DYNAMICS OF LAND USE IN RELATION TO GREEN REVOLUTION IN INDIA

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Contents

Summary

The Green Revolution provided India with a greater genetic diversity and institutional capacity to produce more crops. It stimulated infrastructure and rural development, increased prosperity of villages, and improved the quality of life. During the period 1950-51 to 1990-91 the areas of barren and uncultivable land, cultivable wasteland, land not available for cultivation and fallow lands showed a steady decline. There was a greater use of such land for agricultural and non-agricultural uses. The area under permanent pasture and other grazing lands also decreased.

The Green Revolution transformed the traditional cropping pattern in favor of rice, wheat and maize at the cost of pulses and coarse cereals. Fertilizer responsive varieties/hybrids were introduced and as more irrigation facilities were created, the acreage under low water requiring traditional crops paved way to water intensive cropping. Short duration crops fitted well into multiple cropping systems. But, perhaps the most significant achievement was the attainment of self-sufficiency in food grains and fibers. This created a sizeable buffer stock, despite the rapid increase in population from 363 million in 1951 to 848 million in 1991, and almost one billion at the end of the twentieth century.

The introduction of high yielding varieties, additional irrigation facilities, a great input flow through fertilizers and pesticides ushered in the Green Revolution. This radical change in land use raised India from a food importing country to a self sufficient and even to a food-exporting nation. This transformation also showed its side effects in terms of regional imbalances, social inequality and second-generation problems of soil degradation.

1. Introduction

The term *Green Revolution* was coined by William Gadd, the administrator of the USAID, to describe the dramatic increase in productivity and production in major cereals, triggered through high yielding varieties (HYV). The Green Revolution helped India to attain self-sufficiency in food and fiber production and to build a sizable buffer stock, thus helping to stop the continuous food grain imports. A combination of factors like the use of HYVs, irrigation, fertilizers, mechanization, land reforms, consolidation of holdings, credit facilities and other rural infrastructure facilities ushered in the Green Revolution. The growth rate in agriculture attained during the Green Revolution period was a phenomenal increase over the historical trends during the previous periods.

The high yielding varieties, which triggered the Green Revolution (GR), were photo- and thermo-insensitive with enhanced spatial and temporal adaptability. Thus, new cropping patterns were feasible. Double or multiple cropping, mixed cropping, relay cropping and so on tended to replace monoculture, increasing the efficiency of land use. Improved seed was a crucial input for increasing the productivity. HYV were a reward of committed and purposive agricultural research. Parallel to this biological revolution, the chemical revolution also initiated the use of chemical fertilizers, insecticides, fungicides and herbicides.

Approximately 27-40%of the agricultural growth in India is attributed to the Green Revolution (Prasad, 1994). Its success is attributed to improved output for the same level of input (Table 1). Improvement in land use technology meant that although the physical area of land remained constant, its economic value/contribution increased through an improvement in production per unit area and time through increase in yield and cropping intensity.

Sr.No.	Commodity	1965-66	1990-91
1	Food grains	629	1470
	Wheat	827	2671
	Rice	862	1879
	Sorghum	429	814
	Maize	1005	1518
2	Pulses	438	623
	Pigeon pea	678	673
	Chick pea	527	712
3	Oilseeds	419	771
	Groundnut	554	904
	Mustard	446	904

Table 1: Yield (kg/ha) of principal crops in the pre-Green Revolution (1965-66) and the Green Revolution Period (1990-91).

The Green Revolution disproved the widely apprehended pessimism of Malthus and others on resolving poverty and hunger problems and made the country food secure. The revolution resulted in a qualitative change in food and agricultural situation. The Pearson report vividly described this achievement as one of the authentic marvels. Randhawa (1984) quoted noble laureate Dr Borlaug's observation "never before in the history of agriculture has a transplantation of high-yielding varieties coupled with an entirely new technology and strategy been achieved on such a massive scale, in so short a period of time and with success".

