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RESEARCH NOTES

Capital Formation in Indian Agriculture: Recent Trends

This paper discusses the trends in capital formation in Indian agriculture during the planning period and also seeks to analyse the factors underlying these trends in capital expenditure. No doubt, there have been several attempts to analyse different dimensions of trends in capital formation in Indian agriculture. A few of these include studies by Rath (1989), Shetty (1990), Mujumdar and Menon (1991) and Kumar (1992). It has been mentioned that there has been a deceleration in agricultural investment during the 1980s compared to the previous decades when agricultural investment was accelerating. Gross investment[1] in agriculture in real terms (at 1980-81 prices) has declined from Rs. 4,636 crores in 1980-81 to Rs. 4,357 crores in 1990-91 (col 2 in Table I). More importantly, there has been a perceptible decline in public sector investment, whereas the private sector investment has remained virtually the same (Government of India, 1993). Hence, this paper aims at re-examining the trends and factors in the light of new data by taking into account the longer time-series from 1950 to 1990 available on a comparable basis.

The organisation of the paper is as follows: Section I analyses the changes in capital formation along with its growth trends over time. Section II describes the factors underlying such changes in capital formation in Indian agriculture. Section III presents the conclusion.

I

EMPIRICAL ANALYSIS OF CHANGES IN CAPITAL FORMATION

Table I furnishes data on gross capital formation in agriculture[2] (GCFAGR) and GDP in agriculture along with the percentage of the former in the latter. It shows that the share of GCFAGR has been steadily rising, of course with some fluctuations, from 6.05 per cent in 1950-51 to 14.05 per cent in 1979-80. In absolute terms, starting at about Rs. 1,262 crores in the early 1950s, GCFAGR reached the peak level of Rs. 5,246 crores during 1978-79 (col. 2 in Table I). Since then it has been persistently declining, which has reached Rs. 4,357 crores in real terms in the late eighties. This, among other factors, has led to relative stagnation in Indian agriculture.

The compound rate of growth of asset formation in agriculture during the period 1950-51 to 1990-91 is 3.07 per cent, which grew at an annual compound rate of about 2.57 per cent per annum in the fifties, 4.68 per cent in the sixties, 4.83 per cent in the seventies and -0.56 per cent in the eighties (Table II). But the negative rate of growth during eighties indicated a declining trend in investment in agriculture. Thus there was a noticeable deceleration in gross capital formation in the eighties after successive acceleration in the rates during the previous decades. More importantly, the growth rate of investment in agriculture in the eighties was -4.20 per cent in the public sector, whereas it was 1.09 per cent in the private sector. In other words, growth rates of all investment variables (such as total investment, public investment and private investment in agriculture) are relatively low in the eighties compared to the previous decades. In fact, during the period 1988 to 1990, there has been a significant increase in agricultural output (col. 3 in Table I), which implies improvement in efficient use of agricultural investment. This efficiency or adequacy of investment is essentially dependent on smaller incremental capital-output ratio (ICOR). But the growth rates over time indicate an increasing ICOR, which has probably led to inadequacy of investment in Indian agriculture.

TABLE I. CAPITAL FORMATION IN AGRICULTURE (1950-1990)

(Rs. crore at 1980-81 prices)

