	0.99	1.00	1.03	0.86	0.72	0.79	0.98	1.10	0.71	0.72	0.75	0.52	0.59
Rajasthan	Chickpea	0.71	0.76	0.69	0.59	0.88	0.54	0.69	0.64	0.48	0.49	0.66	0.39	0.41
	Wheat	0.73	0.64	0.67	0.59	0.54	0.55	0.67	0.59	0.38	0.33	0.35	0.27	0.24
	Mustard	1.20	1.21	1.28	1.04	0.83	0.95	1.25	1.50	0.87	0.88	0.93	0.61	0.58

Source : See Appendix A7.

Table 9A Nominal Protection Coefficients (NPC) - Farm Harvest Price Estimates

State	Crop	1980-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
Haryana	Chickpea	1.22	0.83	0.70	0.72	1.32	0.67	0.77	0.99	0.72	0.70	0.81	0.48
	Wheat	0.94	0.84	0.92	0.79	0.69	0.72	1.00	0.97	0.52	0.40	0.48	0.36
	Mustard	1.78	1.56	1.65	1.09	0.86	1.25	2.47	2.78	1.28	1.31	1.53	0.88
Uttar Pradesh	Chickpea	1.07	0.72	0.58	0.62	1.08	0.72	0.65	0.79	0.63	0.61	0.73	0.41
	Wheat	0.74	0.66	0.74	0.56	0.52	0.55	0.66	0.65	0.43	0.31	0.41	0.32
	Mustard	1.99	1.30	1.53	1.45	0.91	1.00	1.85	2.63	1.04	1.06	1.34	0.79
Madhya Pradesh	Chickpea	1.37	0.77	0.63	0.70	1.47	0.79	0.81	0.95	0.81	0.70	0.83	0.45
	Wheat	0.95	0.74	0.89	0.69	0.60	0.68	0.81	0.79	0.58	0.39	0.46	0.38
	Mustard	1.54	1.13	1.16	1.16	0.77	0.79	1.39	1.76	0.86	0.82	1.10	0.68
Rajasthan	Chickpea	1.41	0.95	0.77	0.73	1.48	0.76	0.88	1.08	0.83	0.76	0.92	0.48
	Wheat	0.86	0.79	0.78	0.68	0.63	0.68	0.79	0.82	0.54	0.37	0.49	0.38
	Mustard	2.04	1.54	1.26	1.37	0.76	1.02	2.04	2.50	1.05	1.05	1.35	0.82

Source : See Appendix A7.

states of Madhya Pradesh and Rajasthan both the government's price policy and the open market prices favored chickpea over wheat cultivators. Finally, between chickpea, wheat and mustard, mustard producers were the most favored both by government policy and open market prices.

Though the NPC coefficients indicate the direction of relative incentives, their interpretation needs to be taken with some caution. First, in India, the government follows a policy of low input and low output prices. Thus, under such a policy, a crop that might appear to be taxed (disprotected) according to the NPC estimates may not actually be so when input subsidies are taken into consideration. The next two sections deal with this problem. Secondly, the exchange rate used here is the official exchange rate, which is overvalued. This tends to give higher NPC values and so underestimates the degree of taxation. However, the relative NPC levels will remain the same.

Effective Protection Coefficients (EPC)

Government policy not only affects output prices but input prices as well. Altering input prices also affects the incentives for crop production. NPCs, which were previously estimated, focus only on output prices, while EPCs take into account distortions in both output prices and the cost of traded inputs. Thus the focus of EPCs is broader than NPCs.

$$EPC_i = \frac{P_i^d - \sum_{j=1}^{k} a_{ij} P_j^d}{P_i^b - \sum_{j=1}^{k} a_{ij} P_j^b} = \frac{\text{Value Added in Domestic Prices}}{\text{Value Added in Border Prices}} \quad \ldots (2)$$

where,

P_i^d = domestic price of output i.

a_{ij} = units of input j per unit of output i.

P_j^d = domestic price of input j.

P_i^b = border price of output i.

P_j^b = border price of input j.

The EPC of a commodity is the ratio of the value added in domestic prices to value added in border prices. Value added refers to the value that is added to the output through the production process, over and above the value of purchased inputs. By subtracting the contribution of traded inputs, it gives a measure of the returns to primary factors (or resources) of production; land, labor, capital - and to non-traded inputs. In this analysis, value added is estimated using the Simple Corden Method[11].

Estimating Value Added - To estimate EPCs, information about the production structure of the crops is needed. Further, the inputs that go into the production process need to be classified into primary factors of production (land, labor, capital assets) and intermediate inputs (fertilizer, electricity, water) which are used up in the production process. These categories are further divided into tradables and non-tradables. The classification of inputs according to the above scheme is described below. In this analysis, fertilizer and seed are considered as the only traded inputs. The import value of NPK fertilizer at the national level is estimated in Appendix A6. The import price of seed has been assumed to be equal to the border price of their respective outputs. This was mainly due to lack of information regarding the import price of seed. For a justification of this see (Gulati, Hanson and Pursell, 1990, 26).

Table 10 Classification of Production Inputs for EPC Calculation.

Traded Intermediate	Non-traded Intermediate	Primary Factors
Fertilizer Seeds	Manure Electricity Irrigation	Human Labor Animal Labor Machine Labor Farm implements Farm buildings

Significance of EPC Coefficients - An EPC >1 means that domestic producers are receiving greater returns to the primary factors (land, labor, capital) and to non-traded inputs than without intervention. This is indicative of positive protection. If EPC < 1, then producers could have received higher returns if they faced border prices rather than domestic prices on inputs and outputs.

EPCs can also take on negative values. Negativity in the EPCs are indicative of basic flaws in the decision to produce the good domestically under the prevalent cost structure and productivity. Negative EPCs occur if either the value added in domestic prices (the numerator) is negative or the value added in border prices (the denominator) is negative. If the former is the case, then production is unprofitable and producers are in business only due to government subsidy. If the latter is the case, then the economy is losing foreign exchange by the domestic production of the commodity. This is because the cost of traded inputs exceeds the gross value of

[11]In Simple Corden Method :Value Added = Value of Output - cost of traded intermediary inputs. (see Tsakok (1990) for details on other methods.)

output at border prices.

A comparison of EPCs across crops and over time better reflects relative incentives for production, and the relative efficiency of production than NPCs. However, they are not indicative of absolute incentives or absolute efficiency.

<u>EPC Estimates</u> - Tables 11 and 11A describe the regional EPCs. The following can be inferred from the EPC estimates :

1) All EPCs are positive indicating that production of these three crops is profitable.

2) Further, the EPC values are almost equal to their corresponding NPCs. This indicates that traded inputs contribute very little to the value added of these crops. Consequently, government manipulation of the price of traded inputs such as fertilizer and/ or seed is of little consequence for the relative incentives of these crops. Further, they suggest that the bulk of production incentives comes from protection or disprotection accorded to primary and non-tradable inputs.

The EPC estimates do not reveal much more than the NPC values about the relative incentives given to the crops under study. A deeper analysis would involve the subsidies given to non-traded inputs. This is what will be considered in the next section.

<u>Effective Subsidy Coefficient (ESC)</u>

The Effective Subsidy Coefficient widens the focus of the EPC even further by explicitly adjusting for subsidies on the primary factors of production (land, labor and capital) and on non-traded inputs. For instance, government policy to promote the production of a crop might involve the supply of free irrigation water. This subsidy, which is not explicitly captured by the EPC, is explicit in the ESC.

$$ESC = \frac{\text{ValueAdded inDomestic Prices} \pm \text{Net Subsidy on Primary Inputs}}{\text{Value Added in Border Prices}} \quad ..(3)$$

Thus the ESC is just the EPC adjusted for net subsidies on primary inputs. The ESC is an attempt to capture the entire structure of protection of a commodity within the economy.

The main subsidies on primary and non-tradable factors of production in India are in the form of electricity subsidies, irrigation subsidies and credit subsidies. Taxes paid on land are insignificant, if not non-existent and so have been ignored. Also, subsidies on fertilizer and seed, the tradable inputs, have already been accounted for in the EPC estimates.

Table 11 Effective Protection Coefficients (EPC) - Procurement Price Estimates

State	Crop	**1980-81**	**81-82**	**82-83**	**83-84**	**84-85**	**85-86**	**86-87**	**87-88**	**88-89**	**89-90**	**90-91**	**91-92**	**92-93**
Haryana	Chickpea	0.61	0.66	0.59	0.51	0.72	0.47	0.56	0.51	0.40	0.41	0.52	0.32	0.34
	Wheat	0.89	0.76	0.84	0.72	0.65	0.69	0.91	0.82	0.45	0.37	0.42	0.30	0.25
	Mustard	1.25	1.25	1.33	1.06	0.85	0.98	1.30	1.66	0.91	0.93	0.99	0.63	0.58
Uttar Pradesh	Chickpea	0.62	0.66	0.60	0.52	0.73	0.47	0.57	0.52	0.40	0.41	0.52	0.33	0.34
	Wheat	0.71	0.61	0.64	0.56	0.52	0.53	0.63	0.55	0.35	0.30	0.33	0.25	0.21
	Mustard	1.23	1.24	1.31	1.05	0.84	0.97	1.28	1.57	0.89	0.90	0.95	0.62	0.58
Madhya Pradesh	Chickpea	0.70	0.76	0.69	0.59	0.88	0.54	0.68	0.63	0.46	0.48	0.66	0.38	0.39
	Wheat	0.73	0.63	0.67	0.58	0.53	0.55	0.67	0.58	0.36	0.31	0.34	0.26	0.22
Rajasthan	Chickpea	0.71	0.76	0.69	0.59	0.89	0.54	0.69	0.64	0.48	0.49	0.67	0.39	0.40
	Wheat	0.72	0.63	0.66	0.57	0.53	0.54	0.66	0.58	0.37	0.32	0.35	0.26	0.22
	Mustard	1.20	1.21	1.29	1.04	0.83	0.95	1.25	1.52	0.87	0.89	0.94	0.61	0.57