The Green Revolution facilitated both intensification and extensification of agriculture, resulting in a substantial increase in regional output and income. Market orientation, rather than population pressures catalyzed these changes. The Green Revolution was not merely the introduction of HYV, but a broad set of mutually reinforcing changes that has transformed the agricultural scenario of the country. Goldman and Smith (1995) declared that the revolution typically involved a suite of new technological components, altered land use components and changes in labor economy. The present article analyses the land use changes as a result of the Green Revolution under these broad dimensions.

2. Pre-Green Revolution Scenario and Background to the Green Revolution

For more than a half century prior to Independence, the performance of Indian agriculture was quite dismal. The disastrous Bengal Famine in 1943 awakened India, to the dire necessity of a rapid augmentation of food production and streamlined the distribution system. To add to the woes, the partition of the country resulted in a disproportionate reduction in growth-stimulating assets, particularly irrigation (17.6 % as compared to undivided India 32 %). By the year 1950-51, the country was experiencing a severe food shortage and the consequent upsurge in food prices. The total food grain production was only 50.8 million tons at an average productivity of 522 Kg/ha. The *per capita* net availability of food grains was only about 395 g per day (Table.2).

Year	Popul. (million)	Food prod. (in million tons)	Per capita availability (g/day)		
			Cereals	Pulses	Total
1951	363.2	48.1	334.2	60.7	394.9
1956	397.3	60.7	360.4	70.3	430.7
1961	442.4	72.6	399.7	69.0	468.7
1966	493.2	63.3	359.9	48.2	408.1
1971	551.3	94.9	417.6	51.2	468.8
1976	617.2	105.9	373.8	51.2	424.3
1981	690.1	105.1	416.2	37.5	453.7
1986	766.1	131.6	434.3	44.0	478.3
1991	847.7	154.3	470.7	40.3	511.0

Table 2: Population, food production and *per capita* food availability in India

The Pre-Green Revolution phase began with the launching of the first Five-Year Plan in 1951. During this phase concerted efforts were made to improve infrastructure, setting up of institutions for crop improvement and allied research, creation of credit facilities,

marketing structures, providing better implements, improving irrigation network and above all improving human resource conditions.

The following developmental programs were initiated to strengthen the pace of development in the country: the Community Development Program (CDP) in 1952, the National Extension Program (NEP) in 1953, the Intensive Agricultural Development Program (IADP) in 1961, the Intensive Agricultural Area Program (IAAP) in 1964, and the Agricultural Price Commission (APC) in 1965.

The main strategy was to increase the agricultural production by increasing acreage, rather than yield improvement. There was an increase in the gross irrigated area from 22.6 million ha in 1950-51 to 30.9 million ha in 1965-66. During the Pre-Green Revolution period, the maximum area increase under irrigation was in wheat (9.1 %) followed by cotton (7.7 %), rice (4.8 %), maize, chickpea and sugar cane, whereas the irrigated area under pearl millet reduced by 0.6 % during this period. Fertilizer made inroads into rural areas.

More land surface including marginal and fallow lands as well as wastelands were brought under cultivation. While between 1950-51 and 1968-69 the area under forest increased to the tune of 6.8 %**,** barren and uncultivated areas decreased from 13.4 to 12.0 %, cultivable wastelands from 8.1 to 5.2 % and scrub forest and groves land decreased by 5.7 % (Table 3).

Land Use/Year	**1950-51**	**1960-61**	**1968-69**
Forests	14.23	18.10	21.11
Not available for cultivation	16.71	17.00	15.43
Non-agricultural uses	3.30	4.97	-
Barren and uncultivated	13.42	12.03	-
Other uncultivated, excluding fallow	17.40	12.61	10.89
Permanent pastures	2.35	4.68	4.35
Other land use-trees, groves	6.97	1.49	1.28
Cultivable waste	8.07	6.46	5.25
Fallow land	9.89	6.64	7.57
Other than current fallow	6.13	3.74	2.96
Current fallow	3.76	3.90	4.61
Net sown area	41.77	44.63	44.98

Table 3: Land use classification during the Pre-Green Revolution
(in percent of reported area)

The net sown area increased from 118.8 to 140.1 million ha (3.2 %) during 1950-51 to 1968-69. Similarly, the area under current fallow increased by 0.8 %. The area under cultivation and forest during the Pre-Green Revolution increased by 10.1 %at the expense of the area under non-agricultural uses mainly from barren and uncultivated and cultivable wastelands and fallow lands (Table 3).

