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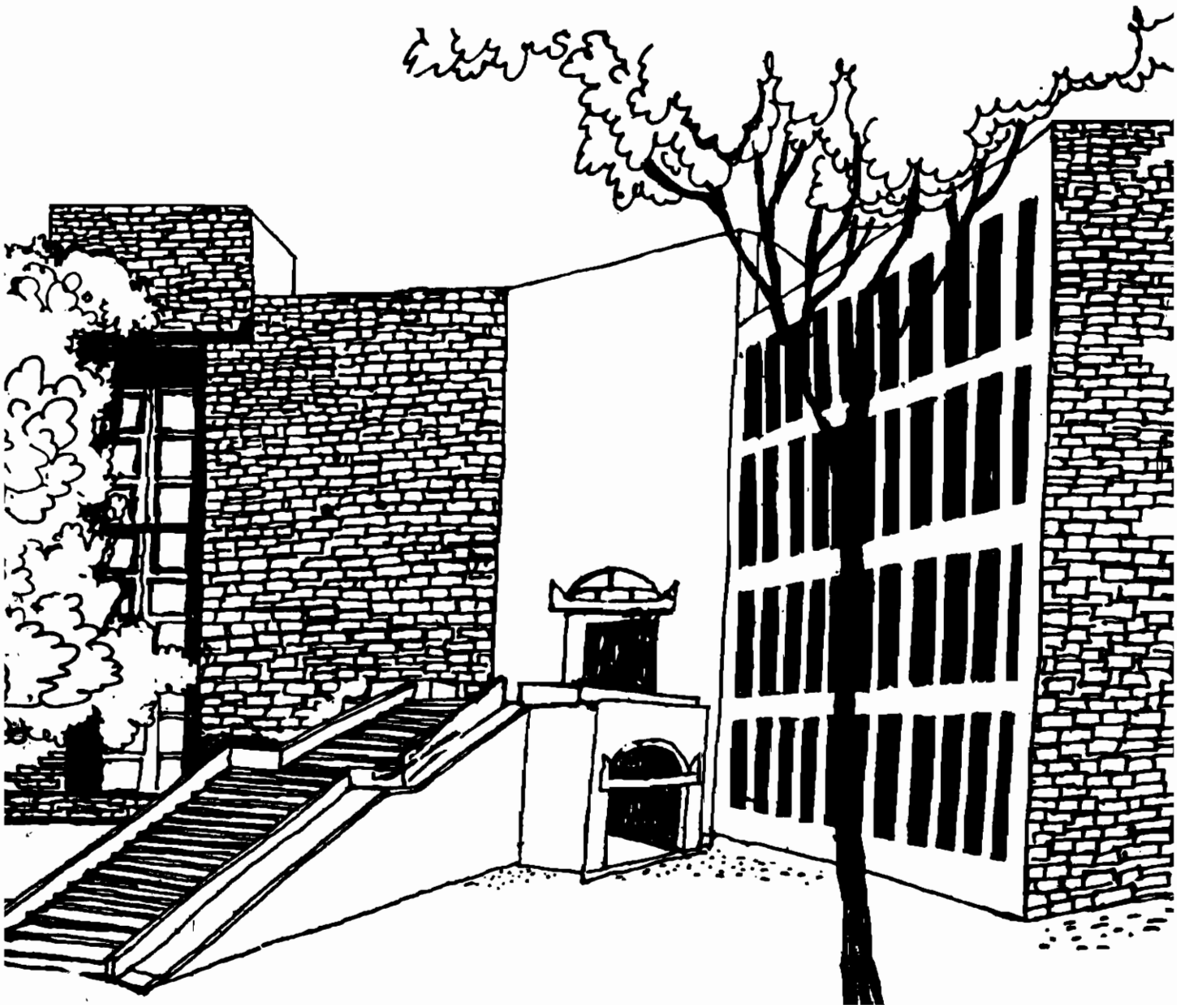

TECHNICAL CHANGE AND MARKET PRICE EFFECTS ON INCOME DISTRIBUTION IN INDIAN RICE ECONOMY

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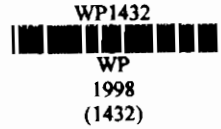

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N.V.Namboodiri*

Introduction

Technological change implies a downward shift in the cost function/ rightward shift in the supply function with consequent increased consumption at lower cost. A new technology may have important direct and indirect implications for the economy and society. Since technological innovations, by definition, have both resource-saving and resource-augmenting effects, it is expected to influence the distribution of income. The new production technology may result in increased income to certain production factors and increased real income to the consumers through decline in prices(relative) of crops as a result of reduction in unit cost. This could improve the distribution of real income both in the urban and rural areas. The income distribution aspect of a given technology encompasses a wide spectrum of groups; the producers, the consumers, the market intermediaries, labourers etc. and the effect of technology on income distribution for these groups may vary. For example, the decline in food prices as a result of technological change would redistribute income in favor of consumers, especially poorer ones since their spending on food is relatively more (Ladejinsky,1976).

