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CHANGES IN AGRICULTURE OF THE GREEN REVOLUTION STATES : IMPLICATIONS FOR AGRICULTURAL DEVELOPMENT

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ABSTRACT

This paper examines the changes in the agriculture of green revolution states. The results revealed that a decrease in the share of agriculture in state domestic product was not accompanied by appropriate fall in the workers in agriculture. Consequently, man-land ratio increased over time, markedly in West U.P. The share of purchased and energy based inputs has increased over the years and formed about 50 per cent of the operational cost. The share of capital in gross value added was substantially higher than that of human labour in the production of wheat, whereas the share of capital and human labour was almost equal in the case of paddy. A sharp decline in the returns to management in the production of wheat calls for developing cost saving technology and reappraisal of price policy.

I

The adoption of new seed-fertilizer based technology and large capital investment (both private and public) in key inputs, particularly in irrigation, have ushered in the "Green Revolution" (GR) in India in the mid-sixties. Consequently, crop production has registered an impressive growth. Because of strong input-output linkages in modern technology, the growth in agriculture was also accompanied by the overall economic development (Bhalla *et al*, 1990). However, certain issues relating to structure of agriculture have become important in the period of green revolution which need attention. The new technology is suspected on the ground that while transforming the subsistence agriculture into commercial farming, it may induce the well-off farmers to accumulate more and more land through tenancy eviction, purchasing land from marginal and small farmers and encroaching on commons. This, coupled with ineffective

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and inadequate land reforms measures and slow transfer of labour from agriculture to non-agricultural sector, may further strengthen the process of polarisation of agrarian economy between commercial farms and wage earners.[1] Further, commercialization of agriculture may lead to indiscriminate use of natural resources endangering sustainability of agriculture. Keeping these issues in view, an attempt has been made in this paper to study the structural changes in agriculture in the GR states since late sixties. The scope of the paper is limited to Punjab, Haryana and West U.P. whch are well known for their outstanding agricultural performance during the green revolution period. The necessary data for the study were compiled from various published sources.

II

A. Overall Growth

In the process of economic development, it is expected that non-agricultural sector would grow faster than agricultural sector in terms of both output and labour absorption. As shown in Table I this process has

Table I. Share (%) of agriculture in net domestic product and employment in green revolution states and India

State	Net domestic product			Employment	
	1970-71	1980-81	1984-85	1970-71	1980-81
Punjab	58.30	49.70	52.29	62.67 (20.10)	59.21 (22.15)
Haryana	64.60	51.90	49.30	65.29 (16.20)	61.65 (16.10)
West U.P.	77.97	69.31	NA	71.76 (27.97)	65.65 (21.92)
All India	49.20	41.60	37.90	69.70 (27.25)	60.51 (22.69)
Net domestic product per worker in agriculture at 1970-71 prices (Rs.)					
Punjab	3412.92	3836.04			
Haryana	3239.30	3113.10			
West U.P.	2002.33	1825.67			
All India	1377.22	1363.64			

Note : Figures in parentheses are percentage of agricultural labourers to total workers.
NA : Not available.
Source : Based on Statistical Abstracts.

1. For detailed discussion on these issues, see Hayami and Kikuchi (1986).

started though slow in the country as a whole as well as in the GR region. However, the share of agriculture in net domestic product (NDP) is higher in the GR states than that for all India. This is because of comparatively higher growth of agriculture in the GR region. The Table further shows that the decline in the share of agriculture in NDP is higher than the decline in labour force in agriculture. This coupled with population growth has led to an increase in the number of workers per hectare of land in the country as well as for the GR region. Further, NDP per worker (at 1970-71 prices) declined in all regions except Punjab. Interestingly, the proportion of agricultural labourers in total agricultural workers has increased in Punjab while remaining constant in Haryana. It dropped in West U.P. and all India during the seventies. This was due to selling of land by small and marginal cultivators as indicated by a decrease in number of holdings less than 2 ha. in Punjab (Table II), thereby increasing the proportion of agricultural labourers in total agricultural workers. The migration of labour into the state have further increased the agricultural labour force. The NSS data indicate that there were 18 migrant households for every one thousand households in Punjab. The agricultural labourers were 37 per cent of these migrants. On the other hand, there were 13 and 14 migrant households for every one thousand households in Haryana and for the country as a whole, respectively. Of these, agricultural labourers were 26 per cent for Haryana and 28 per cent for the country as a whole.