The annual growth rate in acreage was very impressive. The average annual rate of

growth of acreage under food grain and non-food grain during 1951-65 was 1.4 and 2.0 % respectively. The ratio of area under food grain to non-food grain crop was 83:17 in 1950-51. The gross sown area increased from 131.8 million ha in 1950-51 to 155.3 million ha in 1965-66. For some years since 1960-61, there was a visible shift in acreage from non-food crops to food crops, being a direct result of the fast rise in food grain prices. Between 1950-51 and 1965-66, the food grains production increased from 48.1 to 63.3 million tons. However, this increase could not cope up with the increase in demand, because of the burgeoning population, thus necessitating frequent food grain imports. The average annual import of food grains during the period from 1950-51 to 1965-66 was around 3.7 million tons. These structural changes resulted in an increase in the output of all agricultural commodities particularly during the first two plan periods (Table 4).

	All agricultural commodities		**Food grains**	
	% increase in production	**Annual growth rate %**	**% increase in production**	**Annual growth rate %**
I Plan 1950-51 to 1955-56	22.2	4.2	27.4	5.3
II Plan 1956-57 to 1960-61	21.7	4.3	18.9	4.0
III Plan 1961-62 to 1965-66	7.4	1	11.5	1.9

Table 4: Annual growth rate observed in different national Five-Year Plans

The dismal performance of the agricultural sector during the third Five-Year Plan necessitated the postponement of forth Five-Year Plan, and plans were formulated on an annual basis for three years. The agricultural sector received a marginal step up in budgetary allocations during this period. It is sheer coincidence that, by this time, after years of international research and experimentation, the new high-yielding, short duration, short stem, fertilizer responsive, photo-insensitive varieties of wheat and rice have proved their potential and became available for commercial cultivation.

India took full advantage of this discovery and its strategy shifted to modern agriculture and to the use of non-farm purchase inputs like fertilizers, pesticides, electric and diesel pump sets, tractors and combine harvesters. The adoption of the High Yielding Varieties Technology yielded spectacular results that the phenomenon was hailed with pardonable euphoria as *"Green Revolution"*. This was initiated during forth Five-Year Plan (1969-74).

3. Changes in Growth Rate at National Level in the Pre-GR and Green Revolution (GR) Periods

The compound growth rate in area during the Pre-Green Revolution period was higher than during the Green Revolution period, indicating that less additional area was put under the plough (Table 5). There was an impressive growth rate in yield of most of the crops due to the adoption of new agricultural technology. Yet the output growth of food grains as well as non-food grains declined during the Green Revolution period, the former from 4.3 to 2.9 % and the latter from 3.5 to 2.8 %. The sharp decline in area growth rate from 1.4 to 0.2 % in the case of food grains, and from 2.5 to 0.5 percent for non-food grains was largely responsible for this.