Year (1)	GCFAGR (2)	GDPAGR (3)	Col. (2) as per cent of col. (3) (4)	AGGGFCF (5)	GFCFAGR (6)	Col. (6) as per cent of col. (5) (7)
1950-51	1,262	20,860	6.05	4,891	1,224	25.03
1951-52	1,439	21,202	6.79	5,332	1,436	26.93
1952-53	1,332	22,084	6.03	4,883	1,244	25.48
1953-54	1,342	24,070	5.58	5,361	1,414	26.38
1954-55	1,335	24,743	5.40	5,980	1,367	22.86
1955-56	1,582	24,377	6.49	7,111	1,500	21.09
1956-57	1,534	25,836	5.94	8,082	1,489	18.42
1957-58	1,585	24,523	6.46	8,584	1,473	17.16
1958-59	1,510	27,281	5.53	8,029	1,413	17.60
1959-60	1,294	26,883	4.81	8,292	1,288	15.53
1960-61	1,668	28,841	5.78	9,793	1,585	16.19
1961-62	1,670	28,748	5.81	9,572	1,665	17.39
1962-63	1,848	28,131	6.57	11,037	1,804	16.35
1963-64	2,000	28,658	6.98	11,963	1,939	16.21
1964-65	2,128	31,619	6.73	12,660	2,103	16.61
1965-66	2,308	27,360	8.44	13,599	2,258	16.60
1966-67	2,346	26,734	8.78	13,239	2,313	17.47
1967-68	2,589	31,298	8.27	13,272	2,580	19.44
1968-69	2,694	31,190	8.64	12,756	2,558	20.05
1969-70	2,871	33,451	8.58	13,578	2,754	20.28
1970-71	2,758	35,930	7.68	13,762	2,625	19.07
1971-72	2,924	34,973	8.36	14,351	2,767	19.28
1972-73	3,180	33,005	9.63	16,277	2,938	18.05
1973-74	3,208	35,786	8.96	15,767	2,902	18.41
1974-75	2,975	34,800	8.55	15,515	2,709	17.46
1975-76	3,388	39,740	8.53	18,117	2,935	16.20
1976-77	4,258	37,323	11.41	18,859	3,646	19.33
1977-78	4,073	41,994	9.70	19,927	3,744	18.79
1978-79	5,246	42,831	12.25	22,150	4,246	19.17
1979-80	5,215	37,108	14.05	21,653	4,440	20.51
1980-81	4,636	42,466	10.92	23,617	4,537	19.21
1981-82	4,499	45,145	9.97	26,408	4,348	16.46
1982-83	4,575	44,570	10.26	28,607	4,409	15.41
1983-84	4,097	49,753	8.23	28,708	3,957	13.78
1984-85	4,551	49,702	9.16	30,560	4,287	14.03
1985-86	4,322	49,855	8.67	31,781	4,068	12.80
1986-87	4,014	48,995	8.19	34,231	3,798	11.10
1987-88	4,418	49,258	8.97	35,843	4,219	11.77
1988-89	4,346	57,949	7.50	38,302	4,257	11.11
1989-90	4,334	59,481	7.29	40,214	4,258	10.59
1990-91	4,357	62,048	7.02	42,170	4,286	10.16

Source: Government of India (1989, 1991 and 1992 *a*).

Notes: GCFAGR = Gross capital formation in agriculture; GDPAGR = Gross domestic product in agriculture; GFCFAGR = Gross fixed capital formation in agriculture; AGGGFCF = Aggregate gross fixed capital formation.

TABLE II. ANNUAL COMPOUND GROWTH RATE

(per cent)

Period (1)	GCFAGR (2)	GFCFAGR (3)	AGGRGCF (4)	AGGGFCF (5)	GDPAGR (6)	PUGCFAGR (7)	PVGCFAGR (8)
1950 to 1990	3.07	3.10	5.28	5.39	2.69	2.31*	3.65*
1950 to 1960	2.57	2.38	6.74	6.51	2.99	-	-
1960 to 1970	4.68	4.69	3.14	3.14	2.02	2.69	5.62
1970 to 1980	4.83	5.10	4.12	5.03	1.53	7.76	3.39
1980 to 1990	-0.56	-0.52	5.68	5.41	3.51	-4.20**	1.09**

Notes: 1950 refers to 1950-51 and so on.

* denotes the growth rate for the period 1960-61 to 1989-90.

** denotes the growth rate for the period 1980-81 to 1989-90.

AGGRGCF = Aggregate gross capital formation; PUGCFAGR = Public gross capital formation in agriculture; PVGCFAGR = Private gross capital formation in agriculture.

In relation to the real GDP in the agricultural sector, GCFAGR at 1980-81 prices, which formed about 6 per cent in the early 1960s and about 8 per cent in the late 1960s and in the early 1970s, increased to a peak of 14 per cent towards the end of the decade (1979-80); since then it has been showing a declining trend almost persistently (col. 4 in Table I). But if one looks at the economy as a whole, it is observed that (col. 4 in the Table III) the rate of capital formation in the economy has been steadily increasing since the 1950s, of course with fluctuations, which was 21.1 per cent of GDP in 1980-81, 22.5 per cent of GDP in 1990-91 and reached a peak of about 26 per cent in the 1981-82.[3] Since then there has not been much decline as it is visualised in the agricultural sector. In fact, despite fluctuations, it is still picking up year after year unlike in the agricultural sector. However, the fixed capital formation in agriculture has shown a fairly steady rise upto the beginning of the eighties and has tended to decline thereafter (Table I).

