Public Fixed Capital Formation in Indian Agriculture : Revisiting the Intellection

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Abstract

What constitutes public GFCF in agriculture has emerged as a major methodological controversy among researchers . Though it has been repeatedly pointed out that there is a need for reconceptualization of agricultural capital formation, a real framework was suggested by the Bhattacharya Committee in 2003. The present paper constructed an alternative series for public GFCF in Indian agriculture, which accounts not only for direct, but indirect GFCF as well. The series constructed at the all-India level was also compared with the conventional CSO series. Broadening of public GFCF series for agriculture reflected an altogether different picture as compared to the CSO series. Among the other sectors of the economy, transportation heads such as rural roads and railways were found to have a dominant contribution towards total public GFCF in Indian agriculture. It was also observed that manufacturing heads in general, and agricultural machinery industry, in particular, experienced a declining share overtime in total public GFCF in the agricultural sector.

Keywords: **agricultural sector, capital formation, GFCF, CSO series, investments**

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Investment is among the three "I"s (investment, incentives, and institution) which form an outline for the agenda of modernizing agriculture (Gulati, n.d.). Large scale investments, particularly capital investments in agriculture, cannot only provide a structural break to the sector, but also lift it up from stagnation. Investment in agriculture, that is, increasing the levels and the quality of investment in agriculture is central to achieving the goals of a smooth economic development, catalyzing structural change and increasing food security (Food and Agriculture Organization, 2011).

Indian agriculture has passed through different development phases, and so has the pattern of long term investments, that is, capital formation. Capital funds flow into Indian agriculture from two sources: the public (broadly termed as the government sector) and the private sector. Though the private sector has been reporting a consistently high share in total agricultural capital formation, the importance of public capital formation in Indian agriculture cannot be undermined. Public investments in Indian agriculture enlarge the productive base of agriculture, provided these result in real investments (Dhawan & Yadav, 1997). Therefore, an examination of trends and components of public capital formation in Indian agriculture can provide an insight into the growth cycle and provide useful clues for how to channel capital investments in the future.

Of late, there has been a wide debate among researchers regarding reconceptualization of capital formation in Indian agriculture. A serious debate started with the paper by Chand and Mishra (1995), who refuted the hypothesis of complementarity between public and private investments at the aggregate level, and raised doubts over the impact of the former over the latter. It has been contended by researchers that the concept of capital formation should go beyond direct capital investments in agriculture and include capital expenditure on other heads/components, which indirectly help in agricultural development. This is precisely what has been attempted in the present paper. Apart from reconceptualizing public capital formation, comparison with conventional CSO

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series has also been presented to analyze if there is a significant difference in the trends. The paper contributes towards the existing literature by providing altogether different boundaries of public capital formation in Indian agriculture and examining component wise share of the same.

Review of Previous Studies

Chand (2000) made the first major attempt in this regard by terming the coverage of CSO as "restrictive" in nature and pointed out that 90% of public investment in agriculture covered by CSO comprised of irrigation investment only. Crucial items such as infrastructure, storage and warehousing, and so forth, which also lead to agricultural capital formation were left out by the CSO series. Two questions raised by him in this regard were – (a) is the absence of complementarity between public and private investment in agriculture due to missing items of public investment ? (b) does the trend in public investment undergo a change when important items such as infrastructure are also included?

In order to have a thorough exploration of capital formation in agriculture, Chand constructed a broader series of capital formation in agriculture for the period from 1974-75 to 1996-97 by including 19 more items - besides the CSO series - which were contributing in agricultural capital formation. The study used data for capital outlay on agriculture and other heads from "Financial Accounts of Union & State Government". The items included to construct this broad series were - crop husbandry, soil and water conservation, animal husbandry, dairy development, fisheries, forestry and wildlife, plantations, food, storage and warehousing, agricultural research and education, investments in agricultural financial institutions, cooperation, other rural development programmes, hill and other North Eastern areas, major and medium irrigation projects, minor irrigation, command area development, rural electrification, fertilizer industries, and district roads.

