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Agricultural Economics Research Review
Vol. 30 (Conference Number) 2017 pp 101-116
DOI: 10.5958/0974-0279.2017.00025.8

Futuristic Private and Public Capital Requirements in Agriculture for Doubling Farmers' Income across the States§

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Abstract

The government's aim to double farmer's real income by 2022-23 requires estimates on the magnitude of private and public capital formation in agriculture and allied activities in the past so that the futuristic investment requirements may be worked out. This paper estimates state-wise public investment '*in*' and '*for*' agriculture from 1981-82 to 2013-14, based on the capital expenditure on key economic heads in Finance Accounts and private (farm household) investment for 1981-81, 1991-92, 2002-03 and 2012-13 based on NSS-AIDIS (schedule 18.2) data. The incremental capital output ratios have been calculated to determine the rate of increase in agriculture and rural infrastructural investments, which would augment, if not double farm income over the 7-year period. The analysis indicates that both private and public investments in agriculture have increased manifold. Assuming that demand for output continues and capital-use efficiency remains unchanged, an investment rate of 26.1 per cent would facilitate doubling of farm income. In absolute terms, an additional investment of ₹ 645 billion on private account and ₹ 1900 billion on public account at 2015-16 prices would be required by 2022-23, which should grow annually at 10.8 per cent and 14.7 per cent, respectively. Though it is easier for the respective state governments to meet this target, it is more important to improve the marginal efficiency of capital in irrigation, rural energy and road-transport, by investing in area-specific and domain-specific needs so as to reap maximum gains. The government must prioritize investments in the less-developed eastern and rainfed states due to higher additional returns per unit of capital compared to that in the developed states. A substantial increase in the institutional credit is recommended to cover as many farmers as possible.

Key words: Futuristic private capital requirement, futuristic public capital requirement, doubling farm income, rural infrastructure, capital-use efficiency

JEL Classification: H54, O16, Q14, Q18

Capital Formation and Agricultural Growth

Capital, be it in physical or human form, greatly contributes towards increasing the efficacy of productive effort (Schultz, 1964). The physical capital in the agricultural sector comprises land improvement, irrigation (wells and canals), farm implements and machinery, tractors, storage warehouses, livestock, agricultural research and development. While most of these investments[1] are undertaken by farm households, the investments on major and medium irrigation,

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§ This paper is drawn from a report submitted by the author to the NCAER, New Delhi as part of the study prepared by the Committee on Doubling Farmers' Income (Volume II), Ministry of Agriculture & Farmers Welfare, July-August, 2017.

[1] The terms 'capital formation' and 'investment' are used interchangeably though have some distinction. As per the NAS, capital formation refers to the accounting value of additions of non-financial produced assets to the capital stock less disposals of these assets. Investment is a broader concept that includes purchase of all kinds of capital assets, be they in physical or financial form, which yield an income in the future.

research and education, extension services, storage warehouses, roads and other infrastructure squarely fall under the public domain. The literature indicates that investment needs may differ across countries and regions given their diverse agro-climatic conditions, level of development in agriculture and infrastructure, pattern of demand, trade and assistance received from the international agencies[2]. Nonetheless, high investments have significantly contributed to higher production and growth in almost every developing country, including India (Fan, 2008; Mogues *et al*., 2015). In particular, the impact of public investments and input subsidy in accelerating agricultural productivity and subsequently, in lessening rural poverty and food insecurity at both national and household levels is well documented (Ravallion and Datt, 2002; Fan *et al*., 2008; Syed and Miyazako, 2013). Accordingly, some studies have worked out incremental capital output ratios (ICORs) to forecast the required increase in the investment rate to meet the specific growth targets in a sector. By and large, the ICOR for Indian agriculture has been estimated between 2.2 and 6.0 under various Five-Year Plan periods since 1980s (Chand, 2000; Roy and Pal, 2001; Gulati and Bathla, 2002). It may further go up if investments on infrastructural development such as roads, markets and energy provided by the government are also considered. For the XII Five-Year Plan (2012-17), a 20 per cent investment rate has been estimated in view of the targeted growth of 3.5 per cent per annum in agriculture and allied activities (GOI-Planning Commission, 2012).