Examining the relation between gross capital formation in agriculture and gross fixed capital formation in agriculture, it is seen that the shares of changes in stock within agriculture during the eighties have generally been higher than those obtaining during the previous decades. Moreover, gross fixed capital formation in agriculture as a percentage of total gross fixed capital formation in the economy (col. 7 in Table I) has increased upto 1979-80 with certain fluctuations and then has been tending to decline consistently.

Besides annual compound growth rates (Table II), the trend growth rates have also been calculated. These growth rates show that the trends in investment in agriculture are significant. We have examined the trends for three major variables, *i.e.*, GCFAGR, PUGCFAGR, PVGCFAGR for the period 1960-61 to 1989-90. The model used for each one of them is of the same type, *i.e.*, a semi-log model: $y_t = \alpha e^{\beta t}$ or, $\log y_t = \log \alpha + \beta t$. The estimated results are presented below. For each equation we have given estimated coefficients along with adjusted R^2 and the D-W statistics, which has been corrected for second-order autocorrelation.

(i)	$\ln (GCFAGR)_t$	$= -64.392 + 0.036648\ T$ (-3.4151) (3.8149)	Adj. $R^2 = 0.9377$ D-W statistic = 1.9864
(ii)	$\ln (PUGCFAGR)_t$	$= -55.807 + 0.031739\ T$ (-2.4113) (2.6906)	Adj. $R^2 = 0.9452$ D-W statistic = 1.7446
(iii)	$\ln (PVGCFAGR)_t$	$= -70.72 + 0.03966\ T$ (-4.6562) (5.1340)	Adj. $R^2 = 0.9038$ D-W statistic = 2.0187

Figures in parentheses are 't' values.

Thus the growth rates of GCFAGR, PUGCFAGR and PVGCFAGR are 3.7, 3.2 and 3.96 per cent respectively for the period 1960-61 to 1989-90, which show a statistically significant trend over the years.

When we relate GCFAGR to aggregate capital formation in the economy (AGGRGCF) as a whole, it appears that there has been some sluggishness in the rate of GCFAGR in relation to the rate of AGGRGCF in more recent years. The ratio of GCFAGR to AGGRGCF has increased with significant fluctuations from over 13 per cent in the early sixties to about 18 per cent in 1980-81. Since then, this has slided to as low a figure as 9.2 per cent in 1990-91 (col. 5 in Table III). And again, comparing col. 4 in Table I with col. 4 in Table III, one can say that even though AGGRGCF has been steadily increasing along with fluctuations, the

same pattern is not experienced in the case of the agricultural sector. This implies that investment in the agricultural sector is receiving inadequate attention in the macro economic policy formulation.

TABLE III. CAPITAL FORMATION: AGGREGATE AND IN THE AGRICULTURAL SECTOR

(Rs. crores at 1980-81 prices)