It was found that of the total items of the broad series, the conventional CSO series included only 48% of the total items of public investment in agriculture . Conversely, it did not cover 52% of the items of the broad series. Another issue raised by Chand was that the CSO series are not an aggregation of regional series, but are indirectly derived from savings behaviour and agricultural investment surveys. He developed time-series data on private investment at the state-level, using data generated by RBI-NSSO and the national - level private investment data developed by CSO. The results of the broader series, when compared with the narrow series of CSO, showed significantly divergent trends about capital formation in agriculture. For the period from 1974-75 to 1981-82, public investment in agriculture as per the CSO series grew at a rate of 10%, and the growth according to the broad series was negative. It led to the inference that only investments on irrigation were rising and on other items, the investment expenditures were falling.

Roy and Pal (2002) developed broad investment series on public investment by considering capital expenditure under 21 heads (including the ones in CSO narrow series) such as crop husbandry, animal husbandry, special area programme, dairy development, command area development, rural electrification, and so forth, and 50% of the revenue expenditure on rural development and agricultural research. The main objective of his study was to analyze the temporal and regional trends in public and private capital formation when all possible investment items are included, and to examine the determinants of public and private capital formation in agriculture when new items are added to the conventional series. It was found that public investment in agriculture, as reported by CSO, covered only 37% of the total public investment in agriculture. Decline in public capital formation in agriculture was found in the conventional CSO series as well as in the new (broader series), but it was comparatively less in the latter than in the former.

Gulati and Bathla (2002) made another attempt to eliminate the narrow coverage of CSO and broaden the investment series for the time period of 1974-75 to 1998-99. The main questions raised by them in the methodological sphere were: (a) what comprises gross capital formation in agriculture and other defined sectors in the economy ? ; (b) how capital accruing from each activity functioning in an economy is categorized in the national income accounts ? ; (c) what investments should be included under agriculture, and if an investment in agriculture, according to the Indian system of national accounts is under covered, what all activities should be

included in the agricultural sector and on what basis ? In order to explore these questions, the authors developed three concepts of public capital formation in terms of increasing scope or coverage.

The three concepts proposed by them were: concept I (business as usual) took conventional definition of public GCFA such as expenditure on major, medium, and minor irrigation schemes and plantations in the forestry sector ; concept II included concept I + a part of investment in the power sector that goes to agriculture. The investments by Centre (Union), States, and development loans given by states for power projects were taken for constructing the series, and concept III included concept II + investment made in agriculture and allied activities as defined in the budgetary heads of the government accounts. The annual growth rates estimated for each of the concepts of public GCFA showed a significant negative rate of growth from 1980-89. The study pointed out that the situation of public sector GCFA was serious, but was not as alarming as it was made out to be, especially when investment in agriculture was re-defined in a broader way to include those investments that facilitated growth in agriculture.

↳ **The Latest Methodological Proposition :** Although, the need for a recourse of methodology on capital formation in agriculture was felt long back, a real framework was suggested by the Bhattacharya Committee (Ministry of Agriculture, Government of India, 2003) in 2003. It focused upon further broadening of the series of capital formation in agriculture by also including the infrastructural contributions made by various sectors of the economy towards agriculture. It was perceived in the report of the committee that different sectors contribute to the development of agriculture, and hence, their proportionate contributes should also be included under agricultural capital formation.

The committee suggested re-grouping of CSO estimates and emphasized on inclusion of the contribution of other sectors of the economy, apart from agriculture, to build a broader picture of capital formation in Indian agriculture. The methodology of the Bhattacharya Committee involved calculation of proportionate contribution of each sector to agriculture and proportion of GFCF of that sector can be included as GFCF for agriculture. By summing the GFCF for agriculture of all sectors, the total gross fixed capital formation can be obtained. The committee estimated the ratio contribution of different sectors for agriculture and also measured growth rates with the conventional and broad definition. The results obtained by the Committee are depicted in the Table 1 and Table 2.