In this study we postulate that the gains from technological change accrue to two groups: those who supply the resources used in the production of the output, *i.e.*, the producers, and those who consume the product, *i.e.*, consumers. Producers falling in the

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category of consumers is possible for certain food crops. The benefits which flow to the consumers are more diffused compared to producers. When producers face an elastic demand for the commodity, increased supply will have little or even no depressing effect on the domestic prices. But with inelastic demand for the producers, price would fall and consumers rather than producers will be major beneficiaries. In developed economies it is generally believed that consumers are the main beneficiaries (Cochrane, 1958). Such theories may not be applicable to crop like rice in India which is predominantly subsistence or semi-subsistence crop. Under subsistence or semi-subsistence conditions the economic gain due to technical change through downward pressure exerted on prices goes to both producers and non-producer consumers. The producers' benefits are on account of reduction in cost of production net of reduction in cash revenue as well as increased consumption at a lower price as a result of increased production. Since only a minor portion of the output is sold by majority of the rice growers, reduction in market price due to rightward shift in the supply curve has relatively little influence on the producers. The benefit internalized by the producers through increased consumption can even exceed that of the benefit to the non-producer consumers. But the non-producer consumers also benefit through reduction in market price.

In 9 out of 15 major rice growing states rice cultivation spreads over two to three seasons (multi-season states) and in the remaining 6 states it is confined to the autumn season (mono-season states). Former states accounts for about three-fourth of the rice area and production and, while the latter accounts for the rest one-fourth. For majority of the rice producers in India rice is a subsistence/semi-subsistence crop and hence a large part of the output represents a major consumption good for them. In 1994-95 the market arrival as a per cent of production for the country as a whole was just over 30 per cent and it varied from

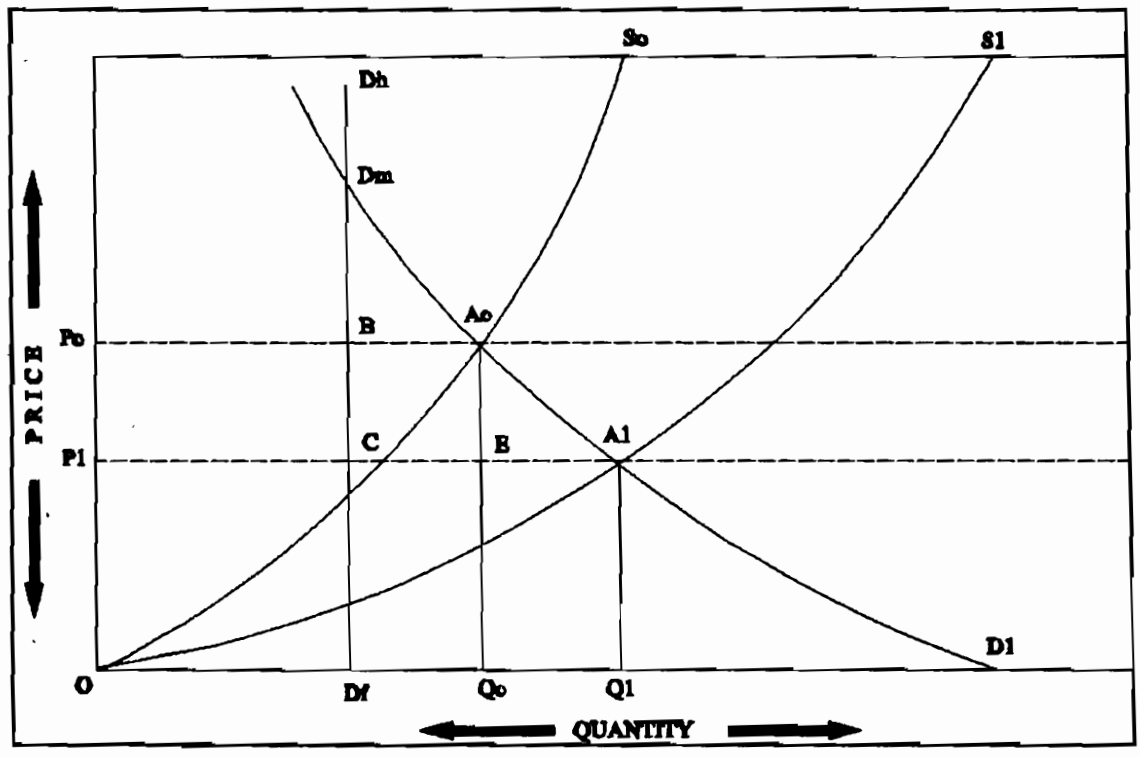
less than 7 per cent in Orissa to over 80 per cent in Punjab(Table 1). Small farmers have relatively low marketable surplus or no marketable surplus at all. More generally rate of marketable surplus improves when farm size expands. Thus, changes in the market price as a result of the supply expansion caused by technological change affects only a fraction of the total output of producers of different size. Therefore this impact on the income of different size of producers could be different. This aspect is beyond the scope of this study.