B. Agricultural Growth—Pace and Composition

Before we analyse the pace and composition of agricultural growth, it would be appropriate to study the changes in land distribution and utilization pattern which in turn determine, to a great extent, the growth in agriculture.

(i) *Changes in Land Distribution*

The distribution of number of holdings and area occupied by various size group of holdings in the GR states and all India are given in Table II. This table clearly supports the well stated fact that agrarian structure is still highly skewed in India as well as in the GR states. The number as well as area under the holdings less than 2 ha continued to be substantially high in West U.P. than those in Punjab and Haryana, and thus leading to the lowest average size of holding. The temporal changes in agrarian structure reveal two distinct patterns. First, in the case of Punjab, there has been a sharp decline in area as well as in number of holdings below

Table II. Changes in agrarian structure in green revolution states and India

Size of holding (ha)	Punjab		Haryana		WestU.P.		All India	
	1970-71	1985-86	1970-71	1985-86	1970-71	1980-81	1970-71	1985-86
1	2	3	4	5	6	7	8	9
				Number of holdings (00 nos.)				
<2	7777 (56.54)	4640 (42.61)	4228 (46.28)	7670 (56.94)	6915 (72.95)	8921 (72.03)	496315 (69.89)	746290 (76.36)
2-4	2811 (20.44)	2910 (26.72)	2051 (22.45)	2810 (20.86)	1590 (16.77)	1637 (14.32)	106814 (15.04)	132540 (13.56)
4-10	2477 (18.01)	2600 (23.88)	2113 (23.13)	2390 (17.74)	872 (9.20)	809 (7.07)	79319 (11.17)	79200 (8.10)
>10	689 (5.01)	740 (6.79)	743 (8.14)	600 (4.46)	102 (1.08)	66 (0.58)	27668 (3.90)	19290 (1.98)
Total	13754 (100.0)	10890 (100.0)	9105 (100.0)	13470 (100.0)	9479 (100.0)	11433 (100.0)	710116 (100.0)	977320 (100.0)
				Area (00 ha)				
<2	5974 (15.03)	4500 (10.96)	3705 (10.75)	6120 (16.48)	4737 (30.04)	5670 (35.92)	338403 (20.87)	471390 (28.76)
2—4	7951 (20.01)	8400 (20.47)	5862 (17.00)	7900 (21.28)	4473 (28.37)	4589 (29.07)	299997 (18.50)	365790 (22.32)
4—10	15142 (38.10)	15890 (38.72)	13126 (38.07)	14090 (37.95)	5039 (31.95)	4574 (28.98)	482335 (29.75)	470080 (28.68)

Table II—Contd.

1	2	3	4	5	6	7	8	9
>10	10671 (26.86)	12250 (29.85)	11782 (34.18)	9020 (24.29)	1520 (9.64)	952 (6.03)	500601 (30.88)	331870 (20.24)
Total	39741 (100.0)	41040 (100.0)	34475 (100.0)	37130 (100 0)	15769 (100.0)	15785 (100.0)	1621336 (100.0)	1639130 (100.0)
Average Workers	2.89	3.77	3.77	2.76	1.66	1.38	2.28	1.68
per hectare	0.62	0.75*	0.50	0.63*	1.56	2.10	0.78	0.90

* For the year 1980-81

Figures in parentheses indicate percentage to the total

Source: Based on Statistical Abstracts.