Year	AGGRGCF	AGGGDPFC	Col.(2) as per cent of col. (3)	GCFAGR as per cent of col. (2)
(1)	(2)	(3)	(4)	(5)
1950-51	5,746	42,871	13.40	21.96
1951-52	6,339	43,827	14.46	22.70
1952-53	4,675	45,117	10.36	28.49
1953-54	5,143	47,863	10.75	26.09
1954-55	6,370	49,895	12.77	20.96
1955-56	7,948	51,173	15.53	19.90
1956-57	9,517	54,086	17.60	16.12
1957-58	9,964	53,432	18.65	15.91
1958-59	8,390	57,487	14.59	18.00
1959-60	9,503	58,745	16.18	13.62
1960-61	11,775	62,904	18.72	14.17
1961-62	10,813	64,856	16.67	15.44
1962-63	12,692	66,228	19.16	14.56
1963-64	13,535	69,581	19.45	14.78
1964-65	14,223	74,858	19.00	14.96
1965-66	14,743	72,122	20.44	15.65
1966-67	15,455	72,856	21.21	15.18
1967-68	14,891	78,785	18.90	17.39
1968-69	13,249	80,841	16.39	20.33
1969-70	15,102	86,109	17.54	19.01
1970-71	16,550	90,426	18.30	16.66
1971-72	17,941	91,339	19.64	16.30
1972-73	17,636	91,048	19.37	18.03
1973-74	20,007	95,192	21.02	16.03
1974-75	20,729	96,297	21.53	14.35
1975-76	22,908	1,04,968	21.82	14.79
1976-77	22,498	1,06,280	21.17	18.93
1977-78	22,415	1,14,219	19.62	18.17
1978-79	28,144	1,20,504	23.36	18.64
1979-80	27,334	1,14,236	23.93	19.08
1980-81	25,794	1,22,427	21.07	17.97
1981-82	34,217	1,29,889	26.34	13.15
1982-83	33,293	1,33,915	24.86	13.74
1983-84	31,316	1,44,865	21.62	13.08
1984-85	33,025	1,50,433	21.95	13.78
1985-86	38,285	1,56,566	24.44	11.30
1986-87	38,159	1,63,271	23.37	10.52
1987-88	37,977	1,70,205	22.31	11.63
1988-89	44,102	1,88,009	23.46	9.85
1989-90	45,514	1,99,329	22.83	9.52
1990-91	47,350	2,10,477	22.50	9.20

Source: Same as in Table I.
Note: AGGGDPFC = Aggregate gross domestic product at factor cost by industry of use.

Nevertheless, the GCFAGR has been falling consistently during the 1980s as compared with the previous decades. In this context, it is essential to see the extent of changes in the case of private and public investment in agriculture. Cols. 6 and 7 in Table IV make it clear that the ratio of PUGCFAGR to total aggregate public gross capital formation (AGGPUGCF) has reached the peak in the year 1980-81, *i.e.*, 15.26 per cent, whereas the ratio of PVGCFAGR to AGGPVGCF has remained more or less stable. In fact, in recent years there

has been a relative decline. Hence, it can be postulated that it is public investment which stimulates or crowds-in private investment. Most of the evidence available in India suggests that the level of public investment in the economy has been an important determinant of the level of private investment in the economy (Nayyar, 1993, p. 649).

TABLE IV: PUBLIC AND PRIVATE INVESTMENT IN THE AGRICULTURAL SECTOR

(Rs. crores at 1980-81 prices)

Year (1)	AGGPUGCF (2)	AGGPVGCF (3)	PUGCFAGR (4)	PVGCFAGR (5)	Col. (4) as per cent of col. (2) (6)	Col. (5) as per cent of col. (3) (7)
1960-61	4,805	6,970	589	1,079	12.26	15.48
1961-62	4,815	5,998	600	1,070	12.46	17.84
1962-63	5,731	6,961	694	1,154	12.11	16.58
1963-64	6,473	7,062	725	1,275	11.20	18.05
1964-65	6,822	7,401	765	1,363	11.21	18.42
1965-66	7,412	7,331	798	1,510	10.77	20.60
1966-67	6,569	8,886	696	1,650	10.60	18.57
1967-68	6,662	8,229	688	1,901	10.33	23.10
1968-69	6,002	7,247	775	1,919	12.91	26.48
1969-70	5,997	9,105	775	2,096	12.92	23.02
1970-71	6,984	9,566	789	1,969	11.30	20.58
1971-72	7,650	10,291	851	2,073	11.12	20.14
1972-73	9,053	8,583	1,049	2,131	11.59	24.83
1973-74	8,969	11,038	993	2,215	11.07	20.07
1974-75	8,757	11,972	919	2,056	10.49	17.17
1975-76	11,030	11,878	1,041	2,347	9.44	19.76
1976-77	12,326	10,172	1,378	2,880	11.18	28.31
1977-78	10,445	11,970	1,534	2,539	14.69	21.21
1978-79	12,519	15,625	1,697	3,549	13.56	22.71
1979-80	13,029	14,305	1,772	3,443	13.60	24.07
1980-81	11,767	14,027	1,796	2,840	15.26	20.25
1981-82	15,178	19,039	1,779	2,720	11.72	14.29
1982-83	16,635	16,658	1,725	2,850	10.37	17.11
1983-84	15,502	15,814	1,707	2,390	11.01	15.11
1984-85	17,588	15,437	1,673	2,878	9.51	18.64
1985-86	18,216	20,042	1,516	2,806	8.32	14.00
1986-87	19,584	18,575	1,428	2,586	7.29	13.92
1987-88	17,958	20,019	1,461	2,957	8.14	14.77
1988-89	19,346	24,756	1,364	2,982	7.05	12.05
1989-90	20,895	24,619	1,169	3,165	5.59	12.86