Here, the moot question is: What is the existing size of private and public capital formation in agriculture at the dis-aggregate state level and what are the future requirements to facilitate doubling of farmers' real incomes (DFI), as has been intended by the government? The question is vital at this juncture as farmers in many states fetch low returns from farming, and any improvement in their asset base would trigger growth in output and productivity. The criticality of government intervention through adequate credit, input subsidies and supportive infrastructure assumes importance in accomplishing this goal and also in inducing farmers to undertake investments.

The income earned by the farm households from agriculture, and other sources has already been benchmarked for the base year — 2015-16 at both national and state levels, along with the targeted rate of growth to augment, if not double income through possible avenues by 2022-23[3]. The magnitude of investment — current and required to accomplish this goal — is yet to be ascertained due to non-availability of estimates on capital formation for most of the states. The national level estimates on gross capital formation in agriculture and allied activities (GCFA) provided in the National Accounts Statistics (NAS) show a consistent increase in both private and public GCFA over time. It has accelerated at an impressive rate during the 2000s, showing a much higher increase in the private GCFA at 8.8 per cent compared to public GCFA at 5.9 per cent per annum. Whether this ongoing rate of growth in GCFA is adequate to facilitate the earmarked 9.23 per cent per annum growth in farm income (from agriculture and animal farming) till 2022-23 is another question to be delved into.

This paper addresses these questions by estimating the magnitude of private (farm household) and public investments in agriculture and key infrastructures and the futuristic requirements under each in 20 selected states. The projections are made on the basis of ICORs, estimated from 1981-82 to 2013-14 and the targeted rate of growth in farm income in each state. The public investment '*in*' agriculture, (refers primarily to the agricultural and allied activities, and minor, medium and major irrigation systems) has been expanded to include rural roads-transport and energy to make it *'for'* agriculture. The latter are considered to account for the infrastructural requirements in this sector, which according to many studies, have favoured agricultural growth.

Data and Methodology

The projection on capital requirements in any sector in a given period is based on a standard methodology, viz. Incremental Capital Output Ratio. The ICOR estimates the additional unit of capital or investment that is needed to produce an additional unit of output for a particular period. It is estimated as: *i/g*,

[2] FAO (1981); Schmidhuber and Bruinsma (2011); Lowder *et al*. (2012) estimated capital requirements for several countries to meet the production targets by 2030 and 2050. Estimates for India are included in South Asian countries.

[3] See among others, NCAER (2017); Satyasai and Mehrotra (2016); Chand (2017).

where *i* is the investment rate and *g* is the incremental gross state domestic product in agriculture and allied activities (GSDPA). It is also an indicator of the efficiency of capital use. The marginal efficiency of capital is estimated as 1/ICOR.

Going by the extant literature and standard assumptions in the traditional Harrod–Domar framework, ICOR has been calculated on following assumptions: (a) farm economy is on a steady growth path, (b) investments translate into productivity capacity without much lag, (c) full capacity utilization exists, and (d) there is an unchanging production structure and no technological change (GoI-Planning Commission, 2012). It is reasonable to assume that output from large public projects will have some lag period. The lag is not considered because additional investment required for DFI may be directed into the ongoing projects and possibly has some immediate and intermediate impacts. Further, this study does not analyse the optimum size of ICOR that a state should have. A high value of ICOR in a particular state may indicate high capital requirement (due to initial low capital base and/or to replace old assets) or it could be a case of over capacity utilization and hence signifies inefficiency. But, in relative terms, a state having low ICOR is preferred as it tends to generate additional units of output with lesser units of capital.

The ICOR for private investment was computed using fixed capital expenditure on farm business by rural households from decennial NSS AIDIS at four points of time (1981 to 2012-13) as official estimates on GCFA are not estimated for all the states. The same on public account is based on capital expenditure incurred by the respective state governments on: (a) agriculture and allied activities (excluding forestry and financial assets), (b) minor, medium and major irrigation and command area development (excluding flood control), (c) rural energy, and (d) rural road and transport[4]. It was calculated under each service/head for seven time periods, starting from 1981-82, approximately corresponding to the five-year plan periods. In order to address large variations in the GSDPA (at factor cost) and capital expenditure, three-year moving averages of these, centred at the mid-point of the triennia, have been worked out. The ICOR was then estimated by taking the ratio of annual averages for a five-year period of expenditure and incremental GSDPA, derived from three-year moving averages.

