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CHANGING CROPPING PATTERN IN BANGLADESH FROM 1971-75 THROUGH 1991-93: IMPLICATIONS ON CROP SECTOR GROWTH

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ABSTRACT

A study of changing cropping pattern for a period is important to understand the shifting nature of the composition of crops in the crop sector and the economic and non-economic factors that cause the cropping pattern change. Over the last quarter of a century of post-Bangladesh years, cropping patterns tilted towards MV variety of crops both in Kharif and Rabi season. Crop diversification has been taking place in the Rabi season. Growths of HYV Aus and wheat areas have been diminishing since the decade of the eighties. Local varieties of rices have been declining and got negative cropping pattern changes including jute, barley, mustard and chilli throughout the whole period of 1971/72-1993/94. It was observed that real output price change and cropping pattern changes had little relationship. Improved technology of production (seed-fertilizer technology) had rather influenced cropping pattern changes. Researches on varietal improvement and production technology should get priority to enhance higher returns from favourable cropping pattern changes and crop mix.

1. INTRODUCTION

Changes have been taking place in crop sector agriculture in terms of area allocation to different crops. Cropping pattern is dependent on physical, historical, social, institutional and economic factors as well as government policies (Agrawal and Kassam, 1976 pp.2-3). The crop sector has experienced accelerated growth for almost a quarter century (1971/72 to 1993/94) after the emergence of Bangladesh. Changes in quantity of output reflects growth performance in crop agriculture. The increase in crop output is the result of changes in several contributing factors like changes in area allocated to a particular crop and yield rates. Area allocation to a particular crop is being influenced by expected output prices relative to input prices, expected yield (based on the art of technology available), rainfall during the pre-sowing period, price and yield risk. Yield is postulated as being influenced by the technology of production, input costs and rainfall/water availability during the growing period.

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In the context of the total cropped area, cropping pattern for a single crop in a particular period of time is expressed by the amount of area under the crop as a proportion of total cropped area. In a multi-crops enterprises situation, relative standing for a single crop area may increase/decrease or may remain unchanged in the context of changing areas of the other crops and/or changing total cropped area between the two periods of time. This pattern of changes for an individual crop is expressed as a change in cropping pattern for single crop. Total production of crop outputs has been changing due to changes in area under cultivation, yield rates, cropping pattern and prices of different crops. Shifting cropping pattern indicates changes in the composition of crops as well as their relative contribution to the total output growths due to proportionate change in areas. If the proportion of area under a high value crop or high yielding varieties increase, it is likely to result in an increase in total returns from the sector even while yield level is stagnating or prices have a declining trend. Analysis of the changes in cropping pattern is important to understand the direction of change in crop sector itself and the role of each crop to changes in total returns from the crop sector. Changes in cropping pattern is pursued by either having technological backup in production of crop (s) or supported by relative price advantages of the outputs or being influenced by the both. It is important to understand the changing pattern of crops over a longer period of time and identify the factors (technology of productions, real output price changes or both) that caused changes in areas of 'the crops' for taking appropriate policy measures in boosting and sustaining crop sector growth. Therefore, this study is designed to compare the returns from different crops between the periods due to changes in cropping pattern. The periods of comparison are i) 1971-1975 with 1991-93, ii) 1971-75 with 1981-85 and iii) 1981-85 with 1991-93. Sub-divisions of total period has been aimed at to see the changing crop sector performances in terms of cropping pattern changes by the decades so far. In section 2, methodology of assessing the changing cropping pattern has been formulated followed by the presentation of empirical results in section 3. Section 4 stands as a concluding part of the study wherein policy implications are noted.