2 ha, while the reverse holds true for the holdings above 10 ha. Consequently, average size of holding increased from 2.89 ha in 1970-71 to 3.77 ha in 1985-86. This could be, as observed earlier, because of selling of land by small and marginal farmers as they may seek gainful employment outside agriculture. Secondly, a decline in area and number of holdings above 4 ha in West UP and above 10 ha in Haryana imply that sub-division of holdings is more strong in this area. The similar subdivision of holding was also observed for the country as a whole. As a result, the average size of holding declined moderately for all India and West UP, and markedly for Haryana.

(ii) *Changes in Land Use Pattern*

Table III brings out that at all India level, only 46 per cent of geographical area was put under cultivation as against a whopping 80 per cent for Punjab and Haryana, and 75 per cent in West U.P. This shows that land was either made suitable for cultivation through land development activities or was considered suitable (exploitation motive) for cultivation in these states. The area under forests though has increased to 5 per cent over time but much below than that for the country as a whole (22 per cent). The land under all other categories has declined in the GR states except under current fallow in Haryana which of course is desirable for maintaining soil fertility particularly in dryland tracts of the state.

It could be further seen from Table III that with the availability of high yielding varieties (HYVs) of wheat and rice, these two crops gained area in Punjab and Haryana. However, this was absent in West U.P. and at all India level. In Punjab, area sown with paddy expanded at the cost of all other *kharif* crops (except cotton). But in Haryana, paddy and wheat gained area mainly through a shift away from pulses. In contrast to Punjab and Haryana, the area under sugarcane rose to 22 per cent in West U.P. due to large scale opening of sugar factories in the area. Thus, Wheat-Sugarcane in West U.P., Wheat-Paddy-Pulses in Haryana, and Paddy-Wheat-Cotton in Punjab emerged as the main cropping pattern. The cropping pattern was not so much specialised for the country as a whole due to large variations in agro-climatic conditions and resource endowment. Thus, unlike all India, crop activities dominated by one or two crops in each season was the main feature of production in agriculture in the GR states. Livestock could not emerge as important activity but continued to be supplementary activity in the region.

Table III. Changes in land use and cropping pattern in green revolution states and India

Land use/ crop	Punjab		Haryana		West U.P.		All India	
	1970-71	1984-85	1970-71	1984-85	1970-71	1984-85	1970-71	1984-85
1	2	3	4	5	6	7	8	9
				Land use pattern (per cent)				
Forests	2.45	4.39	2.25	3.01	4.90	5.11	21.54	21.82
Non-agric. uses	8.27	8.86	7.02	6.76	9.61	11.24	5.29	6.72
Barren and uncultivable area	4.13	1.45	4.11	2.39	3.01	1.61	9.86	6.65
Permanent pasters, grazing land and misc. trees	0.18	0.16	1.30	Neg.	1.21	0.48	5.67	5.11
Cultivable wasteland	1.65	0.81	0.93	1.05	3.30	2.48	4.96	5.22
Current fallow	2.76	1.03	3.41	3.83	2.33	1.75	3.63	5.05
Fallow other than current fallow	Neg.	0.06	Neg.	Neg.	0.97	1.51	2.96	3.13
Net sown area	80.56	83.24	80.98	88.35	74.67	75.82	46.13	46.30
				Cropping pattern (per cent)				
Paddy	6.87	23.44	5.43	10.11	7.14	7.04	22.45	23.33
Wheat	40.49	44.12	22.78	30.93	32.51	33.28	10.90	13.36

Table III—Contd.