Objectives and Methodology

The objective of this paper is two-fold. First is to examine the relative share in total economic gain from the new rice technology internalized by the producers-cum-consumers (PCC) and the non-producer consumers (NPC) at two points of time, viz., triennium ending 1982-83 and triennium ending 1994-95. Second is to derive the implications of the change in relative distribution of income between the PCC and NPC to agricultural input subsidies and output price support.

The Marshallian concepts of *Consumers' and Producers'* surpluses have been used to analyze the benefit associated with technological change in agricultural production. These concepts were used to estimate the benefits of hybrid corn and poultry research in the United States(Griliches,1978 and Peterson,1967); cotton research in Brazil (Ayer and Schuh, 1972); research on tomato harvester (Schmitz and Seckler, 1970); rice research programme in Colombia (Scobie and Posada, 1978), Asia (Evenson and Flores, 1978) and the Philippines (Hayami and Herdt, 1978). The basic framework of these studies is followed here and is depicted in *Figure 1*.

Figure 1: Impact of Technological Change on Rice Economy



Let D_mD_1 be the market demand for rice and D_hD_f be the demand for producer households for home consumption. The horizontal difference between D_mD_1 and D_hD_f measures the quantity purchased by non-rice producers, both urban and rural. Let OS_0 be the supply curve for rice before technological change and OS_1 be the supply curve after the technological change. As the supply curve shifts, the equilibrium point moves from A_0 to A_1 resulting in a decline in the rice price from p_0 to p_1. This results in an increased consumption of consumers, *i.e.,* D_fQ_0 to D_fQ_1 at the reduced price from OP_0 to OP_1. And it represents an increase in consumers' surplus by the area A_0BCA_1. Correspondingly the producers' cash revenue changes from $A_0BD_fQ_0$ to $A_1CD_fQ_1$ on the assumption that the producers' home consumption remains unchanged.

The production cost changes from the area A_0OQ_0 to A_1OQ_1 . While assuming that the real value of home consumption is determined by the quantity consumed, change in

producers' income is reflected in the cash income. However, whether the producers' cash income would increase or decrease due to technological change depends on the nature of demand and supply functions. The reduction in cash revenue in case of completely commercialized agriculture would be equal to the area $A_0P_0P_1E$ less area $A_1EQ_0Q_1$. This is clearly larger than A_0BCE less $A_1EQ_0Q_1$ which would be the case in subsistence agriculture. On the other hand, the increase in consumers' surplus is smaller in subsistence agriculture (an area of A_0BCA_1) than in commercialized agriculture (an area of $A_0P_0P_1A_1$). Considering no change in the rice demand function, the new equilibrium price would be OP_1'. As a result, consumers' surplus would be reduced to A_0BCA_1'. Correspondingly, the producers' cash revenue reduces to A_1CDJQ_1'. The production cost changes from A_0OQ_0 to A_1OQ_1. These are under the assumption of constant household consumption. However, the net effect of producers' income is determined by the price elasticity of supply relative to the demand elasticity that is common for both PCC and NPC.

Let E_{ti} represents the total economic gain and E_{pi} and E_{ci} be the gain to PCC and NPC respectively in state i during year t. Using the above framework these gains could be estimated for each state during triennium ending 1982-83 and 1994-95 as follows:

$$E_{pi} = p_{0i}q_{0i}\Theta_i\,[\beta - r_i + \alpha_i(1-r_i)/(\alpha_i+\beta)(1+\alpha_i)]$$

$$E_{ci} = p_{0i}q_{0i}\Theta_i\,[r_i/(\alpha_i+\beta)]$$

$$E_{ti} = E_{pi} + E_{ci}$$

In order to apply the above model to Indian rice economy we need information on (i) the rate of supply function shift in different states (Θ_i), (ii) price elasticity of supply for rice in various states (α_i), (iii) rate of marketed surplus in various states (r_i), and (iv) price elasticity of demand for rice (β). The values for these variables are discussed next.

Supply Function Shift (Θ): The new rice technology comprising irrigation, high yielding varieties, fertilizers, pesticides, improved farm practices etc. have contributed to substantial production and productivity gains although it varied across states. This rice technology is co-existent with the old technology. But with the use of modern inputs traditional varieties also showed improvement in yields in certain areas. The high yielding varieties and additional use of modern inputs accounts for only a fraction of the total additional production implying thereby that the growth in aggregate yield can not be attributed to high yielding varieties alone. The rate of supply shift or technical progress is defined as the growth in yield weighted by area under HYVs as a ratio of total rice production less the contribution of HYVs. Using this conceptual approach the annual supply function shift for 15 major rice growing states is estimated for triennium ending 1982-83 and 1994-95 considering the base period triennium ending 1969-70. Accordingly, the aggregate supply function shift in state i in period t would be :