Crop	1949-50 to 1964-65			1967-68 to 1990-91		
	A*	P*	Y*	A*	P*	Y*
Rice	1.33	3.49	2.13	0.58	2.82	2.26
Wheat	2.68	3.99	1.27	1.83	5.05	3.16
Sorghum	0.99	2.50	1.50	-0.73	1.30	2.04
Pearl millet	1.08	2.34	1.24	-0.80	0.52	1.33
Maize	2.66	3.87	1.18	-0.06	1.35	1.41
Finger millet	0.84	3.08	2.22	-0.19	1.31	1.50
Minor millet	-0.30	-0.20	0.09	-2.84	-2.18	0.68
Barley	-0.64	-0.28	0.36	-5.07	-2.97	2.20
Coarse cereal	0.90	2.23	1.32	-1.01	0.66	1.69
Total cereal	1.30	3.24	1.87	0.16	3.00	2.83
Chick pea	1.64	2.66	1.00	-0.65	-0.38	0.26
Pigeon pea	0.57	-1.34	-1.90	1.58	2.02	0.43
Other pulses	2.07	1.28	-0.77	0.61	1.66	1.05
Total pulses	1.90	1.39	-0.50	0.33	0.93	0.59
Total food grains	1.41	2.93	1.52	0.20	2.80	2.60
Sugarcane	3.27	4.26	0.95	1.62	2.91	1.28
Groundnut	4.01	4.33	0.31	0.38	1.53	1.14
Sesame	0.14	-0.32	-0.46	-0.19	1.89	2.09
Rapeseed and mustard	2.97	3.36	0.37	1.85	4.67	2.76
Total oilseeds	2.69	3.11	0.48	0.36	2.37	2.01
Cotton	2.47	4.56	2.04	-0.28	2.27	2.55
Jute	3.00	3.51	0.49	0.09	2.23	2.13
Mesta	6.21	7.97	1.66	-1.09	0.02	1.11
Total fibers	2.57	4.45	1.84	-0.26	2.14	2.41
Potato	4.37	4.27	-0.11	3.47	6.49	2.92
Tobacco	1.66	2.79	1.11	-0.51	1.63	2.17
Non food grain	2.52	3.54	0.99	0.54	2.82	2.27
All crops	1.61	3.13	1.50	0.28	2.81	2.53

*A, P and Y respectively denote growth rate of Area, Production and Yield.

Table 5: All India compound growth rates of area, production and yield during the Pre-Green Revolution (1949-50 to 1964-65) and the Green Revolution Period (1967-68 to 1990-91) (in percent per annum)

The main spurt in production and yield has been in the irrigated sector. Among the cereals only the wheat output recorded a significant positive change, from 4.0 % during the Pre-Green Revolution period to 5.0 % during the Green Revolution period. This was due to a substantial improvement in productivity. Moreover, about 75 % of the wheat was irrigated. Singh et. al. (1990) substantiated that, in terms of development and coverage under HYV (Table 5), wheat and rice were the major beneficiaries of the Green Revolution. They shared a major portion of irrigation potential created, recorded higher fertilizer consumption and benefited most from the Government's price support and procurement policies. The Green Revolution witnessed the evolution of the rice-

wheat cropping system as the largest double cropping, and this system occupied about 12.3 million ha in 1993.

Despite technological innovations during the Green Revolution period the growth rate of area and production of rice declined from 1.3 to 0.6 percent and 3.5 to 2.8 % respectively. The growth rate in yield is also not noteworthy. Rice could not reap the benefits of the Green Revolution because about 55-60 % of the rice area is un-irrigated. Crops like sorghum, pearl millet, maize, finger millet, minor millets and barley among cereals, chickpea among pulses, sesame among oilseeds, cotton among fiber crops and tobacco registered negative growth rates in area (Table 5). The performance of coarse cereals (maize, sorghum, millets etc.) in terms of area, production and yield during the Green Revolution period was not very promising either.

Another disturbing feature of the Green Revolution scenario is the significant decline in the growth rate of pulse production. During the Pre-GR, the compound growth rate was 1.4 % per annum, but it declined to 0.9 % per annum in the Green Revolution period. The higher production growth rate in the earlier period was due to an area expansion in pulses, which occurred at a rate of 1.9 % per annum, compared to 0.3 % per annum in the latter period. However, the Green Revolution contributed to a growth in productivity, which increased by 0.6 % per annum as compared to -0.5 % during the Pre-Green Revolution period. It may be noted that only 10 % of the pulse area is under irrigation.

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Biographical Sketches

Dr. O. Challa, is working as Principal Scientist and Head, Division of Land Use Planning at National Bureau of Soil Survey and Land Use Planning, Nagpur (India). He received his M.Sc.(Agri) and Ph.D. in Soil Science from G.B.P.U.A.&T., Pantnagar, U.P. (India). He has 25 years of experience in Soil Resource Mapping, Land Evaluation and Land Use Planning. Additionally he received training on Soil Survey Interpretations at the University of Reading, Reading, U.K. He has been a driving force and instrumental for ISSLUP and publication of its journal *Agropedology*. He taught Land Evaluation and

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