At first, the respective ICORs (averaged for the period 2007-12 and 2012-14) were multiplied with the targeted rate of growth in the farm income which gave the investment rate required under each head over 7-year period. The additional investments under various heads were worked out by applying the estimated ICORs to projected income at 2015-16 prices. The additional private and public investments *'in'* and *'for'* agriculture were summed up to get aggregate gross capital[5] needed by 2022-23 for DFI. The annual rate of growth in each investment was arrived at by taking the base year (2015-16) investments and additional investments required. The base year private and public GCFA were estimated using the annual rate of growth from 2000-01 to 2013-14 at the current prices. The exercise was based on the presumption that farm income would grow at the same rate with no change in efficiency in capital-use and continuance of demand for additional output. The ICOR given for 'all states' was estimated separately and might not be comparable with the all-India estimates reported in the literature.

The state-wise estimates on the real farm income and the anticipated rate of growth at 2015-16 prices, estimated using the NSS 59th and 70th rounds (schedule 33), were sourced from the NCAER (2017). The NAS, Central Statistical Organisation and GOI-Agricultural Statistics at a Glance, Ministry of Agriculture and Farmers Welfare were referred to for the national level estimates on GCFA, GSDPA, net sown area and other indicators. For constructing time series on public GCFA, Finance Accounts were referred to using the capital expenditure[6] heads on irrigation, and agriculture

[4] The bifurcation of expenditure on rural energy is based on the share of energy consumption in agriculture and roads-transport based on the percentage share of rural population in each state. Due to inconsistency in capital expenditure on energy in many states, the series was estimated in stock terms, allowing 10 per cent depreciation annually. The ICOR increases substantially from 0.09 to 0.42.

[5] It included changes in stock/inventory and depreciation of assets under the respective investment heads.

[6] Capital expenditure is gross and includes the government's investment in financial stocks. Hence, it may be an over-estimation of actual investment in the respective heads/services. This was the major data limitation.

Table 1. Magnitude of public and private GCFA at all India (in billion ₹) and annual rate of growth (per cent) at 2004-05 prices

Period	Public GCFA	Private GCFA	GCFA	GSDPA	Public GCFA	Private GCFA	GCFA	GSDPA
	Investment (in billion ₹)				Annual growth rate (%)			
1981-1989	105	232	337	3343	-2.49	1.81	0.49	2.90
1990-1999	93	330	423	4534	2.78	3.11	3.06	3.34
2000-2013	188	948	1136	7081	5.90	8.82	8.33	5.42
1981-2013	138	577	715	5343	3.06	6.58	5.77	3.52

Source: GOI-NAS, CSO.

and allied activities for 20 selected states[7]. The public investment in the newly formed states, viz., Chhattisgarh, Jharkhand and Uttarakhand, is available from 2000 onwards and has been merged with the respective parent states, viz., Madhya Pradesh, Bihar and Uttar Pradesh. The all-India estimates on private GCF by rural households refer to all states and UTs[8]. The current expenditures were converted into real prices at base 2004-05 using GSDP deflators.

Who Makes Investments in Agriculture and How Much?

Magnitude of Private Investment in Agriculture & Allied Activities: 1981-82 to 2012-13

The NAS provides estimates at the all-India level, bifurcated into gross fixed capital formation and changes in stock, and as per the institutions, viz. households, and public and private corporations. Table 1 shows that both public and private GCFA have increased three-times during the 2000s compared to that in the 1990s. A higher increase in the private GCFA at 8.82 per cent may be attributed to a big push in the public GCFA from early-2000s complemented with favourable prices, weather conditions, and flow of credit. These factors seem to have helped agriculture grow remarkably at 5.4 per cent per annum during the 2000s and sustain a 3.5 per cent rate of growth during 1981-2013. A greater dominance in GCFA is mainly of the household sector (viz. farmers), share in total being nearly 82 per cent. Although many private companies are making forays into agriculture, their share in total GCFA is low at 2.8 per cent. The share of public GCFA in total, which mainly pertains to agriculture and irrigation systems, has consistently decreased from 44 per cent during the 1960s to 15 per cent till date. This has been explained by the diversion of government expenditure towards revenue account owing to an increase in input subsidies and day-to-day expenses, inadequate funds, and low priority to spend on agriculture and rural development (Mishra and Chand, 1995; Chandrasekhar and Ghosh, 2002; Bathla, 2014).