$\Theta_{it} = S_i t / (Q_{it} - S_{it})$, where

Θ_{it} = The annual rate of supply function shift in state i during period t

$S_{it} = AH_{it} (Y_{it} - Y_{i0})$

AH_{it} = Area under high yielding varieties of rice in state i during period t

Q_{it} = Total rice production in state i during period t

Y_{it} = Average rice yield in state i during period t

Y_{i0} = Average rice yield in state i during triennium ending 1969-70

The estimated annual supply function shift based on the method described above is given in **Table 1**. For all states together the estimated supply function shift during triennium ending 1982-83 was in the order of over 11 per cent. However, it rose to about 47 per cent by 1994-95. The rate of supply function shift in mono-season states (0.389) was more than

three times that of multi-season states (0.119) during 1982-83. But in 1994-95 it improved in the multi-season states(0.409) which accounted for about three-fourth of the supply shift in mono-season states(0.527). In a number of major rice growing states such as Assam, Bihar, Madhya Pradesh, and Orissa the rate of supply function shift was at around 5 per cent or below during triennium ending 1982-83. By 1994-95, there was a substantial improvement in supply function shift particularly in West Bengal, Orissa and Madhya Pradesh. In Punjab, Haryana, Andhra Pradesh, and Tamil Nadu the rate of supply function shift was of the highest order during 1982-83. And these states maintained their top position as far as supply function shift is concerned in 1994-95 as well. The states where the rate of supply function shift was very modest are Assam, Bihar, and Kerala.

Price Elasticity of Rice Supply (α): The empirical work based on Indian agricultural data provides ample evidence of the rationality of farmers in allocating resources to competing crops (Tyagi 1974, Bapna 1981). In case of rice there is limited possibility of inter-crop substitutions in major rice growing areas. The principal conclusions emerging from the studies on elasticity of supply are: with few exceptions, (a) the average response of producers to relative price changes is positive, (b) the response of cash crops to price stimuli is more pronounced than that of subsistence crops, and (c) for individual crops by and large it is positive but low for certain crops, especially subsistence/semi-subsistence crops. Various estimates of price elasticity of supply used in this study are given in Table 1. While it was positive in all states, it was as low as 0.1 or below in five states namely Assam, Kerala, Madhya Pradesh, Orissa and Rajasthan. The magnitude of price elasticity of supply was of the higher order, viz., over 0.25 in three states namely Haryana, Punjab and Tamil Nadu.

Table 1: Production, Rate of Supply Shift and the Price Elasticity of Supply of Rice in Multi-season and Mono-Season States

	Rice Production (000 tonnes)			Supply Shift (%)		Price
	Triennium Ending			Triennium Ending		Elasti-city
State	1969-70	1982-83	1994-95	1982-83	1994-95	of Supp-ly[1]
1.Andhra Pradesh	4574	7486	9093	0.335	0.708	0.34
2.Assam	2096	2446	3324	0.054	0.151	0.08
3.Bihar	4652	4573	5230	0.009	0.130	0.12
4.Karnataka	2034	1975	3086	0.089	0.235	0.14
5.Kerala	1244	1307	1072	0.070	0.121	0.09
6.Orissa	4259	4163	6113	0.014	0.219	0.05
7.Tamil Nadu	4194	4313	6948	0.232	0.779	0.34
8.Uttar Pradesh	3857	5668	9950	0.197	1.001	0.13
9.West Bengal	5929	7588	11879	0.068	0.341	0.14
Multi-Season	32839	39519	56695	0.119	0.409	0.22
1.Gujarat	379	592	870	0.334	0.710	0.18
2.Haryana	306	1252	2049	0.706	0.410	0.26
3.Madhya Pradesh	3136	3760	5752	0.019	0.305	0.06
4.Maharastra	1408	2247	2415	0.247	0.408	0.11
5.Punjab	481	3699	7443	0.992	1.223	0.26
6.Rajasthan	87	125	164	0.038	0.106	0.09
Mono-Season	5796	11674	18693	0.389	0.527	0.24
Above States	38635	51193	75388	0.112	0.468	0.23

1 Source: See reference 4,9,10,16, and 17.

Rate of Marketed Surplus (r): The market arrival of rice as a per cent of production in various states is considered as the marketed surplus. On an average it was around 30 per cent for all states together. It varied from less than 5 per cent in Orissa to over 92 per cent in Haryana with an overall average of 29.3 per cent during triennium ending 1982-83 (**Table 2**). In the mono-season states the rate of marketed surplus was more than double that in the multi-season states during both 1982-83 and 1994-95, it being 0.234 and 0.517. Only in four states, namely, Gujarat, Karnataka, Kerala, and Maharastra there was significant improvement in the rate of market arrival as a per cent of production during triennium ending 1994-95 compared to 1982-83. But the interstate variation has narrowed down during 1994-95 compared to 1982-83, i.e., the coefficient of variation reduced from 80 percent to 70 per cent. While there was marginal improvement in the rate of marketed surplus in multi-season states between 1982-83 and 1994-95, it showed marginal decline in the mono-season states.

Price Elasticity of Food Demand (ß): Majority of the people in the country not only spend a large proportion of their low income on foodgrains, but also a large part of any increase in income is spent on foodgrains. Therefore one expects a moderate price elasticity of demand for foodgrains. The price elasticity of demand for food at the All India level is estimated at -0.349 (Radhakrishna.R., and K.N.Murthy, 1995) using extended linear expenditure systems. We have considered the demand elasticity at 0.35 for rice(ignoring the sign).