Source: Same as in Table I.
Notes: PVGCFAGR = GCFAGR-PUGCFAGR. Similar is the case for aggregate private capital formation.

Falling real public investment in agriculture is a cause for major concern. It has been falling at a time when the overall real public investment has grown. Superficial observation would attribute this to low savings, absence of integration between saving and investment, etc. But on a closer scrutiny, these appear to be only proximate causes. The decline in public investment in agriculture during the 1980s was mainly because of a large proportion of the total resource flows to the agricultural sector going into current expenditure on subsidies for fertilisers, irrigation, electricity, credit and other agricultural inputs, rather than investment. There is a need for a gradual reduction in the level of current expenditures which release resources for investment in the agricultural sector, specially in irrigation, that has high potential to enhance yields and employment.

The private investment as a percentage of private sector GDP in agriculture has remained

more or less stable except for a slight fluctuation during the late seventies (col. 3 in Table V). This indicates the crucial importance of public investment in determining macro magnitudes. It has to be so used that efficiency in the whole economy can be achieved.

TABLE V. PRIVATE INVESTMENT AS PERCENTAGE OF PRIVATE GDP IN AGRICULTURE

(Rs. crores at 1980-81 prices)

Year	PVGDPAGR	PVGCFAGR as per cent col. (2)	NDPFCAGR	GIA	RAIN
(1)	(2)	(3)	(4)	(5)	(6)
1960-61	28,689	3.76	27,982	27,980	99.0
1961-62	28,544	3.75	27,843	28,460	97.4
1962-63	27,923	4.13	27,180	29,453	94.7
1963-64	28,402	4.49	27,694	29,707	85.9
1964-65	31,307	4.35	30,568	30,705	97.5
1965-66	26,983	5.60	26,187	30,901	80.0
1966-67	26,310	6.27	25,478	32,683	87.9
1967-68	30,852	6.16	30,013	33,207	92.0
1968-69	30,675	6.26	29,839	35,483	93.5
1969-70	32,953	6.36	32,083	36,970	97.0
1970-71	35,315	5.58	34,545	38,194	96.5
1971-72	34,340	6.04	33,500	38,431	99.0
1972-73	32,362	6.58	31,432	39,059	86.0
1973-74	35,129	6.31	34,134	40,280	99.5
1974-75	34,112	6.03	33,079	41,740	85.5
1975-76	39,018	6.02	37,953	43,363	97.0
1976-77	36,575	7.87	35,433	43,552	94.3
1977-78	41,202	6.16	40,009	46,030	98.5
1978-79	41,975	8.46	40,712	48,306	97.5
1979-80	36,247	9.50	34,836	49,178	85.0
1980-81	41,544	6.84	40,056	49,875	97.0
1981-82	44,215	6.15	42,643	51,554	99.0
1982-83	43,594	6.54	41,957	52,121	89.4
1983-84	48,734	4.90	47,053	53,937	95.0
1984-85	48,650	5.92	46,918	54,083	90.0
1985-86	48,787	5.75	46,991	54,652	90.0
1986-87	47,888	5.40	46,117	55,690	85.3
1987-88	48,142	6.14	46,333	56,229	88.6
1988-89	56,863	5.24	54,953	59,329	109.6
1989-90	58,385	5.42	56,401	59,429	98.6

Source: (1) For cols. (2) to (5), same as in Table I.
(2) Col. (6) from *Government of India, Economic Survey*, Ministry of Finance, New Delhi (various issues).
Notes: PVGDPAGR = Gross domestic product in agriculture from private sector, which has been derived by deducting public sector gross domestic product in agriculture from total GDPAGR. NDPFCAGR = Net domestic product at factor cost in agriculture; GIA = Gross irrigated area (in thousand hectares); RAIN = Rainfall index (100 = normal).