Table 11A Effective Protection Coefficients (EPC) - Farm Harvest Price Estimates

State	Crop	1980-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
Haryana	Chickpea	1.22	0.83	0.70	0.72	1.32	0.67	0.77	0.99	0.72	0.70	0.81	0.48
	Wheat	0.96	0.84	0.92	0.78	0.69	0.73	1.01	1.00	0.50	0.39	0.47	0.34
	Mustard	1.84	1.61	1.68	1.09	0.87	1.27	2.54	3.02	1.33	1.35	1.60	0.91
Uttar Pradesh	Chickpea	1.07	0.72	0.58	0.62	1.08	0.72	0.65	0.79	0.63	0.61	0.73	0.41
	Wheat	0.73	0.65	0.72	0.54	0.51	0.54	0.64	0.63	0.41	0.29	0.39	0.30
	Mustard	2.06	1.33	1.55	1.46	0.92	1.01	1.89	2.73	1.05	1.07	1.36	0.80
Madhya Pradesh	Chickpea	1.38	0.76	0.63	0.70	1.48	0.79	0.81	0.95	0.81	0.71	0.83	0.44
	Wheat	0.96	0.74	0.89	0.68	0.59	0.68	0.80	0.78	0.58	0.38	0.45	0.37
Rajasthan	Chickpea	1.41	0.95	0.77	0.73	1.49	0.76	0.88	1.09	0.83	0.76	0.92	0.48
	Wheat	0.87	0.79	0.77	0.67	0.63	0.68	0.78	0.82	0.53	0.36	0.48	0.37
	Mustard	2.05	1.55	1.26	1.37	0.76	1.03	2.05	2.57	1.06	1.05	1.37	0.83

Of all the agricultural subsidies, perhaps irrigation is the most significant. This analysis has tried to capture the combined effect of all these subsidies on the cost of a unit of water (see Section 4). Though this method does not capture the entire subsidy given to the agricultural sector (like subsidized machinery, fuel, electricity for threshing and other purposes), it does capture a significant part of it, especially the most important ones for agricultural production.

ESC Estimates - Table 12 and 12A describe the ESC estimates, calculated per hectare of cultivated area. The following can be observed from a survey of the ESC values:

1) The differences in the relative incentives have become much greater with the inclusion of subsidies on primary factors of production. This indicates that primary factors and inputs of production are heavily subsidized in Indian agriculture.

2) Mustard, in keeping with its trend in NPCs and EPCs, has the highest ESCs among its competing crops. In addition its ESC values are much higher than its NPC and EPC values. This indicates that mustard not only had a favorable output price policy, but that its producers received considerable input subsidies too. Clearly, government policy is strongly biased towards encouraging mustard production in India.

3) Relative incentives between wheat and chickpea change significantly when input subsidies are involved. In Haryana, wheat, on average, seems to have received neutral protection before 1988/89, with its ESC fluctuating around unity. However chickpea seems to have been disprotected, with ESCs lower than unity. This is true of both the government prices (Table 12) and the open market prices (Table 12A). This clearly indicates a policy and incentive bias against chickpea producers in Haryana. In Uttar Pradesh, the ESCs of chickpea seem higher than wheat, especially when farm harvest prices are concerned (Table 12A). However, the difference in the ratios is not that large indicating that chickpea received only slightly more protection.

4) In Madhya Pradesh, between 1980/81 and 1989/90, both wheat and chickpea were positively protected (ESC greater than unity). This is especially true of the open market prices (Table 12A). Also, the ESC values of chickpea are generally higher, especially for open market prices, indicating that chickpea producers received greater effective protection than wheat producers.

5) In Rajasthan, ESC values of chickpea are all greater than unity indicating that chickpea producers are positively protected. Wheat, with ESC ratios around unity, had neutral protection. This indicates that chickpea farmers received a higher degree of effective protection relative to wheat.

Reviewing the regional estimates of ESCs, it is clear that when all input and output subsidies are taken into consideration (i.e. effective incentives), certain crops have strong regional incentives for their production. Mustard seems to have

Table 12 Effective Subsidy Coefficients (ESC) - Procurement Price Estimates

State	Crop	1980-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93
Haryana	Chickpea	0.70	0.74	0.70	0.61	0.86	0.56	0.70	0.66	0.53	0.51	0.70	0.47	0.47
	Wheat	1.03	0.89	1.01	0.89	0.81	0.88	1.20	1.14	0.65	0.53	0.63	0.47	0.40
	Mustard	1.53	1.51	1.62	1.32	1.06	1.27	1.74	2.26	1.28	1.24	1.43	1.00	0.99
Uttar Pradesh	Chickpea	0.78	0.80	0.75	0.66	0.98	0.66	0.85	0.84	0.70	0.68	0.94	0.63	0.66
	Wheat	0.86	0.75	0.80	0.73	0.69	0.74	0.93	0.87	0.59	0.50	0.59	0.47	0.42
	Mustard	1.26	1.28	1.38	1.12	0.90	1.05	1.43	1.79	1.03	1.02	1.12	0.76	0.74
Madhya Pradesh	Chickpea	1.07	1.07	1.01	0.92	1.46	0.94	1.23	1.27	1.01	0.97	1.40	0.90	0.93
	Wheat	1.13	0.98	1.06	0.99	0.95	1.03	1.32	1.30	0.90	0.74	0.88	0.72	0.65
Rajasthan	Chickpea	0.99	1.02	0.99	0.90	1.39	0.90	1.20	1.26	0.99	0.98	1.49	1.01	1.07
	Wheat	0.95	0.83	0.90	0.83	0.77	0.82	1.03	0.99	0.67	0.56	0.65	0.52	0.50
	Mustard	1.33	1.33	1.42	1.17	0.95	0.97	1.49	1.86	1.11	1.14	1.14	1.26	0.81

Table 12A Effective Subsidy Coefficients (ESC) - Farm Harvest Price Estimates

State	Crop	1980-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
Haryana	Chickpea	1.30	0.91	0.80	0.82	1.45	0.76	0.91	1.14	0.85	0.80	0.99	0.62
	Wheat	1.10	0.98	1.09	0.96	0.85	0.92	1.30	1.32	0.71	0.55	0.68	0.51
	Mustard	2.14	1.87	1.97	1.35	1.08	1.56	3.01	3.67	1.70	1.68	2.06	1.28
Uttar Pradesh	Chickpea	1.23	0.85	0.73	0.76	1.33	0.91	0.93	1.11	0.93	0.88	1.15	0.72
	Wheat	0.88	0.78	0.88	0.71	0.68	0.75	0.93	0.95	0.65	0.49	0.65	0.53
	Mustard	2.09	1.37	1.62	1.53	0.98	1.10	2.05	2.96	1.19	1.19	1.53	0.94
Madhya Pradesh	Chickpea	1.76	1.07	0.95	1.04	2.08	1.20	1.36	1.60	1.36	1.19	1.56	0.95
	Wheat	1.35	1.09	1.28	1.09	1.00	1.16	1.46	1.49	1.10	0.80	0.98	0.83
Rajasthan	Chickpea	1.71	1.21	1.07	1.04	2.01	1.12	1.39	1.71	1.35	1.24	1.73	1.09
	Wheat	1.09	0.98	1.00	0.93	0.87	0.96	1.16	1.23	0.84	0.61	0.79	0.63
	Mustard	2.19	1.67	1.39	1.51	0.87	0.89	2.30	2.92	1.29	1.33	1.30	1.70

received the greatest incentives across all regions, a clear outcome of government policy to promote the production of this crop. Wheat has greater incentives than chickpea in Haryana. In Uttar Pradesh chickpea seems to have received slightly more protection than wheat. In Rajasthan and Madhya Pradesh chickpea was positively protected and received much stronger incentives for its production than wheat.

Coefficients of Comparative Advantage

The coefficients of protection described in the previous section measure the relative incentives given to wheat, chickpea and mustard due to government intervention. In estimating coefficients of comparative advantage, the analysis attempts to judge which crop yields the greatest return to the Indian economy, i.e. which of these three crops India has comparative advantage in production. This entails finding out which production activity (wheat, chickpea or mustard) is the most efficient (uses resources most productively). Thus, coefficients of comparative advantage are measures of relative efficiency. Coefficients of protection and comparative advantage are complementary in that together they indicate what the relative incentives in production are and where efficiency in the same activities lie.

Estimating comparative advantage involves assuming the free trade of goods internationally and the absence of government intervention. All inputs and outputs are valued at their opportunity cost. Using the equilibrium exchange rate, the value added in domestic and border prices needs to be estimated[12], by subtracting the cost of traded inputs from the output price. This value added is an indicator of benefit as it shows how much the economy would save (if an import substitute) or earn (if an export) given foreign trade opportunities open to the economy. After this, all domestic resources need to be estimated at their shadow prices, which would give the cost of domestic resources. In comparing the benefit with the cost (i.e. cost-benefit), the relative efficiency of production among the activities can be evaluated. Production activities with the greatest relative benefit are relatively the most efficient.

Net Economic Benefit (NEB)

Estimating NEB is akin to estimating the economic profitability of producing a crop. It gives the net economic returns per unit of cropped land in the presence of free trade and the absence of input subsidies. Economic profitability is different from private profitability, as in the former the prices of all inputs and outputs are valued at their opportunity cost. Profit maximizing farmers will allocate their land to a crop on the basis of the relative private profitability of that and competing crops. However, as explained, this private profitability calculation is based on the prices

[12]In this analysis, both the official exchange rate and the black-market exchange rate has been used.

that they actually face, which might be distorted by government policy. Thus in estimating the economic profitability of producing a crop(s), the profit in a distortion free, open economic environment is calculated. This value is also a measure of comparative advantage and hence efficiency. Therefore, from among a set of competing crops the crop with the highest 'economic profitability' is the one which will be produced by profit maximizing farmers in the absence of government intervention. This crop will also be the most efficient one to produce with all resources being put to the most productive use. The resulting cropping pattern will be also be most profitable socially. The details of estimating the NEB are described in Appendix A8.

Net Economic Benefit	=	Border price of output	-	Sum of traded inputs at border prices	-	Sum of domestic resources and nontraded inputs valued at domestic shadow prices

Significance of NEB - A ranking of NEBs indicates the level of efficiency for domestic production or international competitiveness. Thus in taking the difference in economic prices, the NEB is a measure of economic profitably. NEB > 0 indicate efficient use of resources as the economy is earning a profit through domestic production. It also indicates international competitiveness and comparative advantage in production. The converse is reflected in a NEB less than unity.