Table 2: Per Hectare Yield, HYV Share and Marketed Surplus of Rice in Multi-Season and Mono-Season States

State	Rice Yield Kg. per hectare			HYV Area as % of Rice Area		Market Arrival as % of Production[1]	
	Triennium Ending			Triennium ending			
	1969-70	1982-83	1994-95	1982-83	1994-95	1982-83	1994-95
1.Andhra Pradesh	1407	2038	2583	0.809	0.910	0.421	0.424
2.Assam	964	1073	1330	0.497	0.476	0.122	0.142
3.Bihar	863	890	1134	0.283	0.481	0.160	0.157
4.Karna-taka	1777	1982	2340	0.791	0.792	0.184	0.232
5.Kerala	1431	1629	2074	0.537	0.348	0.170	0.109
6.Orissa	972	1013	1363	0.336	0.627	0.046	0.053
7.Tamil Nadu	1585	1999	3006	0.911	0.926	0.353	0.325
8.Uttar Pradesh	860	1087	1840	0.489	0.824	0.262	0.290
9.West Bengal	1221	1493	2068	0.352	0.620	0.166	0.154
Multi-Season	1125	1342	1864	0.497	0.684	0.233	0.234
1.Gujarat	756	1223	1462	0.655	0.860	0.428	0.477
2.Haryana	1350	2560	2731	0.876	0.575	0.923	0.727
3.Madhya Pradesh	730	778	1141	0.305	0.650	0.163	0.157
4.Maharas tra	1022	1496	1566	0.627	0.834	0.155	0.226
5.Punjab	1391	2946	3427	0.943	0.926	0.904	0.842
6.Rajas-than	768	874	1113	0.303	0.310	0.358	0.299
Mono-Season	845	1342	1824	0.504	0.738	0.493	0.517
Above States	1072	1342	1854	0.499	0.698	0.293	0.304

Source: Food Statistics, Directorate of Economics and Statistics, Govt. of India.

Analysis of Results

Total Economic Gain: Using the demand and supply elasticities, rate of marketed surplus and the rate of supply function shift stated above the economic gain from technical change in rice production is computed for both PCC and NPC. The total economic gain during triennium ending 1982-83 is estimated at Rs.4258 million in 1969-70 prices (**Table 3**). It rose to Rs.15197 million during the triennium ending 1994-95. This is more than three and half times of 1982-83. In multi-season states the total economic gain increased by roughly four times, whereas it was less than three times in mono-season states.

Distribution Between PCC and NPC: For all states together the relative share of PCC has increased from 23.8 per cent in 1982-83 to 41.5 per cent in 1994-95 and thereby the share of NPC has declined from 76.1 per cent to 58.5 per cent. In both the multi and mono-season states the share of PCC has increased though the extent of this increase is more for the latter(Table 3). This could be mainly attributed to decline in rate of marketed surplus in seven out of 15 states between 1982-83 and 1994-95. The decline in rate of marketed surplus could be due to such factors as decline in farm size, change in PCC's preference for rice and lack of growth in the production of inferior cereals and millets. But the share of PCC declined in Andhra Pradesh, Assam, Karnataka, Orissa, Uttar Pradesh, Gujarat and Maharastra and it being substantial in Karnataka, Uttar Pradesh, Gujarat and Maharastra. Hence in all these states share of NPC has increased (Table 3).

Table 3 : Relative Share of PCC and NPC in Total Economic Gain in Multi-and Mono-Season States

State	Share of PCC(%)		Share of NPC(%)		Total Economic Gain (Rs. Million)	
	1982-83	1994-95	1982-83	1994-95	1982-83	1994-95
1.Andhra Pradesh	18.3	17.7	81.7	82.3	940.5	1989.5
2.Assam	69.4	64.3	30.6	35.7	101.9	287.0
3.Bihar	62.0	62.6	38.0	37.4	42.5	630.4
4.Karnataka	57.1	46.0	42.9	54.0	116.4	307.2
5.Kerala	57.9	72.9	42.1	27.1	87.5	151.6
6.Orissa	88.0	86.0	12.0	14.0	65.6	1053.9
7.Tamil Nadu	31.4	36.9	68.6	63.1	983.0	3294.6
8.Uttar Pradesh	38.2	31.7	61.8	68.3	470.5	2396.2
9.West Bengal	61.5	64.2	38.5	35.8	459.8	2288.1
Multi-Season	37.2	44.6	62.8	55.4	3267.6	12398.4
1.Gujarat	4.7	-6.1	95.3	106.1	129.1	274.9
2.Haryana	-90.7	-50.2	190.7	150.2	153.1	88.8
3.Madhya Pradesh	57.9	59.5	42.1	40.5	98.3	1566.8
4.Maharastra	62.7	45.4	37.3	54.6	270.2	445.4
5.Punjab	-86.7	-74.0	186.7	174.0	337.1	415.7
6.Rajasthan	11.4	25.9	88.6	74.1	2.4	6.6
Mono-Season	-20.0	27.4	120.0	72.6	990.2	2798.3
Above States	23.9	41.5	76.1	58.5	4257.8	15196.6

Distribution Among States: The distribution of total economic gain has improved for multi-season and mono-season states from 76.7 per cent in 1982-83 to 81.6 per cent in 1994-95 (**Table 4**). For multi-season states this has increased in Bihar, Orissa, Uttar Pradesh and West Bengal. Among mono-season states it has increased only in Madhya Pradesh (Table 4). In Bihar, Orissa and Madhya Pradesh this distribution has improved for both PCC and NPC, while in Uttar pradesh and West Bengal it has improved for NPC(see Table 4). All these states have more acute and wide spread poverty.