II

FACTORS UNDERLYING AND IMPACT OF CAPITAL FORMATION

Hypothetically, several factors can be said to be responsible for the declining trends in capital formation in agriculture in recent years. Among them, inadequate growth of domestic savings, low productivity, adverse terms of trade, the role of institutional credit and structural factors like farm size are most important. Particularly, much of the decline in capital formation in agriculture is attributable to falling real public investment in agriculture. The share of agriculture in real GDP has come down and there are indications that the terms of trade have on the whole moved against agriculture (Shetty, 1990). There are studies which show the terms of trade were favourable to agriculture during the fifties and sixties (Thamarajakshi, 1969, 1977). Nadkarni (1993) has also shown that while the terms of trade had moved against

agriculture in the seventies due to exogenous shocks from the hike in oil prices, they have moved to the earlier pattern of increasing trend in the eighties. Nevertheless, the trend in the terms of trade of agriculture is indeed debatable, and many intricate issues are involved into which we need not go here.

Notwithstanding, it must be noted that had the terms of trade not moved in favour of agriculture in the eighties, then private investment in agriculture would have declined. Since private investment in agriculture has remained more or less stable without any declining trend, the terms of trade also may not have declined. However, the terms of trade are not the only factor in influencing private investment in agriculture, as the latter depends exogenously on the behaviour of government investment in agriculture.

Moreover, capital formation is a function of the level of technology. Indian agriculture in the fifties and the early sixties was characterised by backward and stagnant technology. Even though our technology has been changing since the mid-sixties, the returns to investment in agriculture seem to have been declining particularly during the eighties. No further technological breakthrough has taken place recently corresponding to the one in the sixties. This may be considered as one of the factors underlying the fluctuations of private investment in agriculture. Average farm size has been declining over the years due to demographic pressure which limits the growth in private investment. Overall, the main factors influencing private investment include the levels of public investment, profitability of production and availability of formal term credit. Institutional credit flow to Indian agriculture in real terms has increased rapidly both in terms of coverage and quantum during the post-bank nationalisation phase, which period is taken into consideration here for analysis (Table VI).

TABLE VI. GROWTH IN PUBLIC SECTOR BANKS' LOANS TO AGRICULTURE (1969 TO 1990)

(Rs. in crores)

Year	Total	Lending to agriculture		Per cent of col. (3) to col. (2)	Per cent of col. (4) to col. (2)	Real total credit
		Direct finance	Indirect finance			
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1969-70	162	40	122	24.69	75.31	440.22
1970-71	301	160	141	53.16	46.84	773.78
1971-72	395	263	132	66.58	33.42	963.41
1972-73	485	310	175	63.92	36.08	1,073.01
1973-74	617	423	194	68.56	31.44	1,136.28
1974-75	781	539	242	69.01	30.99	1,148.53
1975-76	1,024	725	299	70.80	29.20	1,523.81
1976-77	1,335	1,003	332	75.13	24.87	1,946.06
1977-78	1,651	1,260	391	76.32	23.68	2,286.70
1978-79	1,851	1,340	511	72.39	27.61	2,560.17
1979-80	2,459	1,825	634	74.22	25.78	2,906.62
1980-81	3,097	2,364	733	76.33	23.67	3,097.00
1981-82	3,901	2,974	927	76.24	23.76	3,569.08
1982-83	5,106	3,954	1,152	77.44	22.56	4,550.80
1983-84	5,973	4,735	1,238	79.27	20.73	4,864.01
1984-85	7,344	5,970	1,374	81.29	18.71	5,584.79
1985-86	9,031	7,611	1,420	84.28	15.72	6,492.45
1986-87	9,231	7,918	1,313	85.78	14.22	6,305.33
1987-88	10,645	9,284	1,361	87.21	12.79	6,754.44
1988-89	12,111	10,700	1,411	88.35	11.65	7,157.80
1989-90	14,369	12,920	1,449	89.92	10.08	7,683.96
1990-91	16,434	15,283	1,151	93.00	7.00	7,839.15

Source: Compiled from Reserve Bank of India, *Report on Currency and Finance, Vol. II, Statistical Statements*, Bombay (relevant issues).