Table 1. Component - Wise Contribution to Gross Fixed Capital Formation for Agriculture at 1993-94 Prices (%)

Sector	1980-81	1985-86	1990-91	1995-96	2000-01	2001-02
Agriculture etc.	79.4	74.1	73.3	66.5	65.7	69.1
Agri. Machinery	0.3	0.3	0.6	1.2	0.8	0.9
Fertilizer & Pesticides	2.8	3.9	3.3	5.8	10.5	9.2
Elect. gas & water supply	4.8	6.8	7.7	6.7	7.2	6.7
Construction	0.7	0.7	1.1	1.7	1.5	1.2
Trade	3.5	4.7	4.9	7.6	4.9	4.8
Railways	1.0	1.2	1.2	1.2	0.9	1.0
Storage	0.4	0.5	0.2	0.3	0.5	0.5
Communication	0.5	1.0	1.6	2.5	3.9	3.2
Banking & insurance	0.2	0.3	1.0	2.7	0.8	0.4
Public administration & Defence	6.5	6.7	5.1	3.6	3.3	3.1
Total GFCF for Agriculture	**100**	**100**	**100**	**100**	**100**	**100**

Source: Ministry of Agriculture, Government of India. (2003)

Data and Methodology

The study is based on secondary data, and the period of study extends from 1981-82 to 2010-11. The data sources included annual and occasional government publications such as National Accounts Statistics (NAS), Annual Survey of Industries (ASI), Ministry of Road Transport and Highways, Economic Survey, Planning Commission, and so forth. The discussion in the present study is in terms of GFCF rather than GCF, since it is difficult to estimate GCF for infrastructural sectors such as electricity and railways. GFCF in the present study refers to any expenditure made for the purpose of asset creation, which leads to generation of income over a period of time. Since capital formation results from capital expenditure, these two terms have been used interchangeably for discussion.

Construction of Alternative Series

↳ **Irrigation :** The all-India public sector GFCF estimates in agriculture were obtained from NAS (Central Statistical Organisation, Ministry of Statistics and Programme Implementation, Government of India, National Accounts Statistics (various issues)) . This sector included capital expenditure on irrigation works and plantations in the forestry sector. The dominant share (more than 90%) is that of irrigation expenditure. As such, GFCF in agriculture from public sector as given in NAS can be broadly termed as irrigation GFCF.

↳ **Allied Heads :** Some activities such as capital expenditure on soil and water conservation, animal husbandry, and so forth are included under "Economic and purpose classification of expenditure of administrative departments" (Statement 35 of NAS) (Central Statistical Organisation, Ministry of Statistics and Programme Implementation, Government of India, National Accounts Statistics (various issues)). GFCF given for "agriculture, forestry, fishing and hunting" was obtained, which includes fixed capital expenditure on various allied heads related to agriculture. The whole of the GFCF estimates of this sector was apportioned for agriculture.

↳ **Storage/Warehousing :** Direct estimates for GFCF in storage/warehousing were available from NAS. These included the GFCF estimates of Central Warehousing Corporation, State Warehousing Corporation, and Food Corporation of India.

↳ **Electricity* :** The GFCF estimates for electricity, gas, and water supply are given collectively in NAS. The separate estimates for electricity are not available. However, the GFCF estimates for electricity from public sector used for irrigation were taken from the Planning Commission report (Planning Commission, 2012) for the

Table 2. Annual Compound Growth of GFCF in and for Agriculture

	Annual compound growth rate (%)							
	Total GFCF in and for agriculture				Public sector GFCF in and for agriculture			
	Current prices		1993-94 prices		Current prices		1993-94 prices	
Time period	GFCF in Agriculture	GFCF for Agriculture	GFCF in Agriculture	GFCF for Agriculture	GFCF in Agriculture	GFCF for Agriculture	GFCF in Agriculture	GFCF for Agriculture
1980-81 to 1990-91	12.0	12.6	1.4	2.2	6.3	9.3	-4.0	-1.2
1991-92 to 2001-02	10.9	10.8	3.2	3.3	11.0	10.9	0.7	1.7

Source: Ministry of Agriculture, Government of India. (2003)

*Role of private sector is negligible in these heads.

time period of 1999-00 to 2008-09. These values have been moved with the GFCF of electricity, gas, and water supply to construct a whole time series for the study period.

↳ **Roads* :** Roads and bridges are included under "transport by other means". The GFCF for roads and bridges are not given in NAS separately. The same is available from the Planning Commission report for the time period of 1999-00 to 2008-09. The GFCF estimates are moved with all-India estimates of "transport by other means" to construct the time series for roads and bridges (Ministry of Statistics and Transport Highways, Government of India, Basic road statistics of India (various issues) . The all-India ratio of rural road length to total road length was applied to derive GFCF in roads and bridges meant for rural roads. The ratio of agricultural income to total income was further applied to derive GFCF estimates from rural roads for the agricultural sector.