1	2	3	4	5	6	7	8	9
Total cereals	61.89	73.46	54.65	59.80	56.36	52.69	60.80	58.91
Total pulses	7.29	2.90	23.38	12.55	7.32	2.71	13.46	12.89
Total oilseeds	5.20	2.87	2.80	6.08	0.69	1.78	9.94	10.73
Sugarcane	2.25	1.13	3.15	2.10	17.58	21.80	1.56	1.67
Cotton	6.99	6.73	3.91	5.35	1.21	0.46	4.54	4.18
Other crops	16.38	12.96	12.02	14.12	16.84	20.56	9.70	11.62
Cropping intensity	140.09	167.41	139.05	152.43	150.20	166.05	118.60	125.21
			Livestock per hectare of net sown area					
Cattle	0.84	0.78	0.69	0.65	—	—	1.26	1.37
Buffalo	0.94	1.10	0.71	0.93	—	—	0.41	0.50
Other	0.36	0.42	0.37	0.51	—	—	0.83	1.12
Total	2.14	2.30	1.77	2.09	—	—	2.50	2.99

— Not available.

Source : Based on Statistical Abstracts.

(iii) *Growth in Crop Production and Productivity*

Since crop production was the main activity in agriculture in the GR states, the growth in the production of major crops, as analysed in this section, should reflect the performance of agriculture in this region. The results presented in Table IV show that crop yields were moderately higher in the GR states than those for all India till the late sixties. But in the seventies and eighties, crop yields particularly of rice and wheat were appreciably higher in the GR states. Also, the yields were fairly stable in the region as compared to other states of the country (Pal, 1986). The Table further shows that in the case of rice, the growth in production was largely attributed to the expansion of area in Punjab and Haryana. This is consistent with the earlier observation of major area expansion under paddy. For wheat, the production increased in the seventies owing to area expansion, but increases in yield mainly contributed to the increased production during the late sixties and eighties. For the country as a whole, the increase in yield accounted for a lion's share of growth in the production of both rice and wheat. The results for pulses and oilseeds are interesting in the sense that the effects of area and yield on changed production are alarmingly high. This is because of the fact that the effects of area and yield on production were opposite in direction. Consequently, the net effect on production was small in comparison to individual effects of area and yield. In pulses, the production decreased mainly due to shrinking area and partly due to a reduction in yields both in Punjab and Haryana. For oilseeds, in Punjab, the production declined on account of a decline in area as well as in yield. But in Haryana, oilseed production showed upward trend, markedly in the seventies and early eighties owing to increase in area as well as in yield. Thus, it may be inferred that increase in the production of rice and wheat was at the cost of pulse production in Haryana and at the cost of pulse and oilseed production in Punjab.

III

Determinants of Agricultural Growth

(i) *Infrastructural Development and Inputs*

Since HYVs are highly responsive to modern inputs which are complementary to each other, well developed infrastructural facilities and input delivery system become a prerequisite for growth in crop yields in the GR states. As evident from Table V, Punjab and Haryana had an edge over the rest of India in the use of key inputs, viz., irrigation, fertilizer,

Table IV. Trends in production and yield of crops and relative contribution of yield & area to changed crop production in green revolution states and India

Crop/year	Punjab				Haryana	
	Production	Yield	Changed production attributed to		Production	Yield
			Yield	Area		
	(000 tons)	(tons/ha)	(per cent)		(000 tons)	(tons/ha)
Rice						
1962-65	295.3	1.12			213.9	1 25
1967-70	482.6	1.39	37.86	53.10	307.6	1.35
1980-83	3708.3	2.95	16.71	39.22	1250.6	2.56
1984-87	5250.0	3.14	15.47	79.95	1499.5	2.63
Wheat						
1962-65	2035.0	1.31			842.3	1.22
1967-70	4223.3	2.08	54.70	27.70	1702.7	1.81
1980-83	8461.6	2.39	38.55	44.56	3839.3	2.41
1984-87	10584.0	3.42	71.67	24.26	4839.0	2.84
Total creals						
1962-65	2854.0	1.21			1571.0	0.75
1967-70	5779.0	1.83	50.08	32.97	2793.3	1.07
1980-83	10071.0	2.40	41.96	44.44	5854.6	1.82
1984-87	16334.3	3.14	49.65	38.50	7034.0	2.12
Total pulses						
1962-65	589.0	0.70			406.4	0.44
1967-70	389.0	0.81	46.04	—124.95	993.3	0.95
1980-83	303.0	1.10	161.95	—193.86	387.1	0.47
1984-87	178.6	0.82	—61.82	—49.39	506.9	0.69
Total oilseeds						
1962-65	170.0	0.79			76.7	0.47
1967-70	258.7	0.64	—36.40	170.47	84.2	0.52
1980-83	225.0	1.06	509.77	—369.05	151.7	0.65
1984-87	180.3	0.95	—52.34	—54.15	273.7	0.81