Distribution of Gain by Rate of Marketed Surplus: The distribution of economic gain between PCC and NPC is governed by the rate of marketed surplus since we have considered same demand and supply elasticities for 1982-83 and 1994-95. Therefore studying the pattern of distribution of gain between PCC and NPC under different rates of marketed surplus has significance. The rate of marketed surplus is divided into four classes, viz., less than 15 per cent, 15 to 25 per cent, 25 to 50 per cent and above 70 per cent. The distribution of economic gain among these four categories in the multi-season, mono-season and for all states given in **Table 5** indicate the following.

For all states together the absolute economic gain has increased for all the four categories. But the relative share in total economic gain has declined for the rate of marketed surplus ranging from 25 to 50 per cent in multi-season states, and for marketed surplus above 25 per cent in mono-season states. These are all likely to be larger farmers. When these are studied separately for PCC and NPC, **Table 6** reveals the following.

While in multi-season states absolute gain of PCC increases in all the classes of rate of marketed surplus, in mono-season states this is so in all classes except with marketed surplus of 25 to 50 per cent. But for the NPC absolute gain increases in all the classes of marketed surplus ratio in both multi and mono-season regions.

Table 4: Percent Distribution of Economic Gain of PCC and NPC in different States

State	PCC (%)		NPC (%)		Total(%)	
	1982-83	1994-95	1982-83	1994-95	1982-83	1994-95
1.Andhra Pradesh	16.9	5.6	23.7	18.4	22.1	13.1
2.Assam	7.0	2.9	1.0	1.2	2.4	1.9
3.Bihar	2.6	6.3	0.5	2.7	1.0	4.1
4.Karnataka	6.5	2.2	1.5	1.9	2.7	2.0
5.Kerala	5.0	1.8	1.1	0.5	2.1	1.0
6.Orissa	5.7	14.4	0.2	1.7	1.5	6.9
7.Tamil Nadu	30.3	19.3	20.8	23.4	23.1	21.7
8.Uttar Pradesh	17.7	12.1	9.0	18.4	11.1	15.8
9.West Bengal	27.8	23.3	5.5	9.2	10.8	15.1
Multi-Season	119.5	87.8	63.3	77.2	76.7	81.6
1.Gujarat	0.6	-0.3	3.8	3.3	3.0	1.8
2.Haryana	-13.7	-0.7	9.0	1.5	3.6	0.6
3.Madhya Pradesh	5.6	14.8	1.3	7.1	2.3	10.3
4.Maharastra	16.7	3.2	3.1	2.7	6.3	2.9
5.Punjab	-28.7	-4.9	19.4	8.1	7.9	2.7
6.Rajasthan	0.03	0.03	0.1	0.1	0.1	0.0
Mono-Season	-19.5	12.2	36.7	22.8	23.3	18.4
Above States	100	100	100	100	100	100

Table 5: Distribution of Total Economic Gain under different Levels of Marketed Surplus in Multi-Season and Mono-Season States

	Total Economic Gain(Rs. Million)			
Marketed Surplus	1982-83		1994-95	
	Absolute	Percentage	Absolute	Percentage
Multi-Season States:				
Below 15	167.5	5.1	1340.9	10.8
15 to 25	706.1	21.6	3377.2	27.2
25 to 50	2394.0	73.3	7680.3	61.9
Total	3267.6	100.0	12398.4	61.9
Mono-Season States				
15 to 25	368.5	37.2	2012.2	71.9
25 to 50	131.5	13.3	281.5	10.1
Above 70	490.2	49.5	504.5	18.0
Total	990.2	100.0	2798.3	100.0
All States:				
Below 15	167.5	3.9	1340.9	8.8
15 to 25	1074.6	25.2	5389.4	35.5
25 to 50	2525.4	59.3	7961.8	52.4
Above 70	490.2	11.5	504.5	3.3
Total	4257.8	100.0	15196.6	100.0

Table 6: Distribution of Gain of PCC and NPC under different Rates of Marketed Surplus in Multi-Season and Mono-Season States