Estimation of NEB - Data used to calculate the NEBs were taken from cost of cultivation data published by the Government of India. Calculating the NEBs requires that all inputs, both traded and non-traded, be valued at their shadow prices. Traded inputs (fertilizer and seed) have been so valued as part of the EPC estimation. Ideally, NEB estimation requires the use of the equilibrium exchange rate for that represents the true opportunity cost of foreign exchange. In this analysis, two sets of exchange rates have been used - the official exchange rate and the black-market exchange rate. The equilibrium exchange rate is assumed to lie between these two rates. Thus, the NEB estimates from official exchange rate can be seen as the lower bound while that of the black-market rate as the upper bound, with the true NEB values lying in-between. As far as non-traded inputs are concerned, the shadow price of irrigation water has been estimated as part of the ESC calculation. However, for the NEB estimation the strong assumption has been made that other non-traded input prices (interest, depreciation etc.) as reported in the cost of cultivation statistics are equal to their shadow prices. In this analysis the shadow price of land has been ignored[13]

NEB Estimates - Tables 13 , 13A, 13B and 13C list the NEBs for chickpea, wheat and

[13] Though the opportunity cost of land could have been taken at its rental value under the assumption of competitive markets, the data source indicated that rental value was taken to be the prevailing village rates or the rates reported by the farmer. Further, the government has laws regarding fair rents. In consideration of this, the opportunity cost of land was excluded from the estimation. Thus, the estimated NEB will reflect economic profit due to the exclusion of the shadow price of land.

mustard in terms of rupees per hectare. Out of these four estimates, the first two estimates use the official exchange rate, while the latter two use the black-market exchange rate. Even though these NEB values fluctuate, the following trends are apparent.

1) In Haryana, wheat has the highest NEB values followed by chickpea and then mustard. Further, in all four estimates (Table 13 to 13C), wheat and chickpea have positive NEB values while mustard generally has negative NEB values. This indicates that Haryana has a comparative advantage in wheat and chickpea production and a comparative disadvantage in mustard production. However, the most efficient crop to produce is wheat, while mustard production results in inefficient resource allocation.

2) In Uttar Pradesh all the four estimates indicate that, in general, prior to 1987/88 chickpea has the highest NEB values followed by wheat and mustard. After this period, wheat has the highest NEB values followed by mustard and chickpea. Therefore, for the whole period (i.e. 1980/81 to 1992/93) it can be stated that wheat had the highest NEB values, though nothing specific can be said about chickpea and mustard. Further, the NEB values of all three crops, in general, are positive. Thus, Uttar Pradesh has comparative advantage in wheat, chickpea and mustard production. However, wheat production leads to the greatest efficiency.

3) In Madhya Pradesh, all the estimates, in general, indicate that chickpea had higher NEB values prior to 1989/90, while after this period wheat does. Though it is difficult to come to any definite conclusion from this trend, if wheat continues to have higher NEB values into the 1990's, then it can be stated that wheat is the most efficient crop to produce. Both wheat and chickpea have positive NEB values indicating that Madhya Pradesh has comparative advantage in both wheat and chickpea production.

4) In Rajasthan, all four estimates (especially with black-market exchange rate, Tables 13B and 13C) indicate that wheat has the highest NEB values. This is followed by mustard and chickpea. Further, all the four crops have positive NEB values indicating that Rajasthan has comparative advantage in the production of all three crops. However, wheat production results in the greatest efficiency.

The above Net Economic Benefit results show that in all the four states studied, wheat is the most efficient crop to produce. Further, Uttar Pradesh, Madhya Pradesh and Rajasthan have comparative advantage in the production of wheat, chickpea and mustard, while Haryana had a comparative advantage only in wheat and chickpea production. Consequently, mustard production in Haryana results in the greatest efficiency losses.

Table 13 Net Economic Benefit (NEB) Using Procurement Prices and Official Exchange Rate (Rs/Ha)

State	Crop	1980-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93
Haryana	Chickpea	214	421	351	775	506	1692	1053	527	1259	2694	1209	2541	3554
	Wheat	427	1099	763	1226	2176	1987	815	-1092	1895	5234	3759	7454	10622
	Mustard	-991	-641	-559	-21	906	410	-235	-1865	-381	659	-60	1253	1339
Uttar Pradesh	Chickpea	-314	516	698	1274	301	1510	789	-717	-15	957	-148	1776	2285
	Wheat	-240	514	513	924	1462	1304	611	-1400	529	2611	1666	3859	5928
	Mustard	-613	-381	-453	29	742	482	-137	-350	781	1656	1314	2365	2596
Madhya Pradesh	Chickpea	-465	-6	195	343	-319	542	178	-1231	-597	98	-695	771	1203
	Wheat	-579	-114	-78	125	434	367	-3	-1853	-738	698	210	1602	2833
Rajasthan	Chickpea	-101	340	362	546	-70	858	381	-848	-149	399	-598	467	698
	Wheat	-324	419	315	512	1218	1232	625	-245	1748	4190	3422	5927	6682
	Mustard	-147	340	323	726	1476	1083	388	-535	565	1200	839	1888	2430

Source : See Appendix 4.10, 4.11, 4.12 and 4.13.

Table 13A Net Economic Benefit (NEB) Estimates Using Farm Harvest Prices and Official Exchange Rate (Rs/Ha).

State	Crop	1980-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
Haryana	Chickpea	266	437	361	800	569	1708	1059	564	1274	2697	1179	2473
	Wheat	416	1081	748	1211	2164	1976	796	-1129	1874	5224	3733	7423
	Mustard	-1033	-673	-592	-25	903	366	-368	-1983	-455	559	-179	1177
Uttar Pradesh	Chickpea	-266	525	694	1295	353	1541	774	-710	-19	934	-200	1668
	Wheat	-237	521	529	920	1460	1309	612	-1382	550	2604	1691	3890
	Mustard	-659	-387	-469	-9	732	476	-186	-428	759	1624	1247	2324
Madhya Pradesh	Chickpea	-511	-6	201	329	-364	526	185	-1234	-603	119	-639	868
	Wheat	-558	-101	-51	138	443	386	15	-1826	-695	718	237	1640
Rajasthan	Chickpea	-158	320	353	529	-119	847	382	-865	-158	411	-561	539
	Wheat	-301	452	336	532	1242	1267	653	-190	1805	4213	3483	5994
	Mustard	-211	304	325	684	1489	1071	304	-621	537	1169	768	1839

Source : See Appendix A8.

Table 13B Net Economic Benefit (NEB) Using Procurement Prices and Black-market Exchange Rate (Rs/Ha).

State	Crop	1980-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93
Haryana	Chickpea	330	577	697	1079	827	2115	1226	860	1794	3148	1402	2816	4354
	Wheat	795	1613	1886	2067	3498	2936	1220	-289	3448	6538	4510	8449	13475
	Mustard	-845	-426	-28	437	1731	924	-15	-1498	356	1217	252	1649	2271
Uttar Pradesh	Chickpea	-168	771	1335	1803	759	2041	1012	-311	605	1414	72	2116	3162
	Wheat	-4	868	1308	1526	2368	1933	877	-867	1540	3426	2134	4470	7693
	Mustard	-500	-219	-93	362	1351	880	22	-93	1313	2072	1562	2675	3362
Madhya Pradesh	Chickpea	-342	193	713	719	15	934	359	-900	-74	483	-497	1067	1976
	Wheat	-450	85	384	470	950	729	155	-1537	-143	1201	505	1987	3934
Rajasthan	Chickpea	47	565	896	940	297	1287	572	-522	379	770	-427	705	1301
	Wheat	-98	761	1066	1052	2071	1849	895	271	2743	5032	3919	6580	8349
	Mustard	1	571	865	1165	2228	1559	583	-232	1140	1610	1082	2193	3238

Source : See Appendix A8.

Table 13C Net Economic Benefit (NEB) Estimates Using Farm Harvest Prices and Black-market Exchange Rate (Rs/Ha).

State	Crop	1980-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
Haryana	Chickpea	382	593	707	1104	890	2131	1232	897	1809	3151	1372	2748
	Wheat	784	1595	1870	2052	3486	2925	1201	-326	3427	6528	4484	8418
	Mustard	-887	-458	-61	434	1728	880	-148	-1615	282	1117	134	1573
Uttar Pradesh	Chickpea	-120	780	1332	1824	811	2073	997	-304	601	1391	19	2009
	Wheat	-8	865	1281	1494	2337	1901	830	-901	1502	3339	2080	4418
	Mustard	-546	-225	-109	324	1341	874	-28	-171	1291	2040	1496	2634
Madhya Pradesh	Chickpea	-388	192	719	706	-30	919	366	-904	-81	505	-442	1163
	Wheat	-429	98	411	484	959	749	172	-1510	-100	1221	532	2024
Rajasthan	Chickpea	-10	545	887	923	248	1275	572	-539	370	782	-390	776
	Wheat	-76	793	1087	1072	2095	1884	923	325	2801	5055	3980	6646
	Mustard	-64	536	868	1122	2241	1547	500	-318	1112	1579	1011	2144

Source : See Appendix A8.

Summary of Results

Summarizing the results of the previous analysis will shed some light on the effect of government policy on chickpea competitiveness. A survey of the NPC, EPC and ESC values showed that even though the output price policy had regional biases (as indicated by the NPCs) towards particular crops, some of these biases were more pronounced when input subsidies were taken into consideration, e.g. mustard. On the other hand, wheat, which was disprotected in the NPC analysis, had neutral to positive protection in its ESC estimates. These movements are indicative of the heavy subsidy given to non-traded inputs in Indian agriculture.

Considering effective incentives (ESC values), mustard received the highest level of protection in all the states examined. This high positive protection is due to both a favorable price policy which gave mustard farmers higher than world prices, and input subsidies. However, this high positive protection also indicates that mustard attracted more resources than it would have under free trade. Resources such as land, labor etc. were diverted into mustard production (see Figures 5.6.7 and 8) and away from chickpea and wheat production due to the higher incentives given to mustard producers.

The levels of protection between chickpea and wheat vary regionally. In the northern wheat growing regions of Haryana, wheat received neutral protection, while chickpea was disprotected. This indicates a bias in the policy against chickpea producers. In Uttar Pradesh chickpea received slightly higher protection than wheat, though the difference was not large. However, in the states of Madhya Pradesh and Rajasthan, chickpea was positively protected and had higher levels of protection than wheat. Wheat received positive protection in Madhya Pradesh and neutral protection in the Rajasthan. Thus in these major chickpea producing states, chickpea received strong incentives for its production and even greater incentives than wheat. This clearly indicates that the price policy favored chickpea producers in these states. However, across all states mustard received the greatest protection and production incentives.