↳ **Railways* :** The GFCF for railways is directly available from NAS. Ratio of food grain, freight, and fertilizer freight to total freight carried by railways was calculated on an annual basis as available from the Economic Survey (Table 1.27) (Government of India, Economic Survey, various issues). This proportion was applied to the total GFCF on railways to derive GFCF from railways meant for agriculture.

↳ **Manufacturing :** Under the manufacturing sector, the role of fertilizer industry, pesticides industry, and agricultural machinery and equipment is important for agriculture.

(a) Agricultural Machinery : GFCF estimates for the registered sector at all-India level were obtained from ASI (NIC code – 3500 (1970 to 1987), 2921 (1998 to 2004), and 2821 (2008 to 2011)). The share of public sector production to total production of agricultural machinery was applied to derive the GFCF in agricultural machinery industry for the public sector (Ministry of Statistics and Programme Implementation , Government of India, various years).

(b) Fertilizer Industry : The GFCF estimates for the registered sector at all-India level were obtained from ASI (NIC code – 3111, 3112, and 3113 (1970 to 1987), 2412 (1998 to 2004), and 2012 (2008 to 2011)).The share of public sector fertilizer production to total fertilizer production was applied to derive the GFCF in fertilizer industry for the public sector (Ministry of Chemicals and Fertilizers, Fertilizer Association of India, various issues ; Ministry of Statistics and Programme Implementation , Government of India, various years).

The total public GFCF for Indian agriculture was calculated as the sum of the individual heads. The current price GFCF series was converted into constant (1993-94) prices using the deflator derived from CSO. (Current price estimates of public GFCF for Indian agriculture have been presented in the Appendix 1. For comparison sake, the public GFCF series as given by CSO were also used. Public GFCF in Indian agriculture at current prices as per CSO series have been presented in the Appendix 2). Hereafter, the series constructed in the present study and the CSO series will be referred to as series 1 and series 2, respectively.

Temporal Pattern : All-India

Analysis of temporal pattern reveals typologies which can throw light on movement of capital investments. Examination of individual components provides idea about the volume and pattern of movement of different components overtime. Total and component wise public GFCF for Indian agriculture has been presented in the Table 3 (figures are in INR).

Total public GFCF in agriculture remained stagnant at less than INR 10000 crores during the period of 1984-85 to 1992-93. Sparing a few years, there was not much acceleration in total public GFCF for agriculture, and it just

*Role of private sector is negligible in these heads.

Table 3. Level of Public GFCF for Indian Agriculture at Constant Prices (in ₹ Crores)