2. METHODOLOGY

Revenue (output times price) of crops over a period of time is dependent on changes in total cropped area, yield, cropping pattern and changes in the prices of the crops. From the total changes of value of crop sector output (returns) for a particular period, if the changes brought about by changes in yield level, total cropped area increase and prices are deducted, the value of outputs thus left over is the outcome of the changes in cropping pattern alone. Algebraically this can be formulated as follows¹:

Let A_0 and A_1 be the total cropped area at the base period and the period of comparison respectively and a_{0i} , y_{0i} and p_{0i} be the area, yield per hectare and price per tonne respectively of the i 'th crop in the base period. Similarly, a_{1i} , y_{1i} and p_{1i} be the corresponding values at the

period of comparison. The total changes in the value of output (returns) between the two periods of time of the crops in aggregate can be expressed as:

$$R = f(T, Y, P, C) = \sum_{i=1}^n a_{li} Y_{li} P_{li} - \sum_{i=1}^n a_{oi} Y_{oi} P_{oi}; \text{ where } i = 1, 2, \dots, n \text{ crops}$$

where R represents total change in the value of output due to the changes in total cropped area (T), Yield (Y), price (P) and cropping pattern (C). This can be aggregated for 'n' number of crops in value terms of output to see the crop sector behaviour as a whole.

From the total effect, changes in yield and prices can be eliminated by multiplying the areas at period of comparison with respective yield rates and prices at the base period and then subtracting from it the total value of production at the base period, which algebraically can be expressed as:

$$R = f(T, C) = \sum_{i=1}^n a_{li} Y_{oi} P_{oi} - \sum_{i=1}^n a_{oi} Y_{oi} P_{oi}$$

The effect of changes in total cropped area increase can be further eliminated to see the effect of changes in cropping pattern (proportionate changes in areas) alone by the following formula:

$$R = f(T, C) - f(T) = f(C) = \sum_{i=1}^n a_{li} Y_{oi} P_{oi} - \sum_{i=1}^n (a_{oi} Y_{oi} P_{oi}) \frac{A_1}{A_0}$$

Absolute area increase/decrease for the periods i) 1971/72 to 1993-94, ii) 1971/72 to 1981/82 and iii) 1982/83 to 1993/94 were estimated through fitting a log-linear (exponential growth trends) time trend equation to relate the cropping pattern changes of respective crops for the corresponding periods (for estimational procedures of such equations, see Alam 1992). All trend growth estimates are autocorrelation (pertinent for time series data) corrected estimates (where autocorrelation of the error term is detected) estimated through Maximum Likelihood (ML) estimator.

CROPS COVERED

To assess the direction of cropping pattern changes (cropwise), almost all the crops are taken into consideration, except the one which covered less than 1 percent of the total cropped area during 1991-93 period (thus, tobacco (0.28%), tea (0.35%) and some of the spices and vegetable crops are dropped). Five year averages of area, yield and prices were used for the periods 1971-75, 1981-85 and three year averages were used for the same for the terminal period of 1991/92-1993/94 (as the latest data were available for the analytical purposes).

THE DATA

All the information pertaining to the crop areas, yields and prices are taken from the publications of the Bangladesh Bureau of Statistics (BBS). In general, the agricultural

statistics generated by the BBS are reliable and can be used for statistical and econometric exercises. About the quality and reliability of the data generated by the BBS have been discussed in detail in Alam (1996).

3. ANALYSIS OF THE RESULTS

Changes in Total Returns due to Cropping Pattern Changes: 1971-75 through 1991-93

During the early nineties cropping pattern has changed conspicuously towards HYV Boro and Aman rice varieties. HYV Boro contributed substantially (94%) followed by HYV Aman (57%) and sugarcane (1.89%). Proportionate areas of local varieties of rices and jute have declined. During the early nineties, the cash crops (sugarcane and potato) and out of eleven Rabi crops, six have contributed positively over first quinquennium of the seventies. Changes in total crop returns (column 2 of Table LA) in 1991-93 originating only through cropping pattern changes (column 4 of Table-1.A) has been 15% through over the period of 1971-75. Share of only Rabi (non-rice) crops to the changes in total returns due to cropping pattern changes was 1.81 percent in 1991-93 over the base period of 1971-75. All other crops (all rices and sugarcane) contributed 13.25% of the total cropping pattern changes (of 15%). That is HYV Boro and Aman dominated overwhelmingly in the cropping pattern changes. In the Rabi season, other than wheat; potato, groundnut, mungbean, lentil and sesamum have shown positive cropping pattern changes over the whole period. Wheat, potato and lentil contributed 8%, 4% and 2% respectively (all others less than one percent in the Rabi seasons).