On estimating the Net Economic Benefit, it became clear that across all the states, wheat is the most efficient crop to produce. All the states had comparative advantage in the production of chickpea, wheat and mustard, except for Haryana which has a comparative disadvantage in mustard production. Therefore the high effective incentives given to mustard, especially in Haryana, are misplaced and lead to inefficient resource use. Consequently, the country would be better off in reducing/stopping mustard production and relying on imports for its domestic requirements. A similar argument holds for chickpea production, especially in Madhya Pradesh and Rajasthan where it enjoys high levels of positive protection.

6. Summary And Conclusions

This chapter will integrate the findings of the previous chapters and based on this, venture some policy suggestions.

Summary of Results

In Section 2, the national growth rates of various crops revealed that while total foodgrain production was showing strong positive rates of growth, pulses in general and chickpea in particular were performing dismally. Further, the negative growth in chickpea acreage and production was responsible for the stagnation of national pulse acreage and production. Chickpea had a high positive growth rate in area and production prior to the Green Revolution, which turned negative in the post-Green Revolution period The declines in chickpea acreage which occurred in the Indo-Gangetic region, especially in the wheat growing states of Punjab, Haryana and western Uttar Pradesh as a consequence of the spread of HYV wheat were mainly responsible for this negative growth in national chickpea acreage. However, chickpea acreage did increase in the central states, though these increases were inadequate to compensate for the acreage lost in the north. In addition, the low productivity of the central regions further reduced the compensatory effect of their increasing chickpea acreage. Finally, it was also seen that the cultivation of chickpea and other pulses was being progressively shunned by large operational holdings, the main market producers. This was especially true of irrigated holdings. Thus, behind the stagnation of pulse production in India is the marginalization of chickpea in the most productive regions and operational holdings.

Section 3 focused on analyzing the specific factors behind chickpea's decline. The area of study was narrowed to Haryana, Uttar Pradesh, Rajasthan and Madhya Pradesh. The first two (representative of the northern wheat growing zones) have experienced steep declines in chickpea acreage in the post-Green Revolution period, while the latter two have experienced increasing acreage (Rajasthan has only recently experienced decreasing chickpea area). In analyzing the factors affecting chickpea competitiveness, there emerged two different patterns in chickpea agriculture - one of the Indo-Gangetic states of Haryana and Uttar Pradesh, the other of the central states of Madhya Pradesh and Rajasthan.

In Haryana and Uttar Pradesh, it was seen that the introduction of modern wheat varieties and the high input technique of cultivation associated with it are perhaps the most significant factors behind chickpea's decline. The cultivation of modern wheat varieties was not compatible with the traditional mixed or sequential cropping of chickpea. The higher wheat yields translated into higher profits compared to competing crops, and with the growth in infrastructure such as irrigation to exploit wheat's yield potential, increasing amounts of land were sown to HYV wheat. Added to this, the higher risk associated with chickpea cultivation in Haryana and Uttar Pradesh further hindered its competitiveness. Besides this, chickpea was not competitive with irrigated mustard. In dryland agriculture, chickpea's situation did not change as it continued to have lower revenues and greater yield risk in comparison to wheat and mustard.

In the main chickpea producing states of Madhya Pradesh and Rajasthan, the trends in chickpea production were different from those of the north. This region, characterized by poor irrigation and other infrastructure, restricted the rapid adoption of HYV wheat. With wheat not having its yield advantage, chickpea remained profitable compared to irrigated wheat in Madhya Pradesh and Rajasthan. In addition, its lower yield risk in Madhya Pradesh clearly put it at an advantage. However, given the profitability and revenue levels of mustard in other states[14], it would seem that irrigated mustard is more competitive than irrigated chickpea in Madhya Pradesh. In Rajasthan too, irrigated mustard had higher returns per hectare making it more competitive. Under dryland conditions in Madhya Pradesh and Rajasthan, chickpea with higher returns than wheat and lower yield risk is certainly more competitive. However, as in Rajasthan, where unirrigated mustard has higher returns, it is possible that in Madhya Pradesh too, dryland mustard is more profitable. Therefore it was concluded that chickpea is not competitive in any of these states under both irrigated and unirrigated conditions.

Sections 4 and 5 focused on the role of the government's agricultural price policy on chickpea competitiveness. It was seen that the input and output markets for chickpea, wheat and mustard were manipulated by government policy. Particularly important were the output prices and irrigation subsidy offered to producers. In Section 5 the effect of this policy on the incentive structure for chickpea, wheat and mustard production was quantified by estimating the various coefficients of protection. Considering effective incentives (ESC estimates), it was seen that across all states, mustard producers received the highest protection relative to wheat and chickpea, and consequently the greatest production incentives. Clearly, the increasing mustard acreage in these states is testimony to this. The levels of protection between chickpea and wheat vary regionally. In the northern wheat growing regions of Haryana, wheat received greater protection than chickpea. This indicates a policy bias against chickpea in this region. In Uttar Pradesh chickpea received slightly higher protection than wheat, though the relative difference was not large. In Madhya Pradesh and Rajasthan, chickpea had higher levels of protection than wheat. Thus in these states, government intervention provided chickpea farmers with strong production incentives. A comparison of the acreage trends and profitability of these crops will show that they are generally in line with their incentive structure. Therefore, from an analysis of the coefficients of protection it is clear that certain crops received strong regional incentives for their production, which are generally in line with their profitability and acreage trends.

[14] Mustard data for Madhya Pradesh not available. Rajasthan would serve as a reasonable indication of mustard's profitability and gross revenue levels in Madhya Pradesh. However, it should be noted that all the crops are affected similarly. The NEB calculations are described in Appendix A8.

On estimating the Net Economic Benefit, it became clear that across all the states, wheat is the most efficient crop to produce. In addition, all states had comparative advantage in the production of chickpea, wheat and mustard, except for Haryana, which has a comparative disadvantage in mustard production. Therefore the high effective incentives given to mustard in Haryana are misplaced and lead to inefficient resource use.

Policy Implications

From the above discussion, it becomes clear that many factors affected chickpea's competitiveness in Indian agriculture. Factors such as low yields, high yield variability and incompatibility with HYV agriculture are technological constraints. As long as chickpea's low yields inhibit its profitability, it will not be competitive with wheat in irrigated agriculture. This is clearly the case in Haryana and Uttar Pradesh. Further, with the spread of proper irrigation in the lesser productive regions of the country (e.g. Madhya Pradesh and Rajasthan) and the consequent increases in HYV wheat acreage further declines in chickpea acreage and production can be expected over the long term.

With no significant technological breakthroughs in chickpea, the only other alternative in making it competitive would be to tinker with the price policy and make it more profitable than its competing crops. Conversely, the government can also make chickpea's competing crops less attractive to farmers by lowering the input subsidies for wheat and mustard production. This would include charging the full cost of inputs such as irrigation, electricity, fertilizer, etc. If output prices are not freed, such a policy will have little impact on chickpea's competitiveness in Haryana and Uttar Pradesh, given that it is not competitive with unirrigated wheat and mustard in these states. In the central regions of Madhya Pradesh and Rajasthan, where neither wheat nor mustard have a yield advantage over chickpea, such a policy would enhance chickpea's competitiveness and consequently increasing acreage can be expected.

Even though reducing or eliminating input subsidies is a step towards efficient pricing and would bring about significant fiscal savings for the government, it is not the best solution if pursued without output price liberalization and would be perceived to be unfair. This is because farmers would be required to pay the full cost of inputs while receiving less than world prices for their output (except mustard) with resulting adverse changes in incentives. Besides this, the government would still be shouldering the burden of subsidizing output prices (e.g. mustard). The obvious and most efficient solution would be to remove barriers so that farmers would face world prices. In effect this would be a free trade scenario with no input subsidies.

The NEB coefficients indicated that under such free trade conditions, wheat is the most efficient and profitable crop to produce. Diverting resources used in the production of chickpea and mustard into wheat production would result in the most efficient allocation of resources. However, such a step directly conflicts with any policy aimed at increasing chickpea acreage. Further, given that wheat has the greatest economic profitability among its competing crops, declines in chickpea (and mustard) acreage can be expected.

Though declines in chickpea acreage would conflict with the national goals of food self-sufficiency and the use of chickpea to diversify the cropping pattern, there are significant benefits to be realized from such a free trade situation. First, the removal of input subsidies, which the Indian government is currently considering, would not only reduce the fiscal burden on the government, but would also force farmers to be more judicious in their use of these inputs. The scarce government funds, which are being spent on supporting inefficient resource use can be usefully used elsewhere. Secondly, the environmental damage done by excessive fertilizer and irrigation use would be controlled if such a input pricing policy takes effect. Finally, the freeing of output prices would in the case of mustard and chickpea (in central India), would relieve the government of having to subsidize the output prices of these crops. Therefore, overall significant and direct savings to the government will result, besides the added benefits of conserving scarce resources and the environment.

One of the common arguments against establishing such a free trade scenario is that self-sufficiency in food production is sacrificed. If the aim of achieving self-sufficiency in chickpea and mustard production is to save foreign exchange by reducing imports, a policy of raising the level of protection on these crops (as was done for mustard) would be counter productive. Foreign exchange can be saved with greater efficiency if resources were allocated to wheat and the surplus wheat exported to earn foreign exchange. The export earnings can be then be used to purchase chickpea from the world market, a policy that would lead to a net savings in foreign exchange without compromising on economic efficiency. However, if the idea behind self-sufficiency is food security or similar concerns, then the resulting economic efficiency of positively protecting chickpea and mustard would have to be taken as a cost of this self-sufficiency.