Years	Direct GFCF		Infrastructural GFCF				Manufacturing GFCF		
	Irrigation	Public Administration	Electricity	Railways	Rural Roads	Storage	Agricultural machinery	Fertiliser industry	Total GFCF
1981-82	6414.49	917.33	327.33	730.51	697.12	71.61	13.44	609.54	9781.36
1982-83	6624.22	1372.81	410.35	697.56	1016.54	59.96	13.77	148.39	10343.55
1983-84	6492.92	1389.28	465.05	615.86	1176.43	77.98	18.31	839.27	11075.12
1984-85	6060.01	1430.06	441.19	534.35	957.95	78.64	11.06	118.42	9631.64
1985-86	5562.65	1171.32	427.72	529.28	1207.09	92.13	9.35	304.89	9304.43
1986-87	5174.19	1425.85	563.14	727.04	1252.33	95.86	6.55	523.61	9768.55
1987-88	5528.94	1246.83	748.84	564.73	1469.36	89.06	8.35	250.69	9906.84
1988-89	5249.38	1194.99	745.39	579.89	1317.97	64.46	9.76	55.37	9217.23
1989-90	4431.25	1041.16	722.41	510.03	1940.66	53.62	16.19	141.41	8856.73
1990-91	4323.51	1110.54	753.21	943.02	2488.23	38.63	21.84	219.93	9898.92
1991-92	3913.53	1102.18	792.08	900.23	2563.62	39.66	16.92	348.59	9676.81
1992-93	4082.87	1110.33	979.2	954.79	2538.44	33.88	17.54	218.71	9935.74
1993-94	4535.76	1057.94	821.93	581.98	2671.86	45.33	15.84	406.71	10137.02
1994-95	4959.53	974.39	844.76	585.24	3324.03	38.44	13.98	696.53	11436.89
1995-96	4868.16	915.35	824.54	895.44	2731.64	45.81	17.35	586.82	10885.11
1996-97	4497.35	1022.29	798.18	871.31	3371.07	47.44	20.02	479.74	11107.14
1997-98	4315.02	822.85	839.96	617.64	4297.52	43.45	22.84	451.72	11410.93
1998-99	3895.62	979.06	704.53	581.12	3179.01	51.25	24.13	337.24	9751.95
1999-00	4216.21	937.96	670.99	581.72	3333.32	72.86	25.72	329.76	10168.54
2000-01	3890.59	918.17	841.61	526.76	5628.06	104.93	27.52	187.07	12124.69
2001-02	4659.83	1008.54	526.65	625.74	5638.22	190.82	12.31	95.12	12757.17
2002-03	3958.38	924.32	734.45	1010.4	5855.22	168.96	14.75	70.91	12737.16
2003-04	6255.47	1436.31	1063.3	1481.78	8659.75	102.05	13.46	42.41	19054.53
2004-05	6088.23	777.72	485.83	1073.84	3271.88	25.19	19.22	88.62	11830.47
2005-06	6955.09	1187.93	841.82	1020.66	4874.44	31.77	44.06	477.69	15433.37
2006-07	7420.15	1040.67	607.61	1039.87	5775.16	59.52	19.51	132.92	16095.44
2007-08	7172.28	1143.21	499.08	851.22	5426.22	19.01	27.72	107.63	15246.27
2008-09	7842.75	1496.14	698.12	1086.63	5692.93	9.31	36.15	131.98	16994.02
2009-10	8956.32	2372.55	724.78	1514.63	4858.74	25.22	49.62	127.62	18629.49
2010-11	8760.75	2596.55	768.66	1377.42	5680.09	33.12	37.52	228.91	19483.01

doubled over the whole study period. However, the different components witnessed different trends during the three-decade period. As for the direct public GFCF in Indian agriculture, irrigation GFCF experienced a consistent downfall since the beginning of 1980s, and reached INR 3914 crores during 1991-92. In other words, it almost halved over the whole decade. Though it increased with a weak magnitude over the next decade, it failed to reach the level observed at the beginning of 1980s. Except for a sharp increase from 2002-03 to 2003-04, there was no noticeable acceleration in irrigation GFCF, though it consistently rose over the late 2000s. The expenditure by government administrative departments (GFCF on allied heads) did not exhibit any unique pattern and remained hovering between INR 8000 crores to INR 1500 crores during 1981-82 to 2002-03. Similar to irrigation GFCF, capital expenditure on allied heads also witnessed a sharp rise, whereby GFCF rose from INR 924 crores to INR 1436 crores during 2002-03 to 2003-04. GFCF in electricity for irrigation purposes rose

Table 4. Decadal and Trend Growth Rate of Public GFCF (%)

Time - period	Series 1	Series 2	Series 2 as a % of Series 1
Decadal			
1981-82 to 1990-91	-1.09	-4.59	57.04
1991-92 to 2000-01	1.23	-0.65	40.61
2001-02 to 2010-11	4.19	8.22	42.92
Entire period			
1981-82 to 2010-11	2.27	0.88	46.86

*Growth rates are based on semi-log model

Table 5. Share of Each Component in Total Public GFCF for Agriculture (%)

	Direct GFCF		Infrastructural GFCF				Manufacturing GFCF		
Years	Irrigation	Public Administration	Electricity	Railways	Rural Roads	Storage	Agricultural machinery	Fertiliser industry	Total
1981-82	65.58	9.38	3.35	7.47	7.13	0.73	0.14	6.23	100.00
1991-92	40.44	11.39	8.19	9.30	26.49	0.41	0.17	3.60	100.00
2001-02	36.53	7.91	4.13	4.90	44.20	1.50	0.10	0.75	100.00
2010-11	44.97	13.33	3.95	7.07	29.15	0.17	0.19	1.17	100.00

consistently and reached INR 792 crores in 1991-92 from INR 327 crores during 1981-82. It remained more or less consistent thereafter, except for the years of 2004-05 and 2007-08, whereby a significant slump was witnessed for electricity GFCF. Experiencing marginal variations, GFCF from railways for agriculture remained below the level of INR 1000 crores during the 20-year period of 1981-82 to 2001-02.GFCF from rural roads rose four times over the period of 1981-82 to 1991-92.