Table IV—Contd.

Haryana		All India			
Changed production attributed to		Production	Yield	Changed production attributed to	
Yield (per cent)	Area (per cent)	(000 tons)	(tons/ha)	Yield (per cent)	Area (per cent)
		36348.6	1.04		
18.20	75.05	39267.7	1.06	61.64	35.96
29.12	37.50	51329.8	1.29	70.60	23.54
13.77	84.45	60897.1	1.48	78.86	19.41
		10802.9	0.80		
47.27	32.57	18398.4	1.16	64.00	24.83
25.81	56.67	39056.5	1.72	42.99	38.20
68.31	27.48	45066.2	1.94	82.96	16.22
		72136.4	0.77		
54.93	30.70	83855.8	0.84	55.96	40.37
63.66	21.59	119510.7	1.15	86.79	9.64
81.82	15.71	133979.4	1.29	100.76	—0.50
		11331.1	0.47		
55.57	5.79	11209.1	0.51	790.71	—820.84
—82.87	—35.56	11291.7	0.49	—532.16	657.97
150.52	—31.57	12432.2	0.53	81.47	17.13
		6934.4	0.47		
108.53	—14.40	7558.3	0.55	189.18	—76.21
30.89	56.29	9203.6	0.58	25.06	71.06
30.65	55.37	11691.1	0.92	25.52	69.67

Note : The contribution of interaction between area and yield to changed production is not reported due to want of space.

Source : Based on data in Estimates of Area and Production of Principal Crops in India.

Table V. Infrastructural development and input use in agriculture in green revolution states and India

	Punjab		Haryana		West U.P.		All India	
	1970-71	1984-85	1970-71	1984-85	1970-71	1984-85	1970-71	1984-85
1	2	3	4	5	6	7	8	9
1. Irrigation								
Net sown area irrigated (per cent)	71.26	86.44	42.97	60.54	73.47	88.19	22.17	29.64
Sources of irrigation								
Canals	44.77	38.64	62.14	54.96	41.42	31.30	40.00	38.02
Wells and tubewells	55.09	61.09	37.47	44.81	57.88	68.05	37.82	48.29
Others	0.14	0.27	0.39	0.23	0.70	0.65	22.18	13.69
2. Fertilizer consumption (nutrients kg/ha of GCA)	40.30	156.00*	17.30	90.90*	43.63	94.50	13.61	62.23*
3. Credit (Rs/ha of GCA at 1970-71 prices)	99.45+	277.67	70.74+	179.59	NA	NA	53.17+	121.21
4. Electricity consumption in agric. (KW/ha of GCA)	81.66	337.13	60.25	296.42	NA	NA	26.70	118.81
5. Area per regulated market (sq. km.)	573	387	NA	470	NA	NA	1190.99	552.00

Table V—Contd.