The crops which have positive cropping pattern changes over the whole period, the most have had significant area growths over the entire period (Table-2 A-C). HYV Boro and Aman areas have grown at the rate of 8 percent per annum (based on exponential growth function) during the period 1971-1993, followed by wheat and lentil at 7 percent and mungbean at 6 percent. Other Rabi crops which have had positive area growth is mustard (3% p. a), and potato (2% p. a). Areas of all local varieties of rices have declined including jute, barley and chilli (cropping patterns for these crops were also negative). Crops having improved cultivars got upperhand in terms of cropping pattern changes. Real output price changes have rather little influence on the changing cropping patterns over the period of 1971-1973 as almost all (having positive cropping pattern trends) crops have exhibited negative real output price increase (Table 3). Crops having improved cultivars have favoured increased cropping pattern changes (HYV rice, wheat, potato, sugarcane, mustard and lentil).

Changes in Returns due to Cropping Pattern Changes: 1971-75 through 1981-85

During the period of 1981-85 over the period of 1971-75, HYV rices contributed positively and substantially to the changes in returns. The positive contributions were also

Table 1A. Contribution of various crops in total changes in returns due to changes in cropping pattern: 1971-75 through 1991-93.

Crops	Average value in 1971-75 (Cr. Tk.)	Average value in 1991-93 at base year prices and yield (Cr. Tk.) (Base 71-75)	Value in 1971-75 multiplied by A_1/A_0 (Cr. Tk.)	Changes in return due to changes in cropping pattern (Cr. Tk.) in 1991-93	Percentage contribution by crops to the changes in returns due to cropping pattern changes during 1991-93 (Base 71-75)
	(1)	(2)	(3)	(4)	(5)
All Boro	369.26	919.45	433.81	485.64	51.26
Local Boro	118.19	61.71	138.85	-77.14	-8.14
HYV Boro	254.00	1188.01	298.40	889.61	93.89
All Aus	450.05	254.20	528.72	-274.52	-28.97
Local Aus	309.28	175.07	363.34	-188.27	-19.87
HYV Aus	70.37	66.17	82.67	-16.50	-1.74
All Aman	1177.21	1203.82	1382.99	-179.17	-18.91
Tr. Aman	658.58	530.39	773.69	-243.3	-25.68
Br. Aman	293.83	293.83	345.19	-51.36	-5.42
HYV Aman	228.90	810.59	269.91	540.68	57.06
Sugarcane	131.50	172.36	154.48	17.88	1.89
Jute	159.37	117.09	187.23	-70.14	-7.40
Sub Total	4220.54	5792.69	4959.28	833.41	87.97
Wheat	22.63	100.95	26.58	74.37	7.85
Barley	3.49	1.72	4.10	-2.38	-0.25
Garlic	14.18*	14.04	16.66	-2.62	-0.28
Groundnut	10.19*	16.69	11.97	4.72	0.49
Mustard	56.38*	56.37	66.24	-9.87	-1.04
Mungbean	3.03*	11.64	3.56	8.08	0.85
Lentil	10.32*	32.54	12.12	20.42	2.15
Sesamum	10.89*	18.06	12.79	5.27	0.56
Chilli	58.41*	48.87	68.62	-19.75	-2.08
Onion	21.83*	22.95	25.65	-2.70	-0.28
Potato	113.75*	172.07	133.53	38.54	4.06
Sub Total	325.10	495.9	381.82	114.08	12.03
All Total	4545.64	6288.59	5341.09	947.49	100.00

Note * Based on the average of four years (1972- to 1975, all others are five year averages. For valuing nominal prices have been used.