It continued to rise during the 1990s and reached as high as INR 8659.75 crores during 2002-03. Though in the next 2 subsequent years, there was a slight dip in GFCF from rural roads, it continued to maintain levels much higher than that observed during the previous two decades. GFCF from storage remained lower than 100 crores for most part of the study period, except for the period from 2000-01 to 2003-04. The post 2003-04 period witnessed a decline, with the GFCF level reaching as low as INR 9 crores during 2008-09. Though storage/warehousing remains a crucial component of the total value chain for Indian agriculture, the loss of momentum for this head can be attributed to increasing participation form private sector as well as inadequate public outlays for the same. The fertilizer industry reported a higher level of GFCF as compared to the agricultural machinery industry. GFCF from the latter remained below INR 50 crores except during 2009-10. While the GFCF levels were below INR 15 crores during 1980s, marginal improvement was seen, and the levels varied between INR 15 - 20 crores during 1990s. With a decline experienced during the early 2000s, GFCF from agricultural machinery reported moderate rise during the later part of the decade. No discernible pattern was witnessed for GFCF from the fertilizer industry. Beginning from a level of INR 610 crores during 1981-82, it slumped to INR 55 crores during 1988-89. Though the scenario improved during the subsequent years, a decline was again witnessed in 1998-99, which continued till 2003-04. This period coincided with the 10th plan period, whereby negligible investments were made for the fertilizer industry, which could be a possible reason for such a sluggish trend in GFCF from the fertilizer industry. In spite of a sharp rise during 2005-06, the momentum could not be maintained during the subsequent years.

In order to analyze the trends and magnitude of public GFCF for Indian agriculture, it is important to analyze the growth of the same overtime. Growth rates for series 1 and series 2 have been presented in the Table 4. It can be observed that while both series experienced a negative growth during the 1980s, the situation was more serious for series 2. This points towards the fact that though indirect GFCF declined during 1980s, direct capital

expenditure, particularly irrigation expenditure, suffered a significant dip during the period.

A contrast picture is observed for the 1990s, whereby series 2 registered a growth rate of 1.23% , while series 1 continued to experience a negative growth rate of -0.65%.This was the immediate post reform period whereby government assiduity to agriculture decreased and shifted towards the industrial sector. The deceleration in growth of capital investments was also cited as one of the reasons for declining agricultural growth (Dev, 2009 ; Jha, 2007 ; Singh, 2006). A regain in momentum is seen for both series during the next sub period, with the momentum being sharper for series 2. This period coincides with the phase when increased government attention to agriculture took place and there was a massive increase in irrigation capital expenditure by the government. As such, the decade of 2000s experienced a significant spurt in growth of agricultural GFCF with reference to both the series.

An exploration of the share of each component overtime as well as the changes in the same can provide an insight into the respective contribution of each component into total public GFCF. Component wise share in total public GFCF in Indian agriculture has been presented in the Table 5. It can be seen that there was a consistent decline in share of irrigation from 1981-82 to 2001-02 .The share almost halved over the period, though there was a rise at the end of the study period, that is, in 2010-11, which can be easily explained by initiation of new medium irrigation projects during the late 2000s, as well as massive outlays for completion of many on-going projects. Share of allied heads remained below 15%, much below the share of irrigation.

As such, it can be observed that irrigation reported much higher shares than allied heads over the whole of the study period. As for the infrastructural heads, rural roads dominated the scene with the share reaching to 44.20% during 2001-02 from a meagre share of 7.13% during 1981-82. The share was an eventual result of the success of the infrastructure development schemes like Rural Infrastructure Development Fund (RIDF) (Ghosh, 2011). However, the share of rural roads again suffered a nosedive and reached 29.15% during 2010-11. In spite of phenomenal expansion of rural roads in India, a decline in share of this head indicates a gradual drift from a government led growth of rural roads to a public - private participation for this infrastructural head. Other infrastructural heads such as electricity, railways, and storage reported shares less than 10% across the study period. In spite of being an important head due to perishable nature of agricultural goods, storage reported the lowest shares among the infrastructural head.