Table 2 furnishes details on private fixed capital expenditure in farm business (FCEFB) (synonymous with GCFA)[9] by rural households and its share in the total fixed capital expenditure (FCE)[10]. At all India level, the per-household investment increased from

[7] Expenditures by the central government and loans/advances have not been taken to avoid double counting. The central government also spends directly on many activities in rural areas, such as on agricultural R&D and flagship programmes, which is generally routed through the states.

[8] The estimates extracted from AIDIS are based on a representative household sample and may not be comparable with the official (NAS) statistics which are definitely high. The NAS includes broader areas of investment such as in tea and coffee plantations, livestock, forestry, and fishery.

[9] The estimates are based on the unit level household data collected by NSS in its decennial report, All India Debt and Investment Survey (Schedule 18.2) (37th, 48th, 59th and 70th Rounds). Since each round is not comparable with the other due to differences in the definition of 'farmer', the investment per rural household was taken.

[10] AIDIS estimates FCE, which is equal to farm business, non-farm business and residential land and buildings; FCE in farm business encompasses eight expenditures, viz. land improvement, livestock, irrigation, transport, farm machinery, implements, orchards and others.

Table 2. State-wise FCEFB per rural household at 2004-05 prices and per cent share in FCE

State	1981-82		1991-92		2002-03		2012-13	
	FCEFB (₹)	FCEFB/ FCE (%)	FCEFB (₹)	FCEFB/ FCE (%)	FCEFB (₹)	FCEFB/ FCE (%)	FCEFB (₹)	FCEFB/ FCE (%)
Andhra Pradesh	687	40.6	533 (-2.5)	37.1	484 (-0.9)	19	1287 (10.3)	20.2
Assam	248	25.2	80 (-10.7)	11.7	119 (3.7)	17.7	303 (9.8)	22.2
Bihar	186	21.2	142 (-2.6)	33	73 (-5.8)	15.8	172 (8.9)	9.0
Gujarat	1405	57	781 (-5.7)	31.5	1220 (4.2)	37.3	3163 (9.9)	50.9
Haryana	2465	53.4	1429 (-5.3)	15.5	2646 (5.8)	27.4	2593 (-0.2)	11.9
Himachal Pradesh	496	23.3	783 (4.7)	15.6	1228 (4.2)	8.3	3412 (10.8)	21.4
Jammu & Kashmir	538	13.8	520 (-0.4)	21.6	711 (2.9)	12.2	1475 (7.6)	12.5
Karnataka	1045	39	1902 (6.2)	54.1	586 (-10.2)	23.0	2430 (15.3)	22.9
Kerala	686	11.9	658 (-0.4)	9.2	703 (0.6)	6.6	2188 (12)	9.3
Madhya Pradesh	664	49.4	1589 (9.1)	58	353 (-12.8)	34.9	3019 (23.9)	51.2
Maharashtra	1129	48.8	1367 (1.9)	45.2	1015(-2.7)	29.7	2674 (10.2)	32.5
Odisha	181	19.2	134 (-2.9)	15.5	327 (8.5)	13.5	350 (0.7)	16.1
Punjab	3245	52	1940 (-5.0)	46.2	2091(0.7)	37.1	4720 (8.5)	47.2
Rajasthan	1134	34.8	1677 (3.9)	45.8	1605 (-0.4)	40.5	3442 (7.9)	27
Tamil Nadu	634	32.5	791 (2.2)	26.3	620 (-2.2)	14.3	626 (0.1)	5.7
Uttar Pradesh	769	34.5	703 (-0.9)	27.3	831 (1.5)	30.6	2253 (10.5)	37.3
West Bengal	232	17.1	194 (-1.8)	18.3	119 (-4.4)	5.2	263 (8.3)	5.2
Telangana	—	—	—	—	—	—	1013	14.7
Bihar-Jharkhand	—	—	—	—	76 (-5.6)	12.7	300 (14.8)	13.8
Madhya Pradesh-Chhattisgarh	—	—	—	—	272 (-14.8)	25.6	1685 (20)	41.2
Uttar Pradesh-Uttarakhand	—	—	—	—	1170 (4.7)	30.9	1451 (2.2)	30.4
All-India	753	35.1	815 (0.80)	32.8	669 (-1.8)	21.8	1631(9.3)	23.3

Note: Figures within the parentheses are annual rate of growth from 1981-91, 1991-2002 and 2002-12.