A_1 , A_0 are defined as the total cropped areas during the terminal period and the base period respectively. Figures in column (4) are obtained by subtracting figures of column (3) from the figures of column (2). In column (5), returns due to changes in cropping pattern alone for individual crops given in column (4) are expressed as percentage of total increase in returns (i. e Tk. 947.47). during 1971-75 through 1991-93. Column 2 equals column (3) plus column (4).

Data Sources : Annual Yearbooks and Agricultural Yearbooks, BBS (Various issues), 1979 to 1995

Table 1B. Contribution of various crops in total changes in return due to changes in cropping pattern: 1971-75 through 1981-85.

Crops	Average value in 1971-75 (Cr. Tk.)	Average value in 1981-85 at base year (Cr. Tk.) (Base 71-75)	Value in 1971-75 multiplied by A_1/A_0 (Cr. Tk.)	Changes in return due to changes in cropping pattern (Cr. Tk.) in 1981-85 over 1971-75	Percentage contribution by crops to the changes in returns due to cropping pattern changes in 1981-85 over 1971-75
	(1)	(2)	(3)	(4)	(5)
All Boro	369.26	511.13	415.27	95.86	48.63
Local Boro	118.19	81.87	132.92	-51.05	-25.90
HYV Boro	254.00	557.20	285.65	271.55	137.77
All Aus	450.05	438.14	506.13	-67.99	-34.49
Local Aus	309.28	327.73	347.82	-20.09	-10.19
HYV Aus	70.37	206.66	79.14	127.52	64.69
All Aman	1177.21	1247.96	1323.89	-75.93	-38.52
Tr. Aman	658.58	690.57	740.64	-50.07	-25.40
Br. Aman	293.83	236.99	330.44	-93.45	-47.41
HYV Aman	228.90	266.70	257.42	9.28	4.71
Sugarcane	131.50	152.92	147.88	5.04	2.56
Jute	159.37	160.13	179.23	-19.10	-9.69
Sub Total	4220.54	4877.93	4746.43	131.57	66.75
Wheat	22.63	98.41	25.45	72.96	37.01
Barley	3.49	1.41	3.92	-2.51	-1.27
Garlic	14.18*	14.16	15.95	-1.79	-0.91
Groundnut	10.19*	8.98	11.46	-2.48	-1.26
Mustard	56.38*	59.27	63.40	-4.13	-2.10
Mungbean	3.03*	3.26	3.40	-0.14	-0.07
Lentil	10.32*	11.23	11.61	-0.38	-0.19
Sesamum	10.89*	8.51	12.25	-3.74	-1.90
Chilli	58.41*	55.83	65.69	-9.86	-5.00
Onion	21.83*	23.94	24.55	-0.61	-0.31
Potato	113.75*	146.14	127.92	18.22	9.24
Sub Total	325.10	431.14	365.61	65.54	33.25
All Total	4545.64	5309.07	5112.04	197.11	100.00

Note : Computational procedure is explained in Table 1.A. * see, footnotes of Table 1. A.

Data Sources: Annual and Yearbooks Agricultural Yearbooks, BBS (Various issues), 1979 to 1995.

Table 1C. Contribution of various crops in total changes in return due to changes in cropping pattern: 1981-85 through 1991-93