Appendix A1 : Import Prices for Selected Commodities and World Inflation Index

Year	Chickpea Import (tons)	Chickpea Import Value ('000 Rs)	Chickpea Unit value (Rs/ton)	Wheat ($/ton)	Mustard ($/ton)	MUV Index (1981/82=100)
1980-81	6139.00	16183.00	2636.10	164.00	305.00	99.53
1981-82	1244.00	3876.00	3115.76	177.00	320.00	100.00
1982-83	1194.00	3892.00	3259.63	161.00	285.00	98.42
1983-84	2873.00	10155.00	3534.63	158.00	299.00	97.76
1984-85	2303.00	5442.00	2363.00	153.00	342.00	97.87
1985-86	5337.00	21694.00	4064.83	138.00	287.00	100.84
1986-87	8340.00	32569.00	3905.16	115.00	246.00	117.77
1987-88	7531.00	27899.00	3704.55	114.00	172.00	109.87
1988-89	7587.00	36222.00	4774.22	146.00	240.00	107.32
1989-90	941.00	5092.70	5412.01	171.00	229.00	99.28
1990-91	44989.00	190165.00	4226.92	137.00	204.00	105.66
1991-92	4812.00	30124.00	6260.18	129.00	199.00	102.17
1992-93	35993.00	247369.00	6872.70	151.00	210.00	104.24

Source : UNFAO, Production Yearbook, Various issues, (Rome : Food and Agricultural Organization of the United Nations).

Government of India, Bulletin on Food Statistics, Various issues, (New Delhi : Ministry of Agriculture).

Appendix A2 Deflated Import Prices and Exchange Rates

Year	Chickpea Unit value (Rs/ton)	Wheat ($/ton)	Mustard ($/ton)	Official Exchange Rates ($/Rs)	Blackmarket Exchange Rate ($/Rs)
1980-81	2648.63	164.78	306.45	0.13	0.12
1981-82	3115.76	177.00	320.00	0.11	0.10
1982-83	3311.87	163.58	289.57	0.11	0.08
1983-84	3615.76	161.63	305.86	0.10	0.08
1984-85	2414.46	156.33	349.45	0.09	0.07
1985-86	4031.07	136.85	284.62	0.08	0.07
1986-87	3315.80	97.64	208.87	0.08	0.07
1987-88	3371.67	103.76	156.54	0.08	0.07
1988-89	4448.70	136.05	223.64	0.07	0.06
1989-90	5451.13	172.24	230.66	0.06	0.05
1990-91	4000.39	129.66	193.07	0.06	0.05
1991-92	6127.43	126.26	194.78	0.04	0.04
1992-93	6593.08	144.86	201.46	0.04	0.03

Source : UNFAO, Production Yearbook, Various issues, (Rome : Food and Agricultural Organization of the United Nations).

Government of India, Bulletin on Food Statistics, Various issues, (New Delhi : Ministry of Agriculture).

Cowitt, Phillip P. , ed. World Currency Yearbook. Brooklyn, New York: Currency Data & Intelligence, Inc.,Various issues.

Appendix A3 : Procurement Prices and General CPI Index for Agricultural Laborers

Year	Chickpea (Rs/ton)	Wheat (Rs/ton)	Mustard (Rs/ton)	Rural CPI (1981/82=100)	Deflated Chickpea (Rs/ton)	Deflated Wheat (Rs/ton)	Deflated Mustard (Rs/ton)
1980-81	1650.00	1300.00	2600.00	91.30	1807.25	1423.90	2847.79
1981-82	2270.00	1420.00	3300.00	100.00	2270.00	1420.00	3300.00
1982-83	2350.00	1510.00	3550.00	107.40	2188.08	1405.96	3305.40
1983-84	2400.00	1520.00	3600.00	116.50	2060.09	1304.72	3090.13
1984-85	2450.00	1570.00	3850.00	117.20	2090.44	1339.59	3284.98
1985-86	2600.00	1620.00	4000.00	123.90	2098.47	1307.51	3228.41
1986-87	2800.00	1660.00	4150.00	129.00	2170.54	1286.82	3217.05
1987-88	2900.00	1730.00	4300.00	145.10	1998.62	1192.28	2963.47
1988-89	3250.00	1830.00	4600.00	161.60	2011.14	1132.43	2846.53
1989-90	4210.00	2150.00	5750.00	167.90	2507.44	1280.52	3424.66
1990-91	4500.00	2250.00	6000.00	185.30	2428.49	1214.25	3237.99
1991-92	5000.00	2750.00	6700.00	224.80	2224.20	1223.31	2980.43
1992-93	6000.00	3000.00	7600.00	239.50	2505.22	1252.61	3173.28

Source : Government of India, Bulletin on Food Statistics, Various issues, (New Delhi : Ministry of Agriculture).

Note : (a) The procurement prices for 1980/81, 1981/82 and 1983/84 are the recommended prices of the Commission for Agricultural Costs and Prices, but not fixed by the government.

Appendix A4.1 : Chickpea - Farm Harvest Prices (Rs/ton).

Year	Haryana	Uttar Pradesh	Madhya Pradesh	Rajasthan	Rural CPI (1981/82=100)	Deflated Haryana	Deflated Uttar Pradesh	Deflated Madhya Pradesh	Deflated Rajasthan
1980-81	3400.00	2941.20	3098.80	3166.00	91.30	3724.04	3221.51	3394.13	3467.74
1981-82	2880.00	2470.90	2281.70	2781.90	100.00	2880.00	2470.90	2281.70	2781.90
1982-83	2770.00	2269.80	2167.50	2607.90	107.40	2579.14	2113.41	2018.16	2428.21
1983-84	3430.00	2879.80	2844.30	2937.70	116.50	2944.21	2471.93	2441.46	2521.63
1984-85	4650.00	3723.40	3959.70	3971.70	117.20	3967.58	3176.96	3378.58	3388.82
1985-86	3750.00	4051.30	3785.00	3614.30	123.90	3026.63	3269.81	3054.88	2917.11
1986-87	3842.90	3171.20	3346.30	3584.90	129.00	2978.99	2458.29	2594.03	2778.99
1987-88	5703.00	4455.00	4350.10	4889.80	145.10	3930.39	3070.30	2998.00	3369.95
1988-89	5944.40	5131.40	5538.90	5654.30	161.60	3678.47	3175.37	3427.54	3498.95
1989-90	7194.80	6203.50	6117.30	6515.50	167.90	4285.17	3694.76	3643.42	3880.58
1990-91	6924.30	6149.60	5770.20	6321.40	185.30	3736.81	3318.73	3113.98	3411.44
1991-92	7232.6	6128.5	5959	6341.5	224.80	3217.35	2726.20	2650.80	2820.95

Source : Government of India, Bulletin on Food Statistics, Various issues, (New Delhi, Ministry of Agriculture).

Appendix A4.2 : Wheat - Farm Harvest Prices (Rs/ton).

Year	Haryana	Uttar Pradesh	Madhya Pradesh	Rajasthan	Rural CPI (1981/82=100)	Deflated Haryana	Deflated Uttar Pradesh	Deflated Madhya Pradesh	Deflated Rajasthan
1980-81	1380.00	1329.60	1711.20	1557.20	91.30	1511.52	1456.32	1874.29	1705.61
1981-82	1550.00	1493.40	1660.10	1772.50	100.00	1550.00	1493.40	1660.10	1772.50
1982-83	1630.00	1678.10	2013.60	1755.10	107.40	1517.69	1562.48	1874.86	1634.17
1983-84	1640.00	1479.30	1781.60	1772.60	116.50	1407.73	1269.79	1529.27	1521.55
1984-85	1660.00	1539.40	1732.50	1854.00	117.20	1416.38	1313.48	1478.24	1581.91
1985-86	1700.00	1668.30	2004.90	2023.90	123.90	1372.07	1346.49	1618.16	1633.49
1986-87	1807.30	1672.50	2002.30	1981.30	129.00	1401.01	1296.51	1552.17	1535.89
1987-88	2038.00	1951.70	2297.00	2434.90	145.10	1404.55	1345.07	1583.05	1678.08
1988-89	2016.60	2116.30	2821.80	2630.00	161.60	1247.90	1309.59	1746.16	1627.48
1989-90	2240.30	2057.20	2597.80	2466.00	167.90	1334.31	1225.25	1547.23	1468.73
1990-91	2492.80	2620.20	2893.80	3116.20	185.30	1345.28	1414.03	1561.68	1681.71
1991-92	3087.50	3289.30	3804.30	3851.30	224.80	1373.44	1463.21	1692.30	1713.21

Source : Government of India, Bulletin on Food Statistics, Various issues, (New Delhi, Ministry of Agriculture).

Appendix A4.3 : Mustard - Farm Harvest Prices (Rs/ton).

Year	Haryana	Uttar Pradesh	Madhya Pradesh	Rajasthan	Rural CPI (1981/82=100)	Haryana	Uttar Pradesh	Madhya Pradesh	Rajasthan
1980-81	3680.00	4112.40	4170.80	4228.20	91.30	4030.72	4504.33	4568.30	4631.17
1981-82	4120.00	3510.70	3769.10	4139.80	100.00	4120.00	3510.70	3769.10	4139.80
1982-83	4370.00	4118.60	4039.00	3482.80	107.40	4068.90	3834.82	3760.71	3242.83
1983-84	3690.00	4863.60	4964.80	4675.50	116.50	3167.38	4174.76	4261.63	4013.30
1984-85	3920.00	4163.80	4147.30	3532.20	117.20	3344.71	3552.73	3538.65	3013.82
1985-86	5080.00	4188.30	3988.30	4312.10	123.90	4100.08	3380.39	3218.97	3480.31
1986-87	7481.10	5873.90	6061.00	6509.80	129.00	5799.30	4553.41	4698.45	5046.36
1987-88	7125.40	6957.40	7202.90	6808.40	145.10	4910.68	4794.90	4964.09	4692.21
1988-89	6433.90	5359.80	5601.70	5496.00	161.60	3981.37	3316.71	3466.40	3400.99
1989-90	8101.20	6746.20	6580.20	6751.20	167.90	4825.01	4017.99	3919.12	4020.96
1990-91	9270.50	8308.00	9001.80	8511.70	185.30	5002.97	4483.54	4857.96	4593.47
1991-92	9297.70	8482.20	8726.80	8862.40	224.80	4135.99	3773.22	3882.03	3942.35

Source : Government of India, Bulletin on Food Statistics, Various issues, (New Delhi, Ministry of Agriculture).