	Producer-cum-Consumers (PCC)			
	1982-83		1994-95	
	Rs.Million	Percentage	Rs.Million	Percentage
Multi-Season States:				
Below 15	128.4	10.6	1090.8	19.7
15 to 25	426.0	35.1	2116.5	38.2
25 to 50	660.6	54.4	2328.1	42.1
Total	1215.0	100.0	5535.3	100.0
Mono-Season States:				
15 to 25	226.3	-114.1	1134.3	147.9
25 to 50	6.4	-3.2	-15.1	-2.0
Above 70	-430.9	217.3	-352.1	-45.9
Total	-198.3	100.0	767.1	100.0
All States:				
Below 15	128.4	12.6	1090.8	17.3
15 to 25	652.3	64.2	3250.8	51.6
25 to 50	666.9	65.6	2312,9	36.7
Above 70	-430.9	-42.4	-352.1	-5.6
All States	1016.7	100.0	6302.4	100.0
	Non-Producer Consumers (NPC)			
	1982-83		1994-95	
	Rs. Million	Percentage	Rs.Million	Percentage
Multi-Season States:				
Below 15	39.1	1.9	250.1	3.6
15 to 25	280.1	13.6	1260.7	18.4
25 to 50	1733.4	84.4	5352.2	78.0
Total	2052.6	100.0	6863.1	100.0

Table 6 (contd.)

Mono-Season States:				
15 to 25	142.2	12.0	877.9	43.2
25 to 50	125.2	10.5	296.6	14.6
Above 70	921.1	77.5	856.6	42.2
Total	1188.5	100.0	2031.2	100.0
All States:				
Below 15	39.1	1.2	250.1	2.8
15 to 25	422.3	13.0	2138.6	24.0
25 to 50	1858.6	57.3	5648.9	63.5
Above 70	921.1	28.4	856.6	9.6
Total	3241.1	100.0	8894.2	100.0

The distribution of the absolute gain among PCC shows that it has increased for all the classes with lower marketed surplus ratios, namely, below 25 per cent in multi-season states and below 70 per cent in mono-season states. Same also holds for the NPC in both the regions.

Sensitivity Analysis

The economic gain and its distribution among PCC and NPC from the new rice technology, as described above, depends on the rate of supply curve shift, rate of marketed surplus and the price elasticity of supply and demand. The price elasticity of supply could be either negative , zero or positive for a given crop. Accordingly,

(i) when $\alpha < 0$, $E_t > S_t$,

(ii) when $\alpha = 0$, $E_t = S_t$,

(iii) when $\alpha > 0$, $E_t < S_t$, ; where E_t and S_t are respectively total economic gain and supply shift during time t.

The economic gain(E_t) would exceed the total supply shift(S_t) when the supply elasticity(α) is negative. And under perfectly inelastic supply the economic gain would be equal to the supply shift. However, when producers respond positively to the market price of the product, the total economic gain would be lower than the supply shift. This is because of the differences in the distribution of this gain between PCC and NPC. But this distribution is determined by the rate of marketed surplus , rate of supply shift and the demand elasticity. Shift in supply function is expected to improve the rate of marketed surplus and the supply shift could be achieved through new seed varieties with high yield potential and use of fertilizers, besides improved farm practices. These influence total economic gain and its distribution among PCC and NPC. Using triennium ending 1994-95 as the base year this is discussed below by considering four hypothetical cases, and assuming demand and supply elasticities to be constant. This assumption is reasonable for a commodity like rice.

First, it is postulated that the supply curve would shift at the rate of 10 per cent and the rate of marketed surplus would increase by 4 per cent and 8 per cent compared to 1994-95 level. Second, it is assumed that the supply curve would shift at the rate of 20 per cent and the rate of marketed surplus would increase by 8 per cent and 16 per cent as in no states marketed surplus exceeds 85 per cent. Using these assumptions the projected economic gain and its distribution among PCC and NPC are given in **Table 7** for the multi-season and mono-season states and for all states.

The change in economic gain under the four hypothetical cases for all states together would be in the range of Rs.1520 million to Rs.3039 million at 1969-70 prices. NPC captures major share of the increment in economic gain irrespective of the rate of shift in supply curve and rate of marketed surplus(see Table 7). PCC's income is adversely affected when the rise in rate of marketed surplus is 8 per cent against 10 per cent shift in supply curve. This also

holds when the marketed surplus is increased by 16 per cent against 20 per cent shift in supply curve. Thus, non-producer consumers(NPC) are the major beneficiaries from future rightward shift in supply curve in the mono-season states, but in multi-season states producer-cum-consumers(PCC) also benefits when rate of marketed surplus is increased by only 4 to 8 per cent.Even when rate of marketed surplus is increased by a higher percentage the adverse impact for them is smaller than in mono-season states.