Crops	Average value in 1981-85 (Cr. Tk.)	Average value in 1991-93 at base year (Cr. Tk) (Base 81-85)	Value in 1981-85 multiplied by A_1/A_0 (Cr. Tk)	Changes in return due to changes in cropping pattern (Cr. Tk.) in 1991-93 over 1981-85	Percentage contribution by crops to the changes in returns due to cropping pattern changes in 1991-93 (Base 81-85)
	(1)	(2)	(3)	(4)	(5)
All Boro	1418.54	2545.37	1481.81	1063.36	78.60
Local Boro	215.09	162.11	224.68	-62.57	-4.63
HYV Boro	1193.73	2545.15	1246.97	1298.18	95.96
All Aus	1156.44	670.95	1208.02	-537.07	-39.70
Local Aus	827.32	441.95	864.22	-422.27	-31.21
HYV Aus	362.31	299.06	378.47	-79.41	-5.87
All Aman	3349.13	3230.66	3498.50	-267.84	-19.80
Tr. Aman	1824.60	1401.39	1905.98	-504.59	-37.30
Br. Aman	626.60	386.38	654.55	-268.17	-19.82
HYV Aman	559.09	1699.19	584.03	1115.16	82.43
Sugarcane	352.34	397.11	368.05	29.06	2.15
Jute	650.20	475.44	679.20	-203.76	-15.00
Sub Total	12535.39	14254.76	13094.48	1160.08	85.75
Wheat	471.76	483.95	492.80	-8.85	-0.65
Barley	2.54	3.09	2.65	0.44	0.03
Garlic	30.97	30.71	32.35	-1.64	-0.12
Groundnut	20.29	37.71	21.19	16.52	1.22
Mustard	117.44	201.76	122.68	79.08	5.85
Mungbean	8.53	30.43	8.53	21.90	1.62
Lentil	43.40	99.64	45.34	54.30	4.01
Sesamum	17.36	36.83	18.13	18.70	1.38
Chilli	92.60	81.06	96.73	-15.67	-1.16
Onion	53.11	50.92	55.48	-4.56	-0.34
Potato	244.72	288.14	255.63	32.51	2.40
Sub Total	1102.72	1344.24	1151.51	192.73	14.25
All Total	13638.11	15599.00	14245.99	1352.81	100.00

Note: Computational procedure is explained in Table I. A.

Data Source : Annual Yearbooks and Agricultural Yearbooks, BBS (Various issues), 1983/84 to 1995

achieved by the crops of sugarcane, wheat (phenomenal contribution of 37%) and potato (9%). Cropping pattern contribution was negative for all the local varieties of rices, jute and minor crops like barley, garlic, groundnut, mustard, lentil, sesamum, onion and chilli (i. e. proportionately areas decreasing for these crops). The contribution of HYV Boro cropping pattern changes has been quite substantial (138%) during the decade of seventies and the early eighties followed by HYV Aus (65%), and HYV Aman (5%). During the Rabi crops season, area contribution of nine minor crops has been negative (e. g; barley, garlic, groundnut, mustard, mungbean, lentil, onion, sesamum and chilli). During the Kharif season cropping pattern contribution of 7 crops was also negative (local varieties of rices and jute; Table 1.B).

Growths of net cultivated area under the crops of HYV Boro, HYV Aus and sugarcane have been significantly increasing during the period of 1971/72 to 1982/83. Area growths of wheat (15% annually) and potato have been significant during the same period. Share of Rabi crops to the total changes in returns due to cropping pattern changes was 33% (substantially contributed by the growth of wheat areas during the period). The large area of wheat came from other minor Rabi crops. During the same period HYV Boro areas also have grown largely (therefore, HYV Boro and wheat appeared not very competing crops as usually upheld). Changes in total returns (through proportionate area change i. e cropping pattern changes) in 1981-85 originating only through cropping pattern changes has been 3.74 per cent (computed using columns 4 and 2 of Table LB). Wheat and potato got boost during the seventies and early eighties.

Changes in Returns due to Cropping Pattern Changes: 1981-85 through 1993-94

Changes in returns due to cropping pattern changes have been positive for HYV Boro, HYV Aman, sugarcane during the Kharif season and barley, groundnut, mungbean, mustard, lentil, sesamum and potato during the Rabi season. The Rabi crops other than wheat got boost during the eighties and the nineties.

HYV growths during the period 1981-85 through 1991-93 have slowed down and was negative for HYV Aus. Only crop varieties of HYV Boro, HYV Aman and sugarcane areas in proportion increased, HYV Boro and sugarcane though at declining rates. Share of Rabi crops to the changes in total returns was 14 percent which declined substantially owing to reduced areas of wheat crop during the period. Though total share of Rabi crops has declined (due to decrease in wheat areas) but proportion of areas of some of the minor Rabi crops have increased. This gives evidence that command area of wheat competes with areas of other minor Rabi crops rather than HYV Boro areas. On the basis of this trend, this can be postulated that wheat cultivation rather than Boro (HYV) has earlier pushed off minor Rabi crops areas.