₹ 753 in 1981 to ₹ 815 in 1991, fell to ₹ 669 in 2002, and then shot up again to ₹ 1631 in 2012 at 2004-05 prices. The large inter-state variations in investment indicate that farmers in Assam, Bihar, Jharkhand, Odisha, Tamil Nadu and West Bengal have been making lower investments compared to those in other states. One observes a modest 0.8 per cent annual growth in FCEFB for almost two decades, followed by a significant decline at 1.8 per cent during 1991-2002 and then an increase at 9.3 per cent during 2000-12. With a few exceptions, most of the states recorded negative rates of growth in the private investment during the 1980s and 1990s. This confirms a deceleration in its growth reported at the national level, followed by a revival in the subsequent decade. The highest growth between 8 and 15 per cent was experienced by almost all the states with a few exceptions, viz., Haryana, Odisha, Tamil Nadu and Uttarakhand.

There have been changes in the composition of investment over the years. The 1981-82 NSS survey shows that the bulk of investment of households went into purchase of machinery and transport (46.1%), followed by expenditure on irrigation (25.4%), and land improvement (14.8%). The irrigation investment became more important during 1991-92 as its share in total farm investment went up to 31.8 per cent, and that in orchards declined. The similar trends were observed during 2012-13, whereby the largest expenditure share (more than 60%) was incurred on farm implements and transport, and irrigation structures. This clearly indicates an unchanged

preference of farmers for these assets over the years. Another important point is that during 2012-13, the households devoted a substantial share of expenditure to livestock (23%). Among all assets, transport, machinery and implements, livestock and irrigation together accounted for 80 per cent of total GCFA. Farmers in the hilly regions tend to spend less on irrigation and more on land improvement, livestock and farm buildings. In contrast, those in the less-developed states incur a higher share of expenditure on irrigation. However, despite this impressive increase, the share of GCFA in total investment has consistently decreased from 35.1 to 32.8 per cent in 1991, and to 23.3 per cent in 2012. Among many, Haryana, Bihar, Rajasthan, West Bengal and Tamil Nadu have experienced a significant decline in the share, which indicates a growing preference of farmers for residential land and non-farm business, that too at the expense of farm investment (Bathla and Kumari, 2017).

Magnitude of Public Investment 'in' and 'for' Agriculture: 1981-82 to 2013-14

The government spends on various economic and social welfare schemes /heads in the respective states. The broad statistics for 20 selected states reveal that the total real public expenditure (for all sectors) increased from ₹ 1,108 billion in TE 1983-84 to ₹ 8,257 billion in TE 2013-14, growing at a rate of 6.73 per cent per year. The per-capita development expenditure increased from ₹ 1,513 to ₹ 7,270 during this period. Within the economic services, the average share of various expenditures reveals that nearly 25 per cent was allocated to irrigation and flood control, followed by agriculture and allied activities (19%), rural development (14%) and rural road-transport (11%). The expenditure on rural energy was significantly below that on road-transport, education and health. Notably, over the given period, the relative share of expenditure on economic services decreased while that on social welfare schemes has increased. Within the economic head, the share of irrigation-flood control fell substantially from 35.5 per cent to 20.1 per cent and that of agriculture from 21.2 per cent to 19 per cent (Bathla *et al*., 2017).

The state-wise scenario pertaining to spending on agriculture and irrigation given in Table 3, shows significant variations. These two heads did not receive much priority in the less- developed states for long but a substantial increase in expenditure on these is visible in recent years at a rate of 2 per cent to 7.3 per cent. Out of the total expenditure, the amount leading to capital (investment) is high for irrigation, the national average being 63.8 per cent in TE 2014, which is slightly higher than that in TE 1983-84.