Note: Real total credit = [Total credit/Wholesale Price Index (1980-81 = 100)]*100.

As could be seen from Table VI, credit for agriculture has increased from Rs. 162 crores in 1969 to Rs. 16,434 crores in 1990, which is given in two components (direct and indirect). The growth in direct credit is much higher than the growth in indirect credit. And also, institutional credit has formed the major proportion of the total fixed capital formation in Indian agriculture (Rath, 1989). Therefore, credit seems to be a contributing factor in enhancing private investment in agriculture.[4]

Furthermore, the fall in agricultural investment has resulted in the slowing down of the development of irrigation in the country. The annual compound rate of growth of gross irrigated area was 2.87 per cent, 2.46 per cent and 1.57 per cent in 1961-71, 1971-81, 1981-87 respectively (Kumar, 1992). At this juncture, it is worthwhile seeing the empirical results behind reduction in investment in agricultural inputs, such as irrigation, on the output of the agricultural sector. Hence, agricultural output is estimated as a function of the rainfall index[5] (RAIN) and gross irrigated area (GIA).

Besides, investment decisions in the private sector are taken, by and large, by farm households. The farmer's perception of improving productivity of land could be time-phased being based on his permanent income. His investment in the farm sector in a year may be related to incomes received in that year or preceding year. Hence, it is postulated that fluctuations in private investment in agriculture may be due to fluctuations in agricultural incomes. Thus we have linked annual gross investment in agricultural sector to the average of current and previous year's agricultural incomes (Pani, 1984, p. 123). In other words, investment in private agricultural sector is postulated to be related to the average of current and previous year's agricultural incomes.

The following are the estimated equations using the range of the data from 1960-61 to 1989-90. Figures in parentheses under each estimated coefficient are the t-statistics, which has turned out to be significant in all the following regressions.

1. The first equation estimated is for the net domestic product at factor cost from agriculture (NDPFCAGR) at constant prices.

$$\underset{}{\text{NDPFCAGR}} = \underset{(-3.6618)}{-18897} + \underset{(10.274)}{0.79655\,\text{GIA}} + \underset{(5.4068)}{236.47\,\text{RAIN}} \qquad \text{Adj. } R^2 = 0.96,\ \text{D-W} = 1.94$$

This exercise has found that agricultural output is significantly affected by investment in irrigation. Here both the coefficients are significantly influencing net domestic product at factor cost from agriculture. In other words, an increase in gross irrigated area leading to an enhanced output would result in more investment.

2. The second equation is concerned with the total gross irrigated area (GIA), which depends on agricultural investment of the previous year and rainfall index. Possibly, GIA would capture indirectly the effect of variation in the cost of inputs such as investment on irrigation. Hence the regression equation of GIA is run using gross capital formation in agriculture with one year lag and rainfall. And both the variables are significant as expected. But rainfall is significant at 0.10 level of significance.

$$\text{GIA} = \underset{(6.59)}{24335} + \underset{(4.3872)}{2.7489\,\text{GCFAGR}_{-1}} + \underset{(1.5358)}{51.609\,\text{RAIN}} \qquad \text{Adj. } R^2 = 0.98,\ \text{D-W} = 1.52$$

3. The third equation models private agricultural investment as a function of public investment in the sector with one year lag. This functional relationship is postulated for the simple reason that government investment in agriculture, through construction of irrigation works, may sometime act as a stimulant for private investment.

$$PVGCFAGR = \underset{(4.3883)}{1216.5} + \underset{(4.0766)}{0.96333}\, PUGCFAGR_{-1} \qquad \text{Adj. } R^2 = 0.80 \quad D\text{-}W = 2.09$$

So it is obvious from the estimates that private investment is significantly affected by public investment with one-year lag.