Coming to the manufacturing sector, contribution of the fertilizer industry remained much higher than that of the agricultural machinery industry. While the share of the latter remained less than 1%, the share of the former also witnessed a gradual decline during the study period. Private participation in the manufacturing sector and overtime decline of public sector industries, coupled with low returns to these industries, could be the chief reasons behind such a low share.

Conclusion

It can be well inferred that inclusion of new components presents a notable difference in growth trends as compared to the conventional CSO series. It was also found that CSO series covered only half the heads covered by the series in the present study. Whereas, the direct GFCF in agriculture, principally irrigation, saw a downturn during 1980s and 1990s ; infrastructural heads and particularly transport components reported rising shares. However, during the last decade of the present century, expansion in irrigation capital expenditure alone was much hurried as compared to the indirect heads. Also, the contribution of manufacturing heads in public sector to total public GFCF declined overtime. As such, two major suggestions regarding public GFCF in agriculture can be forwarded . Firstly, given the importance and dominant share of transport heads for agriculture, suitable measures must be taken by the government to strengthen the base of these heads so that they further contribute towards agricultural development. Secondly, instead of focusing alone on major and medium irrigation projects, attention must be paid to develop all those activities which directly or indirectly help in agricultural production.

Research and Policy Implications

The public sector in general, and Central and State governments, in particular, have huge significance for agriculture in the form of formulation of macroeconomic policies, provision of adequate resources for ongoing schemes for various heads, as well as initiation of new schemes to maintain and develop the infrastructure which is essential for agricultural development. Furthermore, enhancement of public investment in infrastructure governs the enlargement of productive base of the agricultural sector. In view of the fact that many of the infrastructural heads are solely provided by the public sector, it can be inferred that public investment will have a leading role to play for the development of irrigation and other infrastructure for agriculture. It is acknowledged that the private sector can also play a vital role for enhancing agricultural growth and provision of needful infrastructure, but the excessive liberalization and making entry of private players easier will prove to be counterproductive if not accompanied by massive public investments. The role of the government must evolve so that those activities which it still does are performed with greater effectiveness in terms of meeting the needs of the agricultural sector. An added dimension to this argument is that public investment in and for agriculture is also helpful in increasing farmers' own investments in agriculture. As such, the current vision of development should focus on the increased role of the government, which can provide the basic necessary and enabling condition for agricultural growth.

Limitations of the Study and Scope for Further Research

Though the present paper dwells upon construction of a new series for public capital formation for Indian agriculture, there remain some limitations, mention of which hereby is in order. Firstly, the paper is confined to the reconstruction of public sector series. An expanded series can be built upon similar lines for the private corporate sector and household sector in the future. Secondly, data constraints regarding capital formation estimates for heads such as rural roads, electricity, and so forth make accurate estimation of capital formation in agriculture an onerous task. The series can be revisited and reconstructed if any proper data set is developed in the future for these heads. Thirdly, the paper is restricted to analysis of capital formation for agriculture at the all-India level only. State wise construction and analysis in the same manner can form a subject matter of a separate research study. In addition to this, many heads, which help the agricultural sector, such as agricultural marketing, banking and insurance, communication, and so forth can be included for expansion of the series. However, it calls for exhaustive availability and exploration of data as well as evolution of appropriate mechanism to include these heads in the series. The present study thus, is only a foundation stone and a lot more can be done to make it more useful.

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Appendix 1. Level of Total Public GFCF in Indian Agriculture at Current Prices (in ₹ crores)