APPENDIX A5
SUBSIDY TO PRIMARY INPUTS

To measure the irrigation, electricity and credit subsidy received by a farmer, the economic price of irrigated water net of water charges needs to be estimated. Various methods for estimating the economic price of irrigation water have been suggested. Among them are :

(1) To take the water rates charged by private water suppliers as representative of the economic price of water. The difference between this price and that charged by government authorities will give the subsidy on water. However, there are several problems with this, among them (a) since private water suppliers usually operate in a localized area, they may not be operating in a competitive market and so the price charged by them could be the result of monopolistic or oligopolistic pricing. Thus it would tend to inflate the economic price, (b) private water suppliers being a local phenomenon, consistent time series data across states is difficult to obtain.

(2) To find the annual/seasonal Operation and Maintenance costs (O & M costs) of a major, medium or minor irrigation project, and thus estimate the cost of producing a unit of water. This methodology equates the economic price of water with its marginal cost of production, thus being a strict estimate of the cost of irrigated water. However, the major drawback of this approach is that it ignores capital cost from the calculation and so will undervalue the economic cost of water.

(3) To estimate the annual/seasonal O & M costs of an irrigation project and add on to that the annualized cost of capital (opportunity cost of capital) adjusted for depreciation. A variation of this method is used in this analysis. Incidentally, this method of estimating the economic cost of water is recommended by the Planning Commission of India.[1] This analysis is confined to estimating the economic cost of water from minor irrigation works only. It is quite possible that the economic cost of water from major and medium irrigation projects will give different values of the economic cost of water.

The economic cost of water will depend on the particular irrigation scheme under consideration as the capital costs, maintenance costs, overheads, .. etc. will be unique for individual schemes. In addition to this, the economic cost of water will vary between major, medium and minor irrigation schemes. Thus to get the economic cost of water for a state, one would have to average the cost among the various irrigation schemes to arrive at a representative figure. However, this study will attempt to evaluate the economic cost of water from deep tubewells of minor irrigation schemes only. This would provide one estimate of the economic

[1]See Government of India, Report of the Committee on Pricing of Irrigation Water, September 1992, (New Delhi : Government of India)

cost of water.

1 Estimating the Economic cost of water for minor irrigation schemes.

Minor irrigation schemes consist of dug-wells, tanks, shallow tube-wells, deep tube wells, lift irrigation schemes, ... etc. Here the economic cost of water from a deep tube well is estimated. This study has adapted the procedure for estimating the economic cost of water as described in Sangal (1991).

The Operation & Maintenance charges for tubewell schemes, set as a percentage of the capital cost are described below. O & M charges translated as a percentage of capital cost is valid on an average basis, but such costs would vary by scheme.

Table A1 Operation and Maintenance Charges for Minor Irrigation Schemes - Tubewell Scheme.

Item	Percentage of Capital Cost (%)
1. Establishment charges	
a. Regular	2.50
b. Work charged	
2. Maintenance of works	2.00
3. Depreciation	4.00
4. Energy charges	2.50
TOTAL	11.00

Note : Cost escalation on items 1,2 is taken at 5 per cent per annum.
Source : Sangal, S.P. "Pricing of Irrigation Waters in India," Economic and Political Weekly, (November 16, 1991) : 2645.

Table A2 Parameters for Calculating Economic Cost of Water for Deep Tubewell.

Parameters	Value
1. Capital cost of tubewell (1980)	Rs. 90,000.00
Capital cost of tubewell (1989)	Rs. 400,000.00
2. Annual compound rate of growth of capital cost (1980 - 1989).	16.10 %
3. Repayment period of capital	15 years
4. Interest rate	8.5 %
5. Horse Power of pump set	30 HP or 22.371 kW
6. Culturable Command Area (CCA)	40 Ha.
7. Discharge (CuM/Hr)	102 m^3 / Hr.
8. Annual working hours	1,500 Hrs.

Adapted from : Sangal, S.P. "Pricing of Irrigation Waters in India," Economic and Political Weekly, (November 16, 1991) : 2646.

The above parameters are based on an actual public sector deep tube well in the state of Gujarat. For the purposes of this study, it has been assumed that the parameters mentioned above hold for other states in India also. The interest rate of 8.5 per cent, is representative of the average yield of government bonds (Gulati and Sharma 1995, A-95). This represents the opportunity cost of capital, as funds for the tubewell scheme could be invested in these government bonds. The economic cost of electricity at the national level was taken from Economic Intelligence Service (1996, 15). The annual working hours of the tube well, which has been taken as 1,500 hours, is the average achieved by public sector wells. Generally, public tube wells operate between 1,500 to 2,000 hours a year, while private ones operate for 3,000 to 3,500 hours a year (Sangal 1991, 2648). Depreciation has not been included in the assessment. For a justification of this see Sanghal (1990).

The details of the calculation of the economic cost of water are given on the following pages. Since capital cost data was available only for the years 1980 and 1990, it has been assumed that capital cost grew at a constant compound rate of 16.10 per cent per annum between these two periods. This growth rate has been assumed to continue into 1992/93. The calculation of the economic cost of water, as shown on the following pages is as follows :

I. Part I, is the calculation of Operational & Maintenance cost. Establishment & Maintenance charges are calculated as a percentage of the total capital cost indicated in Table 1. The energy cost is calculated as the total energy cost of running the tubewell for one year (1,500 hrs.).

II. The main idea behind the calculation in part II is to find the present value of total amount spent in setting up and running this tubewell for 15 years (the loan period). Since there is a 5 per cent annual increase in Establishment & Maintenance costs, Ib and Ic are suitably increased. This value is given in IIa. The present value (PV) of the total amount spent in Establishment & Maintenance (II b) over the 15 year period is calculated with the following formula, commonly used to estimate the present value of a 'growing annuity' :

$$PV = \frac{A}{r_2 - r_1}\left[1-\left(\frac{1+r_1}{1+r_2}\right)^t\right]$$

where,

PV = Present value of yearly installments over 15 years.
A = Annual installment

r_1 = rate of growth of yearly installment (in this case 5 %)

r_2 = rate of interest on loan (8.5 %)

t = number of years to repay loan (15 years)

The present value of energy costs (II c) over the 15 year period was calculated using the following formula for the present value of a 'annuity':

$$PV = \frac{A}{r_2}\left[1-\left(\frac{1}{1+r_2}\right)^t\right]$$

PV = Present value of yearly installments over 15 years.

A = Annual installment

r_2 = rate of interest on loan (8.5 %)

t = number of years to repay loan (15 years)

When the Present Value of the costs IIb and IIc are added to the capital costs (IIe), it gives the Total Present Value (IIf) of setting up and operating the tubewell system. This is the total cost of setting up and operating the tubewell system over the 15 year loan period. Since this cost has to be spread over 15 years the yearly installment to accomplish this is given in the Equated Annual Installment (IIIa). Thus the value in IIIa represents the cost of running the tubewell system every year. This value divided by the volume of water discharged in a year will give the cost of a unit of water (IVa).

From the economic cost of water, the economic cost of irrigating a hectare of wheat, chickpea and mustard in each state is calculated. Each of these crops have different water requirements in each state and this has been incorporated (see Appendix 5.2). From this cost, the price of irrigation water in each state has been subtracted to arrive at the total subsidy on the particular crop in each state. Therefore, by valuing electricity and credit at its economic cost, estimating the cost of water in this fashion incorporates the subsidy on electricity and credit on crop production.

APPENDIX A5.1

Year	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93
I													
a. Capital cost for Deep Tube Well (Rs)	90000	104478	121285	140795	163444	189737	220259	255691	296822	344571	400000	464346	539043
b. Establishment charges - 2.5% Capital cost (Rs)	2250	2612	3032	3520	4086	4743	5506	6392	7421	8614	10000	11609	13476
c. Maintenance charges -2% Capital cost (Rs)	1800	2090	2426	2816	3269	3795	4405	5114	5936	6891	8000	9287	10781
d. Average Cost of Power Supply (paise/Kwh)	41.90	46.77	52.22	58.29	65.07	71.55	78.67	86.50	95.11	104.58	114.99	126.43	139.02
e. Energy charges (Rs)	14060.17	15695.76	17521.61	19559.86	21835.22	24008.75	26398.64	29026.43	31915.80	35092.78	38586.01	42426.96	46650.25
f. Total Operation + Maintenance Cost (Rs)	18110.17	20397.26	22979.42	25895.64	29190.20	32546.90	36310.28	40532.51	45272.80	50598.46	56586.01	63322.53	70907.19
II													
a. First year Establishment+Maintenance cost	4253	4937	5731	6653	7723	8965	10407	12081	14025	16281	18900	21940	25470
b. Present Value of Est.+Main. Cost (15 yrs)	47203	54797	63611	73844	85723	99513	115521	134105	155678	180721	209792	243541	282718
c. Present Value Energy Costs (15 yrs)	116759	130341	145504	162430	181325	199374	219221	241042	265036	291419	320427	352324	387395
d. Present worth O+M charges (15yrs)	163962	185138	209115	236274	267048	298888	334742	375147	420714	472139	530220	595864	670113
e. Capital Cost	90000	104478	121285	140795	163444	189737	220259	255691	296822	344571	400000	464346	539043
f. Total Present Value	253962	289616	330400	377069	430492	488624	555001	630838	717536	816710	930220	1060210	1209156
III													
a. Equated Annual Installment	30582	34876	39787	45407	51840	58840	66833	75966	86406	98349	112017	127671	145607
IV													
a. Economic Water Rates Per Cu M (Rs)	0.10	0.11	0.13	0.15	0.17	0.19	0.22	0.25	0.28	0.32	0.37	0.42	0.48

Source : Economic Intelligence Service, India's Energy Sector, (Mumbai : Center for Monitoring the Indian Economy Pvt. Ltd., September 1996), 15.