4. In the fourth equation we estimate private agricultural investment again, linking it to the average of current and previous year's agricultural incomes.

$$PVGCFAGR = \underset{(1.6478)}{659.25} + \underset{(3.8084)}{0.043308}\, (NDPFCAG + NDPFCAG_{-1})/2 \qquad \text{Adj. } R^2 = 0.81 \quad D\text{-}W = 2.12$$

The results make it clear that agricultural income is the major source of capital formation in the private sector.

5. Further, the following equation is concerned with modelling private investment in agriculture, specified as a function of real total credit given to agriculture.

$$PVGCFAGR = \underset{(9.2497)}{2176.4} + \underset{(2.3285)}{12.869}\, RCREDIT \qquad \text{Adj. } R^2 = 0.51 \quad D\text{-}W = 2.09$$

The results indicate that the role of formal credit in private investment is significant, which suggests that credit does have an indirect role in promoting growth through increasing capital formation. In terms of overall statistical fit, all the three equations of private agricultural investment provide satisfactory results. Besides, the coefficients of all other estimated equations are positive and significant, as expected. The Durbin-Watson test revealed first-order positive autocorrelation in the beginning in all the above regressions, which was later on corrected using Pagan's (1974) procedure. The corrected estimates have been reported here.

III

CONCLUSION

Capital formation *per se* is the flow of capital per unit of time. It is now recognised that without adequate investment of capital, agriculture can not make substantial contribution to the economic development of the country. During the last few decades, the structure of the Indian economy has undergone significant changes, with the share of the primary sector in net domestic product declining over the years especially during the eighties; one of the possible reasons could be the relatively lower investment, both public and private, in agriculture. Slowing growth of gross domestic capital formation in agriculture, in particular declining public capital formation, is a clear warning sign and worrisome trend for future growth. Even though private investment, which forms about 65 per cent of the total agricultural investment in the country, appears to be slowing down in recent years, still it has grown considerably in real terms. To a large extent, public and private investment are complementary, rather than substitutes for each other, and thus falling public investment may be affecting private capital formation. Hence, it is the increase in public investment in

agriculture which influences the trends in private investment in agriculture.

While it is unlikely that, allocations to agriculture can be increased, given India's current fiscal crisis, there is considerable scope for improving the impact of public expenditures within the sector even in the short term. Key actions are: (*a*) reduce subsidies; (*b*) prune and focus expenditures on a smaller array of programmes and services; (*c*) target priority areas; (*d*) increase cost recovery; (*e*) control recurrent expenditures; and (*f*) strengthen sectoral management and budgeting. There is also a need to stimulate private investment in agriculture. Changes in the incentive structure (removing disprotection, easing the trade regime and reducing industrial protection) will exert powerful influences on incentives for investment in agriculture (The World Bank, 1991, pp. 94-96).

Furthermore, capital formation gains momentum in such areas where conditions for transforming the traditional agriculture into modern one exist. In the context of the green revolution in Indian agriculture, capital formation was of prime necessity for its rapid development. The dynamic changes which took place as a result of the green revolution have resulted in high growth rates in agriculture during the sixties and seventies. Since capital formation is a function of productivity, which, in turn, is a function of capital investment, the increase in capital investment during the 1960s and 1970s led to high productivity in agriculture which gave rise to high rate of growth in capital formation during that period. Thereafter, it got a setback due to the deceleration in the growth of capital formation. Thus in order to improve upon the situation, capital investment especially public capital investment has to be increased which will set the pace and pattern of economic growth once again.

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NOTES

1. Investment in agriculture takes place by both public and private sectors. Private investment in agriculture is predominantly in groundwater development, land improvement, machinery and equipment (including tractors and pumpsets), and livestock. Public investment is concentrated in irrigation infrastructure, public services (research and extension), conservation and commodity development programmes.

2. In this paper, capital formation in agriculture excludes investment on forestry, logging and fishing.

3. Due to the lower capital-output ratio in agriculture, it is not expected that capital formation should be at the same rate as in the total economy. The concern is about the fall (Nadkarni, 1993, p. 18).

4. In the distribution of institutional credit, there also remain large differences among regions, types of credit, and farm size.

5. All-India Cumulative Rainfall Index is constructed for the entire season by using the average area sown under *kharif* rice in each meteorological zone as weights (for the triennium 1980-81 to 1982-83), (Government of India, 1992, p. 102).

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