Table 7: Sensitivity of PCC and NPC's Gains to Change in Rate of Supply Shift and Marketed Surplus Ratio(MS)

	Supply Shift(k) = 10%		Supply Shift(k) =20%	
	MS = 4%	MS =8%	MS =8%	MS=16%
Multi-Season States				
PCC	251.6	-50.4	448.2	-210.6
NPC	988.2	1290.2	2031.5	2690.3
Total	1239.8	1239.8	2479.7	2479.7
Mono-Season States:				
PCC	-12.8	-102.0	-41.6	-236.6
NPC	292.5	381.7	601.2	796.2
Total	279.7	279.9	559.6	559.6
All States				
PCC	238.8	-152.4	406.6	-447.2
NPC	1280.9	1672.4	2632.7	3486.5
Total	1519.7	1519.7	3039.3	3039.3

Implications for Fertilizer Subsidy and Rice Support Price Policy

Government investment/expenditure which influences technical change/supply shift not only benefit PCC but also NPC. Fertilizer subsidy which encourages more of its use influences supply shift. Since the supply function represents a cost curve, it can be shifted by lowering the price of an input in which the new technology is embodied. In case of sub-optimal demand for such an input, the input subsidy in the early stages of adoption could stimulate its use and lead to a net welfare gain to the society, provided adequate supplies of the input along with other complementary inputs are available (Barker and Hayami, 1976). Major share in the resulting economic gain is captured by NPC who are mainly the rural net purchasers, landless and urban consumers. But the PCC benefit through increase in self consumption which alleviate rural poverty. This would be the case for subsidy on fertilizers as its use is more pervasive. Over 60 per cent of the rice cultivators operate less than 1 hectare and many of them are net purchasers. This suggests that they benefit both as producers (from fertilizer subsidy) and as consumers (from lower price). Fertilizer subsidy during 1994-95 was over Rs.9000 million at 1969-70 prices. Assuming a shift in supply curve by 10 per cent, the economic gain works out to Rs.1500 million. This amounts to over 16 per cent return on fertilizer subsidy. More than three-fourth of this gain is shared by the non-producer consumers(NPC) who also include rural net purchasers as states earlier.

Rice price support prior to technical change would provide limited gain on account of relatively low supply elasticity and it may not shift the supply function. But fertilizer subsidy provide more optimistic route to improving technical change and consequent gain to NPC, besides some gain to PCC. However, rice price support would be necessary after technology-associated significant shift in its supply function occurs. This is because this change reduces both absolute and relative share of economic benefit for the producer-cum-consumers(PCC) with higher increase in rate of marketed surplus as can be seen from Table

7. Moreover, the decline is more marked for the rice farmers in mono-season states where the rate of marketed surplus is higher than in multi-season states.

Summing-up and Implications

The total economic gain from technical change in rice production during triennium ending 1982-83 was over Rs.4250 million in 1969-70 prices. This rose to over Rs.15000 million during triennium ending 1994-95. In multi-season states while the total economic gain has increased by four times, in mono-season states this was less than three times and consequently the relative share of multi-season states in total economic gain improved more. Though non-producer consumer(NPC) are the major beneficiary in both 1982-83 and 1994-95 and more so in the mono-season states, the relative share of producer-cum consumer(PCC) in total economic gain has improved in both multi and mono-season states. For all states together the relative share of PCC has improved from 23.8 per cent to 41.5 per cent. This could be mainly attributed to the decline in marketed surplus in few states particularly those with high rate of marketed surplus during 1982-83.

For all states together the total absolute economic gain has increased for all the marketed surplus classes but the relative share has declined for classes with high rate of marketed surplus. The shares of both producer-cum consumer(PCC) and non-producer consumer(NPC) in total economic gain have improved for marketed surplus below 25 per cent. The extent of this gain to PCC was larger compared to NPC in both multi and mono-season states. Sensitivity analysis shows that NPC are the major beneficiaries from future rightward shift in supply curve in the mono-season states though the PCC also benefit in the multi-season states. These findings have largely resulted from the rate of supply function shift as well as change in rate of marketed surplus. Changes in these are as follows.

Substantial variation in the rate of adoption of the new rice technology is observed

among different states as explained by the rate of supply function shift. During triennium ending 1982-83 the rate of supply function shift varied from 2 per cent to 99 per cent in various states with an overall average of 11 per cent. During triennium ending 1994-95 this variation was 11 to 122 per cent with an overall mean of 47 per cent accompanied with a decline in interstate variation. The supply shift in the mono-season states in 1982-83 was more than three times that of the multi-season states and in 1994-95 this was below 33 per cent. The rate of marketed surplus varied from 5 per cent to 90 per cent during triennium ending 1982-83 with a mean of 29 per cent. Despite a decline in interstate variation in rate of marketed surplus during triennium ending 1994-95, the marketed surplus for all states together almost remained same. This holds true for both multi-season and mono-season states. This is in spite of an increase in rice production by over 50 percent between treinnium ending 1982-83 and 1994-95.

The preceding suggests that the policies that encourage technical change and market infrastructure development must be emphasized. For the former research and extension through government investment for rice to provide a continuous flow of technology along with complementary inputs must be strengthened pro-actively to shift the supply function more rapidly than the demand function. And for the latter government expenditure on regulated markets would be desirable. Both of these should also aim at reducing the inter-state variation in rate of supply shift and marketed surplus so as to make technical change broad based. Once this occurs the rice price support may follow. This is because of adverse impact of the supply curve shift on rice prices for the producers who tend to have then lower share in total gain. Such a policy would also ensure future technical change in rice which tend to benefit non-producer consumers(NPC) more.

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