Net cultivated areas under the crops have significantly grown for HYV Boro and HYV Aman. During the Rabi season, area growths have been significant for potato, mungbean,

Table 2A. Area growths (through exponential growth equation¹) of different varieties of rice, jute, sugarcane and Rabi crops (1971-1993).

Crops	Dependent Variable	Constant	Time Trend	R ²
All Boro*	Area	9.85	0.05 (8.40) ^{hs}	0.93
Local Boro	Area	15.72	-0.03 (-10.24) ^{hs}	0.83
HYV Boro*	Area	6.45	0.08 (12.82) ^{hs}	0.96
All Aus*	Area	16.95	-0.02 (-1.85)	0.93
Local Aus*	Area	17.65	-0.03 (-2.33) ^s	0.95
HYV Aus*	Area	6.84	0.017 (2.20) ^s	0.93
All Aman*	Area	15.52	0.00 (0.27)	0.14
HYV Aman*	Area	6.88	0.08 (4.30) ^{hs}	0.81
Broadcast Aman*	Area	17.01	-0.03 (-5.94) ^{hs}	0.88
Trans. Aman*	Area	15.90	-0.01 (-2.07) ^s	0.79
Sugarcane	Area	10.82	0.01 (10.45) ^{hs}	0.83
Jute	Area	14.58	-0.01 (-2.43) ^s	0.22
Rabi crops				
Wheat	Area	6.40	0.07 (3.81) ^{hs}	0.96
Potato	Area	9.73	0.02 (14.75) ^{hs}	0.91
Onion	Area	10.07	0.003 (2.39) ^{hs}	0.21
Mungbean*	Area	4.59	0.06 (3.03) ^{hs}	0.81
Lentil*	Area	6.67	0.059 (3.82) ^{hs}	0.81
Mustard*	Area	9.66	0.03 (4.39) ^{hs}	0.74
Garlic*	Area	9.47	-0.00 (-0.25)	0.22
Groundnut*	Area	8.50	0.02 (1.52)	0.68
Barley*	Area	12.98	-0.04 (-2.32) ^s	0.66
Sesamum*	Area	8.76	0.03 (1.49)	0.61
Chilli	Area	12.21	-0.01 (-4.15) ^{hs}	0.46

Notes : *Estimate is free from 1st order autocorrelation (Estimator ML). In all other cases the Estimator is OLS (when no autocorrelation is detected).

¹ - For estimational procedure of such a model and equation, see Alam, 1992.

hs- signifies highly significant at 1 per cent (a two tailed test) error level.

s - significant at 5 per cent error level or below.

Table: 2B. Area growths (through exponential trend equation) of different varieties of rice, jute, sugarcane and Rabi crops (1971/72-82/83).

Crops	Dependent Variable	Constant	Time Trend	R ²
All Boro*	Area	11.64	0.0296 (3.41) ^{hs}	0.54
Local Boro	Area	15.78	-0.0361 (-2.86) ^s	0.44
HYV Boro*	Area	6.54	0.0885 (4.46) ^{hs}	0.80
All Aus*	Area	14.71	0.0032 (0.71)	0.21
Local Aus*	Area	15.75	-0.0117 (- 4.54) ^{hs}	0.67
HYV Aus*	Area	-0.74	0.1729 (5.87) ^{hs}	0.95
All Aman*	Area	14.92	0.0085 (5.39) ^{hs}	0.74
Tr. Aman*	Area	14.68	0.0046 (0.95)	0.32
Br. Aman*	Area	15.05	- 0.0091 (-2.51) ^s	0.41
HYV Aman*	Area	11.23	0.0232 (0.54)	0.09
Sugarcane	Area	10.79	0.0145 (3.22) ^{hs}	0.51
Jute*	Area	14.77	-0.0175 (-0.88)	0.24
Wheat*	Area	0.69	0.1522 (6.33) ^{hs}	0.97
Potato	Area	9.13	0.0300 (7.66) ^{hs}	0.85
Onion*	Area	9.45	0.0122 (1.54)	0.34
Mungbean*	Area	9.59	0.0003 (0.02)	0.16
Lentil*	Area	10.11	0.0142 (1.91)	0.54
Mustard*	Area	11.41	0.0098 (1.14)	0.12
Garlic*	Area	9.38	0.0007 (0.21)	0.19
Groundnut*	Area	10.86	- 0.0108 (-0.93)	0.23
Barley*	Area	15.20	-0.0684 (-6.12) ^{hs}	0.96
Sesamum*	Area	11.96	-0.0157 (-1.27)	0.34
Chilli	Area	11.29	-0.0003 (-0.07)	0.00