Years	Direct GFCF		Infrastructural GFCF				Manufacturing GFCF*		
	Irrigation	Allied	Electricity	Railways	Rural Roads	Storage	Agricultural machinery	Fertiliser industry	Total
1981-82	1881.00	269.00	95.99	214.22	204.42	21.00	3.94	178.74	2868.31
1982-83	2099.00	435.00	130.01	221.03	322.11	19.00	4.36	47.02	3277.54
1983-84	2248.00	481.00	161.01	213.22	407.31	27.00	6.34	290.57	3834.46
1984-85	2390.00	564.00	174.00	210.74	377.80	31.00	4.36	46.70	3798.61
1985-86	2536.00	534.00	195.00	241.30	550.31	42.00	4.26	139.00	4241.87
1986-87	2591.00	714.00	281.99	364.07	627.11	48.00	3.28	262.20	4891.65
1987-88	3042.00	686.00	412.01	310.71	808.44	49.00	4.59	137.93	5450.68
1988-89	3176.00	723.00	450.98	350.85	797.41	39.00	5.91	33.50	5576.64
1989-90	2975.00	699.00	485.00	342.42	1302.90	36.00	10.87	94.94	5946.13
1990-91	3134.00	805.00	545.98	683.57	1803.65	28.00	15.83	159.42	7175.46
1991-92	3256.00	917.00	659.00	748.98	2132.89	33.00	14.07	290.02	8050.96
1992-93	3736.00	1016.00	896.01	873.67	2322.78	31.00	16.05	200.13	9091.63
1993-94	4536.00	1058.00	821.98	582.01	2672.00	45.00	15.84	406.73	10137.57
1994-95	5548.00	1090.00	944.99	654.68	3718.43	43.00	15.64	779.18	12793.93
1995-96	6164.00	1159.00	1044.03	1133.79	3458.77	58.00	21.97	743.03	13782.59
1996-97	6357.00	1445.00	1127.98	1231.59	4765.00	67.00	28.30	678.05	15699.92
1997-98	6555.00	1250.00	1275.99	938.26	6528.42	66.00	34.63	686.19	17334.50
1998-99	6613.00	1662.00	1195.98	986.45	5396.51	87.00	40.96	572.48	16554.38
1999-00	7754.00	1725.00	1234.01	1069.84	6130.28	134.00	47.29	606.45	18700.87
2000-01	7267.00	1715.00	1572.00	983.90	10512.31	196.00	51.37	349.41	22647.00
2001-02	9255.00	2003.00	1046.00	1242.79	11198.22	379.00	24.45	188.88	25337.34
2002-03	8715.00	2035.00	1617.00	2224.55	12890.71	372.00	32.47	156.13	28042.86
2003-04	10666.00	2449.00	1813.00	2526.53	14765.45	174.00	22.95	72.31	32489.24
2004-05	15226.00	1945.00	1215.00	2685.45	8182.63	63.00	48.07	221.58	29586.73
2005-06	18829.00	3216.00	2279.00	2762.99	13196.10	86.00	119.29	1293.23	41781.59
2006-07	23936.00	3357.00	1959.99	3354.43	18629.56	192.00	62.94	428.77	51920.70
2007-08	26030.00	4149.00	1810.99	3089.30	19693.10	69.00	100.52	390.63	55332.55
2008-09	27793.00	5302.00	2473.99	3850.79	20174.48	33.00	128.11	467.69	60223.07
2009-10	33031.00	8750.00	2672.99	5585.98	17919.08	93.00	182.99	470.67	68705.71
2010-11	32802.00	9722.00	2878.00	5157.34	21267.38	124.00	140.47	857.10	72948.28

*Since 95% of the pesticides industry falls under the private corporate sector, and due to non-availability of data for bifurcation into the public and private sector, the pesticides industry was included under the public sector.

Appendix 2 . Level of Public GFCF in Indian Agriculture as per CSO Series (in ₹ crores)

Year	Current prices (Crores)	Constant prices (Crores)
1981-82	1881.00	6414.49
1982-83	2099.00	6624.22
1983-84	2248.00	6492.92
1984-85	2390.00	6060.01
1985-86	2536.00	5562.65
1986-87	2591.00	5174.19
1987-88	3042.00	5528.94
1988-89	3176.00	5249.38
1989-90	2975.00	4431.25
1990-91	3134.00	4323.51
1991-92	3256.00	3913.53
1992-93	3736.00	4082.87
1993-94	4536.00	4535.76
1994-95	5548.00	4959.53
1995-96	6164.00	4868.16
1996-97	6357.00	4497.35
1997-98	6555.00	4315.02
1998-99	6613.00	3895.62
1999-00	7754.00	4216.21
2000-01	7267.00	3890.59
2001-02	9255.00	4659.83
2002-03	8715.00	3958.38
2003-04	10666.00	6255.47
2004-05	15226.00	6088.23
2005-06	18829.00	6955.09
2006-07	23936.00	7420.15
2007-08	26030.00	7172.28
2008-09	27793.00	7842.75
2009-10	33031.00	8956.32
2010-11	32802.00	8760.75

Source: National Accounts Statistics, various issues.