1	2	3	4	5	6	7	8	9
6. Road length per 1000 km. of area (km.)	275.20	671.10	260.43	495.93	NA	NA	111.60	227.74
7. Rural literacy**	33.91	40.86	26.90	36.14	25.76	34.74	23.69	29.65

* for the year 1988-89

** according to 1971 and 1981 censuses

\+ for the year 1973-74

NA : Not available

Source: Based on data compiled from Statistical Abstracts.

electricity, credit, etc. The area irrigated, in comparison to all India, was two times higher in Haryana and nearly three times higher in Punjab and West U.P. in the year 1984-85. Further, much of the increase in irrigated area in both the states was on account of private investment in the exploitation of groundwater. Both the states were utilising 70 per cent of available groundwater which is far above the 24 per cent at all India level (Pal and Haque, 1989). This in turn led to more than proportionate increase in the area irrigated by wells and tubewells. However, the most undesirable feature of irrigation development in the region was the emergence of ill-effects of irrigation which needs immediate direct intervention (for details, see Chopra, 1990).

(ii) Changes in Inputs Use

The changes in the composition of inputs use were examined using the cost of cultivation data for paddy and wheat. As shown in Table VI, the changes in the share of different inputs in total cost of cultivation per hectare reveals three broad patterns. First, the share of energy based (machinery, fertilizer, insecticides and irrigation by groundwater) and purchased inputs rose sharply to nearly 50 per cent of operating cost in both the crops. Secondly, the expenditure on human labour and bullock labour declined substantially in both the crops. The latter declined due to the substitution of machine for bullock labour as indicated by the appreciable increase in the expenditure on machine labour. The former declined because of less than proportionate increase in the use of human labour (in physical terms). Thirdly, fertilizer and irrigation together accounted for a lion's share of the cost of cultivation. However, there was no change in their relative share over time except that for fertilizer which rose to 16 per cent from 9 per cent in the case of wheat in Haryana.

IV

Functional Distribution of Income in Crop Production

Table VII presents the changes in factor share in gross value added in the production of paddy and wheat. Factor shares were calculated as the payment received by the factors of production and thus show the functional distribution of income. The results depict that the gross value added in the production of wheat declined in the eighties in both the states. For paddy, it increased by 14 per cent in Punjab, but it was con-

Table VI. Share of input expenditure in per hectare cost of cultivation of paddy and wheat in green revolution states

(per cent)

Inpur	Paddy				Wheat			
	Punjab		Haryana		Punjab		Haryana	
	1974-75	1986-87	1977-78	1984-85	1970-71	1986-87	1970-71	1986-87
1	2	3	4	5	6	7	8	9
Fixed cost	26.87	40.46	26.23	33.00	43.97	40.28	37.34	32.72
Operational cost	73.13	59.54	73.77	67.00	56.03	59.92	62.66	67.28
Human labour	30.46	21.75	27.74	21.18	19.84	15.79	18.36	14.19
Bullock labour	7.34	2.16	8.70	2.32	8.63	2.11	13.33	5.81
Machine labour	1.53	6.03	3.35	7.99	4.86	13.22	4.29	13.04
Seed	3.81	1.71	1.21	1.47	3.95	4.32	7.65	7.16
Fertilizer and manure	14.56	13.64	17.20	13.38	13.24	17.11	9.14	16.05
Insecticides	Neg.	2.30	Neg.	4.41	Neg.	1.99	0.00	1.28
Irrigation charges	13.68	10.34	13.45	14.45	4.35	3.37	8.66	7.94
Interest on working capital	1.75	1.59	1.98	1.80	1.13	1.61	1.23	1.79

Table VI—Contd.

1	2	3	4	5	6	7	8	9
Purchased inputs*	39.97	52.67	50.05	50.90	43.89	55.89	24.88	43.46
Farm raised inputs*	60.03	47.33	49.95	49.10	56.11	44.11	75.12	56.54
Energy based inputs*	30.72	44.70	33.55	47.38	34.56	57.12	24.65	50.48

* As percentage of operational cost.

Note : Purchased inputs include casual and attached labour, hired bullock labour, hired machinery, fertilizer and insecticides. Energy based inputs include machinery, fertilizer and insecticides and irrigation by groundwater (total irrigation charges adjusted according to area irrigated by tubewells).