Notes : * Autocorrelation corrected estimates through ML estimator
 hs- signifies highly significant at 1 per cent error level.
 s - significant at 5 per cent error level or below.

Table 2C. Area growths (through exponential growth equation) of different varieties of jute, sugarcane and Rabi crops (1983/84-1993/94).

Crop	Dependent Variable	Constant	Time Trend	R ²
All Boro*	Area	8.70	0.0660 (4.29) ^{hs}	0.91
Local Boro*	Area	15.22	-0.0296 (-6.59) ^{hs}	0.83
HYV Boro*	Area	6.75	0.0865 (4.52) ^{hs}	0.93
All Aus*	Area	20.43	-0.0654 (-6.77) ^{hs}	0.96
Local Aus*	Area	21.06	-0.075 (-5.84) ^{hs}	0.96
HYV Aus	Area	15.65	-0.0304 (-2.32) ^s	0.56
All Aman*	Area	15.90	-0.0036 (-0.86)	0.08
Trans. Aman*	Area	17.89	-0.0336 (-9.06) ^{hs}	0.90
Broadcast. Aman	Area	18.71	-0.0547 (-6.09) ^{hs}	0.80
HYV. Aman*	Area	2.97	0.1243 (8.76) ^{hs}	0.96
Sugarcane	Area	10.84	0.0139 (4.46) ^{hs}	0.68
Jute	Area	17.56	-0.0481 (-2.82) ^{hs}	0.47
Wheat*	Area	13.15	0.0014 (0.21)	0.00
Potato	Area	9.97	0.0193 (4.96) ^{hs}	0.73
Onion*	Area	10.41	0.00 (0.03)	0.01
Mungbean*	Area	-1.23	0.1338 (2.20) ^s	0.66
Lentil*	Area	1.97	0.1131 (2.35) ^s	0.65
Mustard*	Area	7.39	0.0587 (2.55) ^s	0.63
Garlic*	Area	9.42	0.0002 (0.19)	0.00
Groundnut*	Area	3.49	0.0769 (2.45) ^s	0.69
Barley*	Area	6.21	0.04 (1.06)	0.11
Sesamum*	Area	2.78	0.0937 (2.07)	0.63
Chilli	Area	12.18	-0.0119 (-2.50) ^s	0.41

Notes : * Autocorrelation corrected estimates through ML estimator.
 hs- signifies highly significant at 1 per cent error level.
 s - significant at 5 per cent error level or below.

Table: 3. Changes of Deflated Prices Over the Years (1971-1993).

Crops	Dependent variable	Constant	Time Trend	R ²
All aman	Deflated Price*	4.05	-0.03 (-6.16) ^{hs}	0.65
All Boro	Deflated Price	4.38	-0.04 (-7.78) ^{hs}	0.75
All Aus	Deflated Price	3.45	-0.02 (-4.53) ^{hs}	0.51
Jute	Deflated Price	4.62	-0.04 (-3.59) ^{hs}	0.39
Sugarcane	Deflated Price	0.33	-0.01 (-2.69) ^s	0.27
Rabi crops				
Wheat	Deflated Price	4.05	-0.03 (-4.67) ^{hs}	0.52
Potato	Deflated Price	3.23	-0.03 (-2.77) ^s	0.28
Onion	Deflated Price	1.31	0.00 (0.14)	0.01
Mungbean	Deflated Price	1.72	0.01 (1.45)	0.16
Lentil	Deflated Price	1.45	0.01 (1.79)	0.14
Mustard	Deflated Price	5.25	-0.03 (-7.22) ^{hs}	0.72
Garlic	Deflated Price	-0.10	0.03 (1.47)	0.53
Groundnut	Deflated Price	3.05	-0.01 (-1.78)	0.14
Barley	Deflated Price	3.61	-0.03 (-2.98) ^s	0.34
Sesamum	Deflated Price	4.31	-0.02 (-4.19) ^{hs}	0.47
Chilli	Deflated Price	3.62	-0.01 (0.33)	0.01