S.P. Sangal, "Pricing of Irrigation Waters in India," Economic and Political Weekly,(November 16, 1991) : 2645

Appendix A5.2 Statewise Irrigation Subsidy

Year	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93
Economic Water Rates Per Cu M (Rs)	0.10	0.11	0.13	0.15	0.17	0.19	0.22	0.25	0.28	0.32	0.37	0.42	0.48
Haryana													
Wheat													
Irrigation depth (mts.)	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51
Economic cost of irrigation (Rs/Ha)	509.70	581.26	663.11	756.78	864.00	980.67	1113.89	1266.10	1440.10	1639.14	1866.96	2127.85	2426.78
Off. Water Rates for Canal Irrigat. (Rs/Ha)	61.78	61.78	61.78	61.78	61.78	61.78	61.78	61.78	61.78	61.78	61.78	61.78	61.78
Net Subsidy for Wheat (Rs/Ha)	447.92	519.48	601.33	695.00	802.22	918.89	1052.11	1204.32	1378.32	1577.36	1805.18	2066.07	2365.00
Mustard													
Irrigation depth (mts.)	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
Economic cost of irrigation (Rs/Ha)	439.74	501.48	572.10	652.91	745.41	846.07	961.00	1092.32	1242.44	1414.16	1610.71	1835.79	2093.70
Off. Water Rates for Canal Irrigat. (Rs/Ha)	66.72	66.72	66.72	66.72	66.72	66.72	66.72	66.72	66.72	66.72	66.72	66.72	66.72
Net Subsidy for Mustard (Rs/Ha)	373.02	434.76	505.38	586.19	678.69	779.35	894.28	1025.60	1175.72	1347.44	1543.99	1769.07	2026.98
Chickpea													
Irrigation depth (mts.)	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Economic cost of irrigation (Rs/Ha)	159.91	182.36	208.04	237.42	271.06	307.66	349.46	397.21	451.80	514.24	585.71	667.56	761.34
Off. Water Rates for Canal Irrigat. (Rs/Ha)	49.42	49.42	49.42	49.42	49.42	49.42	49.42	49.42	49.42	49.42	49.42	49.42	49.42
Net Subsidy for Chickpea (Rs/Ha)	110.49	132.94	158.62	188.00	221.64	258.24	300.04	347.79	402.38	464.82	536.29	618.14	711.92

Appendix A5.2

Year	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93
Uttar Pradesh													
Wheat													
Irrigation depth (mts.)	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
Economic cost of irrigation (Rs/Ha)	519.70	592.66	676.12	771.62	880.94	999.90	1135.73	1290.92	1468.34	1671.28	1903.57	2169.57	2474.37
Off. Water Rates for Flow Irrigat. (Rs/Ha)	143.32	143.32	143.32	143.32	143.32	143.32	143.32	143.32	143.32	143.32	143.32	143.32	143.32
Net Subsidy for Wheat (Rs/Ha)	376.38	449.34	532.80	628.30	737.62	856.58	992.41	1147.60	1325.02	1527.96	1760.25	2026.25	2331.05
Mustard													
Irrigation depth (mts.)	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Economic cost of irrigation (Rs/Ha)	169.90	193.75	221.04	252.26	288.00	326.89	371.30	422.03	480.03	546.38	622.32	709.28	808.93
Off. Water Rates for Flow Irrigat. (Rs/Ha)	143.32	143.32	143.32	143.32	143.32	143.32	143.32	143.32	143.32	143.32	143.32	143.32	143.32
Net Subsidy for Mustard (Rs/Ha)	26.58	50.43	77.72	108.94	144.68	183.57	227.98	278.71	336.71	403.06	479.00	565.96	665.61
Chickpea													
Irrigation depth (mts.)	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
Economic cost of irrigation (Rs/Ha)	419.76	478.69	546.09	623.23	711.53	807.61	917.32	1042.67	1185.97	1349.88	1537.49	1752.35	1998.53
Off. Water Rates for Flow Irrigat. (Rs/Ha)	143.32	143.32	143.32	143.32	143.32	143.32	143.32	143.32	143.32	143.32	143.32	143.32	143.32
Net Subsidy for Chickpea (Rs/Ha)	276.44	335.37	402.77	479.91	568.21	664.29	774.00	899.35	1042.65	1206.56	1394.17	1609.03	1855.21

Appendix A5.2

Year	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93
Madhya Pradesh													
Wheat													
Irrigation depth (mts.)	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
Economic cost of irrigation (Rs/Ha)	629.63	718.03	819.14	934.85	1067.30	1211.42	1375.98	1564.00	1778.95	2024.82	2306.24	2628.52	2997.79
Off. Water Rates from all sources (Rs/Ha)	61.78	61.78	61.78	61.78	61.78	61.78	61.78	61.78	61.78	61.78	61.78	61.78	61.78
Net Subsidy for Wheat (Rs/Ha)	567.85	656.25	757.36	873.07	1005.52	1149.64	1314.20	1502.22	1717.17	1963.04	2244.46	2566.74	2936.01
Mustard													
Irrigation depth (mts.)	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
Economic cost of irrigation (Rs/Ha)	239.86	273.53	312.05	356.13	406.59	461.49	524.18	595.81	677.69	771.36	878.57	1001.34	1142.02
Off. Water Rates from all sources (Rs/Ha)	44.88	44.88	44.88	44.88	44.88	44.88	44.88	44.88	44.88	44.88	44.88	44.88	44.88
Net Subsidy for Mustard (Rs/Ha)	194.98	228.65	267.17	311.25	361.71	416.61	479.30	550.93	632.81	726.48	833.69	956.46	1097.14
Chickpea													
Irrigation depth (mts.)	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Economic cost of irrigation (Rs/Ha)	489.72	558.47	637.11	727.10	830.12	942.21	1070.21	1216.45	1383.63	1574.86	1793.74	2044.40	2331.62
Off. Water Rates from all sources (Rs/Ha)	42.01	42.01	42.01	42.01	42.01	42.01	42.01	42.01	42.01	42.01	42.01	42.01	42.01
Net Subsidy for Chickpea (Rs/Ha)	447.71	516.46	595.10	685.09	788.11	900.20	1028.20	1174.44	1341.62	1532.85	1751.73	2002.39	2289.61

Appendix A5.2

Year	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93
Rajasthan													
Wheat													
Irrigation depth (mts.)	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
Economic cost of irrigation (Rs/Ha)	629.63	718.03	819.14	934.85	1067.30	1211.42	1375.98	1564.00	1778.95	2024.82	2306.24	2628.52	2997.79
Off. Water Rates, all sources (Rs/Ha)	74.13	74.13	74.13	74.13	74.13	74.13	74.13	74.13	74.13	74.13	74.13	74.13	74.13
Net Subsidy for Wheat (Rs/Ha)	555.50	643.90	745.01	860.72	993.17	1137.29	1301.85	1489.87	1704.82	1950.69	2232.11	2554.39	2923.66
Mustard													
Irrigation depth (mts.)	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
Economic cost of irrigation (Rs/Ha)	239.86	273.53	312.05	356.13	406.59	461.49	524.18	595.81	677.69	771.36	878.57	1001.34	1142.02
Off. Water Rates from all sources (Rs/Ha)	56.84	56.84	56.84	56.84	56.84	56.84	56.84	56.84	56.84	56.84	56.84	56.84	56.84
Net Subsidy for Mustard (Rs/Ha)	183.02	216.69	255.21	299.29	349.75	404.65	467.34	538.97	620.85	714.52	821.73	944.50	1085.18
Chickpea													
Irrigation depth (mts.)	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Economic cost of irrigation (Rs/Ha)	489.72	558.47	637.11	727.10	830.12	942.21	1070.21	1216.45	1383.63	1574.86	1793.74	2044.40	2331.62
Off. Water Rates from all sources (Rs/Ha)	71.66	71.66	71.66	71.66	71.66	71.66	71.66	71.66	71.66	71.66	71.66	71.66	71.66
Net Subsidy for Chickpea (Rs/Ha)	418.06	486.81	565.45	655.44	758.46	870.55	998.55	1144.79	1311.97	1503.20	1722.08	1972.74	2259.96

Source : Appendix A5.1

Planning Commission, Report on the Committee on Pricing of Irrigation Water, (New Delhi : Government of India, September 1992)

Appendix A6 Nominal Protection Coefficients (NPC) of Fertilizers

Fertilizer	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93
Urea - N (46% Nitrogen)													
Import (f.o.b. Mid East, US$/ton)	-	-	-	-	-	-	-	108.00	130.00	135.00	125.00	180.00	146.00
Freight, Mid East-Bom (US$/ton)	-	-	-	-	-	-	-	23.50	23.50	23.50	23.50	23.50	15.63
Exchange Rate ($/Rs)	0.13	0.11	0.11	0.10	0.09	0.08	0.08	0.08	0.07	0.06	0.06	0.04	0.04
C&F Price ($/ton)	-	-	-	-	-	-	-	131.50	153.50	158.50	148.50	203.50	161.63
Border Price (Rs/ton)	1896.00	2085.00	1380.00	1400.00	2000.00	2160.00	1340.00	1707.79	2224.64	2641.67	2651.79	4963.41	4040.75
Handling expenses (Rs/ton)	750.00	900.00	900.00	900.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
Dealers margin (Rs/ton)	105.00	120.00	120.00	130.00	115.00	130.00	130.00	130.00	130.00	130.00	130.00	130.00	130.00
Border price at Farmgate (Rs/ton)	2751.00	3105.00	2400.00	2430.00	3115.00	3290.00	2470.00	2837.79	3354.64	3771.67	3781.79	6093.41	5170.75
Domestic price (Rs/ton)	2000.00	2350.00	2350.00	2150.00	2150.00	2150.00	2350.00	2350.00	2350.00	2350.00	2350.00	3300.00	2760.00
NPC	0.73	0.76	0.98	0.88	0.69	0.65	0.95	0.83	0.70	0.62	0.62	0.54	0.53
Di-Ammonium Phosphate (DAP)													
Import (f.o.b. US Gulf, US$/ton)	-	-	-	-	-	-	-	185.00	200.00	202.00	178.00	186.00	165.00
Freight, US Gulf-Bom (US$/ton)	-	-	-	-	-	-	-	48.50	48.50	48.50	48.50	48.50	36.00
C&F Price ($/ton)	-	-	-	-	-	-	-	233.50	248.50	250.50	226.50	234.50	201.00
Border price at Farmgate (Rs/ton)	2185.00	2206.00	2210.00	2050.00	2550.00	2490.00	2500.00	3032.47	3601.45	4175.00	4044.64	5719.51	5025.00
Domestic price (Rs/ton)	750.00	900.00	900.00	900.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
Dealers margin (Rs/ton)	125.00	145.00	145.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00
Border Price at Farmgate (Rs/ton)	3060.00	3251.00	3255.00	3140.00	3740.00	3680.00	3690.00	4222.47	4791.45	5365.00	5234.64	6909.51	6215.00
Domestic price (Rs/ton)	3050.00	3600.00	3600.00	3350.00	3350.00	3350.00	3600.00	3600.00	3600.00	3600.00	3600.00	5040.00	6800.00
NPC	1.00	1.11	1.11	1.07	0.90	0.91	0.98	0.85	0.75	0.67	0.69	0.73	1.09