Source : Based on data in Reports of the Commission for Agricultural Costs and Prices on Price Policy.

Table VII. Share of factors of production in gross value added in the production of paddy and wheat in green revolution states

(Rs/ha)

Factor	Paddy				Wheat			
	Punjab		Haryana		Punjab		Haryana	
	1974-75	1986-87	1977-78	1984-85	1970-71	1986-87	1970-71	1986-87
Value of output	2460.72	8884.55	2925.31	5329.21	1982.53	5665.11	1875.65	5480.40
Gross value added	1532.86 (62.29)	6815.62 (76.71)	2006.93 (68.60)	3651.55 (68.52)	1625.74 (82.00)	4265.27 (75.29)	1553.74 (82.84)	4011.04 (73.19)
Factor Share								
Human labour	881.64 (57.52)	1607.59 (23.59)	796.11 (39.66)	1054.15 (28.87)	328.30 (20.19)	825.08 (19.34)	232.31 (14.95)	642.64 (16.02)
Capital	451.19 (59.60)	1397.87 (20.51)	652.66 (32.51)	1124.47 (30.79)	388.81 (23.91)	1441.96 (33.80)	394.93 (25.42)	1401.60 (34.94)
Land	633.64 (41.34)	2315.45 (33.97)	502.47 (25.03)	1120.84 (30.69)	580.69 (35.72)	1547.39 (36.28)	315.97 (20.34)	1014.23 (25.29)
Surplus	—433.61 (—28.29)	1494.71 (21.93)	55.71 (2.78)	352.09 (9.64)	327.94 (20.17)	450.84 (10.57)	610.53 (39.29)	952.57 (23.75)
Surplus-cost (c) ratio	—0.15	0.20	0.02	0.07	0.20	0.09	0.48	0.21

Note : Figures in parentheses are per cent factor share in gross value added. For gross value added, figures in parentheses are gross value added at percentage of total value of output (main and byproduct).

Source : As in Table VI.

stant in Haryana. The share of capital was higher than that of human labour in wheat; the gap further increased in 1986-87. The share of capital and labour decreased over time for paddy in both the states. This decline was greater for capital. Consequently, the share of capital was smaller than that of labour in paddy production. This is expected because of higher labour requirement of paddy especially during transplanting. The share of land is reduced by 7 per cent in Punjab and by 9 per cent in Haryana for paddy, whereas it improved marginally for wheat in Haryana. The surplus, which indicates return to management, showed an appreciable increase over time for paddy in both the states. Contrary to this, the surplus declined by 10 per cent or more in the case of wheat on account of an increase in the share of capital. From these results we may conclude that capital has not gained its share in gross value added at the cost of wages. But low surplus in comparison to cost calls for suitable policy actions to make crop production an attractive activity (Mruthyunjaya and Kumar, 1989). The comparison of low surplus with other investment opportunities and its implications, is another important aspect which is beyond the scope of this paper.

V

Implications for Agricultural Development

The sustainable agriculture envisages that the productivity in agriculture should be maintained at a technologically specified level over time and if possible to enhance the same without damaging the ecological integrity of the system. As seen earlier, there have been an emergence of certain undesirable changes in the agriculture of irrigated or "GR" region of the country. A detailed summary of these undesirable changes related to input use, product mix and profitability and thier implications for sustainable agriculture are given in Table VIII. As evident from this table, these changes are the side effects of the "GR" or the new technology. The adoption of the HYVs of rice and wheat, which need intensive use of modern inputs, was essential for meeting the growing food demand. This coupled with profit motive of the farmers and the slow growth in off-farm employment led to indiscriminate use of land and water. As a result, there was depletion of soil fertility and groundwater. Futher, the declining rate of value added in production and low returns to labour and management have caused unrest among the farmers. These undesirable changes are, indeed, serious in nature as well as in magnitude especially in the context of sustainable agricultural development. To reverse these changes, a combination of both technological advancement and supporting economic policies is indispensible. The technological advancement should concent-