Note: * Year to year nominal prices were reduced at par at the rate of percentage increase of consumer prices index (disentangling nominal increase) for middle class income group.

lentil, mustard and groundnut (Table 2 C)². Contribution of cropping pattern changes to total crop returns during 1991-93 has been significantly higher (8.67%) over the period of 1981-85 in comparison to 1981-85 to 1971-75 period (3.71%). That is, cropping pattern changes has been higher during the early nineties than over the first quinquennium of the eighties.

Cropping pattern for HYV Aman, mustard, lentil, potato and some of the minor Rabi crops have shifted sharply toward these crops and yielded higher returns from cropping pattern changes than the period of seventies.

4. CONCLUSIONS AND POLICY IMPLICATIONS

Share of percentage contribution of Kharif crops including Boro rice in total returns for the entire period has been 88% and 12% by the non-rice Rabi crops. For the period 1971-75 to 1981-85, the share of percentage contribution of Kharif crops including Boro has been 67% and 33% by the non-rice Rabi crops (with phenomenal contribution of wheat area expansion during this period). The share of percentage contribution of Kharif crops and Rabi crops (non-rice) during the period 1981-85 to 1991-93 has changed to 86% and 14% in total terms respectively. Study of the cropping pattern changes over almost a quarter century of crop sector agriculture indicated that the farmers tilted towards high yielding variety crops (or higher value added crops) for increasing their cultivated areas. HYV Boro, HYV Aus, wheat and sugarcane have shown phenomenal growth rates during the seventies and the early eighties and then area growth rates have started declining around the mid-eighties to the early nineties. Area growths as a proportion of total cropped area for HYV Aman have grown substantially and contributed to increasing trend in total returns from the cropping pattern changes during the early nineties. At the face of declining proportionate areas of HYV Boro and wheat, some minor Rabi crops have got spurt in increase in areas contributing to a trend of diversification of crops during the Rabi season. It appears from the declining cropping patterns of HYV Boro and wheat since the mid eighties that these crops might have reached their threshold levels of further expansion with the given technology of production. Cropping pattern contribution of jute crop has been negative although over the whole period and declined rather sharply during the eighties to the nineties. However, total returns from the changing cropping pattern in the early nineties have been higher than any previous period. This has happened in the face of declining returns from the HYV Boro and HYV Aus rices, jute and wheat crops. That means, the increased returns have been generated from the proportionate increased area allocations to non-rice Rabi crops. This could be the beginning, but the full potential of diversification in the Rabi season has yet to be fully achieved in addition to increased emphasis on the expansion of HYV Aman areas in the Kharif season. Farmers appeared more inclined to expand their areas specialising towards improved variety of crops (HYV rices, sugarcane, potato and lentil). Real output price changes have exhibited little influence on the changing cropping patterns over the period of 1971-1993. Therefore, varietal improvement of crops should get the highest priority in terms of public expenditures for crop sector growth. Yield increase of crops can face the declining output prices in terms of input costs. Researches on varietal improvement of jute and minor Rabi crops should get priority to enhance the cause for shifting rice based crop sector to diversification.

Footnotes:

1. The methodology adapted for this study was developed by National Council of Applied Economic Research (NCAER), New Delhi, 1966 for their study "Cropping Pattern in Punjab".
2. Though absolute area growth may not result in proportionate area increase for a particular crop due to simultaneous changes in areas of other crops.

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