Appendix A6

Fertilizer	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93
Muriate of Potash (MOP)-60%K20													
Import (f.o.b. Canada, US$/ton)	-	-	-	-	-	-	-	69.00	87.00	100.00	100.00	112.00	115.00
Freight, Vancouver-Bom (US$/ton)	-	-	-	-	-	-	-	30.35	30.35	30.35	30.35	30.35	35.00
C&F Price ($/ton)	-	-	-	-	-	-	-	99.35	117.35	130.35	130.35	142.35	150.00
Border Price (Rs/ton)	1192.00	1246.00	935.00	1000.00	1200.00	1350.00	1190.00	1290.26	1700.72	2172.50	2327.68	3471.95	3750.00
Handling expenses (Rs/ton)	750.00	900.00	900.00	900.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
Dealers margin (Rs/ton)	80.00	90.00	90.00	95.00	95.00	95.00	95.00	95.00	95.00	95.00	95.00	95.00	95.00
Border price at Farmgate (Rs/ton)	2022.00	2236.00	1925.00	1995.00	2295.00	2445.00	2285.00	2385.26	2795.72	3267.50	3422.68	4566.95	4845.00
Domestic price (Rs/ton)	1100.00	1300.00	1300.00	1200.00	1200.00	1200.00	1300.00	1300.00	1300.00	1300.00	1300.00	1820.00	4500.00
NPC	0.54	0.58	0.68	0.60	0.52	0.49	0.57	0.55	0.46	0.40	0.38	0.40	0.93
Wt. Avg NPC of NPK Fertilizer	0.77	0.81	0.97	0.89	0.72	0.69	0.91	0.80	0.69	0.61	0.61	0.57	0.70
NPK domestic prices (Rs/ton)	2132.00	2509.50	2509.50	2309.50	2309.50	2309.50	2509.50	2509.50	2509.50	2509.50	2509.50	3520.00	3840.20
NPK border prices (Rs/ton)	2738.79	3041.53	2535.85	2538.35	3162.30	3282.85	2718.05	3092.64	3609.26	4066.74	4061.91	6105.05	5364.65
NPC	0.78	0.83	0.99	0.91	0.73	0.70	0.92	0.81	0.70	0.62	0.62	0.58	0.72

Note : (a) Ocean freight for 1990/91 has been used for the years 1987/88 to 1989/90.
b) Handling expenses for 1986/87 have been used for 1987/88 to 1991/92.
c) In NPK the weights for N,P,K have been taken in the ratio of 0.67:0.22:0.11. This is the ratio of their consumption levels averaged over 1980/81 to 1985/86.
d) The border prices for 1980/81 to 1986/87 were taken from Gulati, Hanson and Pursell, Effective Incentives in India's Agriculture - Cotton Groundnuts, Wheat, and Rice, New Delhi : The World Bank, Country Economics Department, January 1990), 53

Source : Ashok Gulati, James Hanson and Gary Pursell, Effective Incentives in India's Agriculture - Cotton Groundnuts, Wheat, and Rice, (New Delhi : The World Bank, Country Economics Department, January 1990), 53.

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APPENDIX A7
METHODOLOGY FOR ESTIMATING BORDER PRICES

If the crop is imported, the relevant price is its c.i.f. price. This price needs to be adjusted for port handling, internal transportation and processing margins to the point at which the import competes with domestic production. There are two extreme points of competition, the port and the farmgate. In this analysis, the point of competition for surplus producing states (e.g. Punjab for wheat) has been taken to be the port. The adjustments made for surplus states are shown below.

Adjusted border price	=	Observed border price	+	Handling costs at border	-	Transport and marketing costs from market to border	-	Processing and marketing costs from farmgate to market

The transportation and marketing costs from the farmgate to the port have been deducted as the price the farmer will receive at the port will be less by the amount of these costs. In the actual computation of the border price, the processing and marketing margins from the farmgate to the market were assumed to be negligible.

For a state deficit in production (i.e. Madhya Pradesh for wheat), the point of competition is taken at the farmgate. To arrive at the border price at the farm-gate the following adjustment needs to be made in the border price to make it comparable at the farm-gate level.

Adjusted border price	=	observed border price	+	handling costs at border	+	transport costs from border to market	+	marketing margins from border to market	-	transport cost from farm to market	-	processing & marketing margin from farm to market

The transport and marketing margins from the port to the market are added on because this cost incurred in bringing the import to the market and so it adds to the cost of the product. In the actual computation of the border price, the processing and marketing margins from the farmgate to the market were assumed to be negligible. Therefore the adjusted border price at the market is taken to be equivalent to its price at the farmgate.

If the crop is exported, then the relevant border price is the f.o.b. price of the crop. To make the border price of an export comparable to the farm-gate price, the following adjustment is made.

Adjusted border price	=	observed border price	-	handling costs at border	-	transport costs from farm to border	-	processing and marketing margins from farm to border

Another important adjustment that needs to be taken into consideration is that the exchange rate used to convert the foreign price into the domestic currency might be under or over valued. Overvaluation taxes exports and subsidizes imports. The opposite is true for under valuation of the currency. In order to get a border price that would be present in the absence of government intervention in the exchange rate market, the equilibrium exchange rate needs to be used for the estimation of the border price. The resultant NPC's are referred to as Net NPC's as opposed to the unadjusted Gross NPC's. Gross NPC's overstate the extent of protection given to tradeables in the presence of overvaluation and understate the protection if the exchange rate is undervalued. However, for the purposes of this study only the Gross NPC's are estimated.

APPENDIX A8
ESTIMATION OF NET ECONOMIC BENEFIT (NEB).

To calculate the Net Economic Benefit per unit of cropped area of a crop(s), detailed information about its input structure is required. All data on input use were taken from various issues of Cost of Cultivation of Principal Crops in India, published by the Ministry of Agriculture, Government of India, New Delhi.

Net Economic Benefit	=	Border price of output	-	Sum of traded inputs at border prices	-	Sum of domestic resources and nontraded inputs valued at domestic shadow prices

Methodology

1) Border price and valuation of output and tradeables - The opportunity cost of crop output is measured by its border price adjusted for internal transportation and marketing costs. This would give the opportunity cost of producing a hectare of wheat at the point of competition of the import with domestic production. The opportunity cost of tradeable inputs (fertilizer and seed) in the crop's production structure is similarly estimated but at the national level. The input use of fertilizer and seed per hectare was taken from cost of cultivation data. The value of this in border price terms is calculated. This value subtracted from the output valued at border prices gives value added at border prices. This procedure is similar to that used for estimating value added at border prices for the EPC calculation.

2) Valuation of land, labor and capital - In estimating the opportunity cost of primary inputs (land, labor, capital), the basic framework used is as follows. Say there is a hectare of land on which farmers can produce two competing crops X and Y. The opportunity cost of any input Z used in the production of X is its contribution to the foregone output Y. Z will be a fraction of Y as there are other contributing inputs. Thus, for every input, its next best alternative use is chosen and the value of a unit of the inputs contribution to the competing alternative, it marginal product, will be the opportunity cost. If the input markets are competitive and in equilibrium, the marginal product of an input across all competing activities is equalized. That is, the marginal product of Z in the production of X and Y will be the same. Thus, the marginal product of Z in X is also its opportunity cost. This assumption, which is followed in this analysis, simplifies the calculation of opportunity cost considerably as will be seen below.

In the estimation of the shadow price of primary and non-traded intermediate inputs it has been assumed that competitive markets operate.

a) Land - Though the opportunity cost of land could have been taken at its rental value under the assumption of competitive markets, the data source indicated that rental value was taken to be the prevailing village rates or the rates reported by the farmer. Further, the government has laws regarding fair rents. In consideration of this, the opportunity cost of land was excluded from the estimation. Thus, the estimated NEB will reflect economic profit due to the exclusion of the shadow price of land.

b) Labor - The opportunity cost of labor is estimated by the wage rate. The wage rate, under the assumption of competitive labor markets, indicates what the market determines is the contribution of a unit of labor to output. This is the marginal product of labor and therefore its opportunity cost also.

c) Capital - In the case of capital, its opportunity cost is given by assessing the marginal productivity of capital in its alternative uses. For instance, the opportunity cost of tractor services is estimated by the rental fee for tractors, under the assumption that competitive market for tractor services exists. Similar assumptions were made for assessing the marginal product of other capital goods.

d) Valuation of Services, Utilities, Credit and Irrigation - The shadow price of irrigation was calculated by estimating the cost of production of a unit of water from a deep tube well (see Appendix A5). From this the cost of irrigating a hectare of wheat, mustard and chickpea was calculated for the various states. This estimation of the price of water involved valuing electricity and credit (capital) at their opportunity cost. Thus, it has indirectly included the opportunity cost of electricity and credit. The opportunity cost of electricity was the cost of supplying it without subsidy and that of capital is taken as the interest rate of short term government bonds.

e) Depreciation - Depreciation reported in the cost of cultivation data is calculated on farm implements and buildings.

Estimation

Cost of cultivation data published by the Indian government gives the per hectare statewise breakdown of the units and costs of individual inputs that go into the production of each crop.

Cost C1 = Value of total human, animal and machine labor
+ Value of seed, fertilizer (traded inputs)
+ Value of insecticides and pesticides
+ Value of manure (owned and purchased)
+ Depreciation on farm implements and buildings
+ Irrigation charges (with subsidies)
+ Land revenue, cesses and other taxes.
+ Interest on working capital (estimated at market int. rates)

+ Interest on owned fixed capital assets (excluding land)

From cost C1, (i) the values of seed, fertilizer and irrigation are subtracted as they are traded inputs (their value at border prices is subtracted from the border price value of the crop to get value added in border prices). (ii) The economic cost of irrigation per hectare of crop is added to this. (iii) With all other costs per hectare valued at their shadow prices (opportunity cost), the resultant is the sum of domestic resources and non-traded inputs (valued at shadow prices). Due to incomplete data, the value of domestic resources were averaged for the periods 1980/81 to 1986/87 and 1987/88 to 1992/93.

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