Table VIII. Trends and policy options for agricultural development

Aspects relating to	Trends	Implications for sustainability	Policy options for sustainable agriculture
1	2	3	4
A. *Resource base*			
(i) Land			
—Distribution	Highly skewed	Widening of inter-personal distribution of income.	Promotion of off-farm employment particularly for weaker section, strengthen land reforms.
—Utilization (Extensive)	Bringing in of more marginal and sub-marginal lands (private and public) under cultivation.	Soil erosion, depleting soil fertility, decrease in ecological region.	Land improvement, fertility management, developing common lands through strong resource support, match between land characteristics and use, and people's participation.
—Utilization (Intensive)	Intensive crop based, highly specialised.	Depleting soil fertility	Integrated fertility management*, land use planning based on carrying capacity and needs, ecosystem development.
—Size of holding	Decreasing due to sub-division, increasing only in Punjab.	Uneconomical and non-viable, more intensive use of natural resources like land and water to augment income.	Transfer of labour from agriculture to non-agriculture, promote second round employment activities like dairy, sugarcane, cotton, etc.
(ii) Water	Increasing pressure on ground water, over-exploitation by private tubewells emerging ill-effects of irrigation.	Difficult for successful crop production on account of either inadequate water (ground) or excess water (surface), increased use of electricity for groundwater extraction, high cost of groundwater use.	Water management through changes in cropping pattern, rational electricity supply, spacing of tubewells, improved drainage system, etc., promote water use efficiency, well designed irrigation system, development of water saving crop technology.

Table VIII—Contd.

1	2	3	4
B. *Inputs Use*			
(i) Nature of inputs	Increased use of energy based, purchased inputs, machine labour, capital intensive.	High pressure on non-renewable energy resources, increased dependence on non-agricultural sector.	Development of cost saving technology, use of renewable energy, more off-farm employment opportunities, well developed infrastructural facilities to ensure timely supply of crucial inputs.
(ii) Fertilizer	Largely chemical fertilizer, diminishing use of FYM and organic manures.	Deteriorating soil structure and hence increased nutrient losses	Integrated fertility management*.
C. *Production*	Highly specialised crop production dominated by paddy and wheat at the cost of pulses and oilseeds	Imbalanced crop production, narrow genetic base, increased dependence on other parts of the country or imports for other food products.	Maintenance of genetic diversity, promotion of less water demanding and high second round employment effect crops, high yielding technology for pulses and oilseeds, balanced development of all crops in harmony with nature and felt needs.
D. *Profitability*	Declining value added in production, declining returns to management, high share of capital in value added.	Low savings and capital formation, intensive use of land to supplement income, deteriorating conditions of wage earners, farmers unrest.	Cost saving technology, transfer of labour, income augmenting activities, suitable price policy for inputs and outputs, system or area approach to ensure sustainability and profitability.

* For detailed discussion, see Maji and Pal (1990)

rate on the cost and water saving technology, integrated fertility management, efficient water use systems including drainage, and the increased use of renewable energy sources. The policy measures should promote the controlled use of groundwater through cropping pattern changes, controlled electricity supply and tubewell spacing, simultaneous development of off-farm employment, and rational price policy. The promotion of crops like sugarcane and cotton, and agro-processing would generate second round employment i.e. employment in processing in addition to employment in crop production *per se*, both for skilled and unskilled labour. The agro-processing may be location specific or otherwise depending upon cost advantage. The increased employment opportunities would reduce pressure on land and hence would accelerate capital formation in agriculture. A similar strategy emphasising on the use of location specific appropriate technology would be more meaningful for avoiding the undesirable changes in other parts of the country. An area or system approach which includes all the sub-systems of agriculture, viz., household, inputs including infrastructure, product, etc. and their interaction with ecosystem and government policies would lead to sustainable agricultural development in the country.

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