The composition of spending under agriculture and allied activities for TE 2014 shows the highest share of crop husbandry (nearly 35%), followed by forestry (15.3%), animal husbandry (10.6%), food storage (11.98%), and cooperation (9.63%). The share of spending on food storage and warehousing in agricultural expenditure is relatively higher in the economically weak states (15%), than that in the developed states (5.5%). The share of spending on agricultural R&D is less than 10 per cent. Given a deceleration in the productivity growth rate of many crops, and also the fact that R&D activity is not undertaken by the private sector in India, it needs to be scaled up. Among various types of irrigation expenditures, the highest share is occupied by medium and major irrigation across all the states. The annual rate of growth in minor irrigation is picking up and is much higher at 11.95 per cent, as compared to that in the major and medium irrigation systems at 5.75 per cent. An increase in investment in minor irrigation, mainly tanks and tubewells, can be explained by the growing inefficiency and long gestation periods in the construction of canals.

As regards investments under the category *'for'* agriculture (*'in'* agriculture-irrigation plus rural roads-transport and energy), Table 4 provides the quantum of revenue and capital expenditure, and the share of latter i.e. investment under each head for TE 2014. Like private GCFA, large inter-state variations may be observed in the public GCFA across the states under each head. As expected, the developed states tend to spend more due to higher income and more resources. The low income states lag behind in infrastructure. Nearly 60 per cent of expenditure on roads-transport goes towards investment as compared to 24.7 per cent in rural energy, which should be scaled up.

Given the large variations in the size and population of states, Annexure Table 1 provides estimates on private and public GCFA on per hectare basis. It shows a sizeable increase in public investment in each state

Table 3. Public expenditure in agriculture and irrigation (₹ billion) and percentage share of capital expenditure (2004-05 prices)

State	Agriculture (₹ billion)		% of capital expenditure		Irrigation (₹ billion)		% of capital expenditure		Annual rate of growth (1981-2014) (%)	
	TE 1984	TE 2014	TE 1984	TE 2014	TE 1984	TE 2014	TE 1984	TE 2014	Agriculture	Irrigation
Andhra Pradesh	5.37	28.45	1.61	1.34	15.94	114.7	57.17	57.29	4.56	7.11
Assam	3.98	12.11	5.73	1.33	3.40	10.88	74.29	61.81	2.08	2.59
Bihar-Jharkhand	4.72	26.56	6.80	5.63	11.89	27.98	72.82	65.07	4.02	2.04
Gujarat	4.02	27.9	24.42	16.3	13.19	47.84	52.85	86.45	5.46	3.91
Haryana	2.36	14.38	2.94	26.14	6.25	10.99	56.4	40.58	—	1.98
Himachal Pradesh	2.58	7.98	8.61	5.02	0.48	3.35	58.39	48.59	3.28	7.45
Jammu & Kashmir	2.03	10.31	6.40	27.04	1.80	4.60	67.43	48.96	4.88	3.68
Karnataka	4.6	48.05	2.88	2.76	9.64	34.49	56.93	88.07	7.30	4.57
Kerala	3.37	24.48	11.18	7.48	3.89	5.46	72.75	47.17	5.59	0.77
Madhya Pradesh - Chhattisgarh	10.76	56.8	6.46	3.18	11.73	37.98	80.17	84.16	4.96	3.75
Maharashtra	18.33	54.88	3.44	17.2	20.07	66.32	62.59	73.94	3.11	4.85
Odisha	3.80	22.56	11.57	3.01	7.79	17.42	84.39	64.42	4.57	2.50
Punjab	2.43	7.56	—	2.25	5.13	9.02	58.37	26.93	—	1.64
Rajasthan	2.64	17.82	7.95	8.98	8.83	12.67	56.96	36.29	5.25	1.72
Tamil Nadu	7.88	37.32	12.62	13.25	4.20	14.18	39.82	62.34	4.34	4.31
Uttar Pradesh – Uttarakhand	6.28	37.88	—	12.21	22.86	47.93	53.11	38.41	5.97	2.07
West Bengal	5.11	15.08	9.97	12.44	4.34	9.63	37.01	42.26	3.03	2.78
All states	90.4	454.2	6.45	9.6	151	477.8	61.04	63.83	4.59	4.00

towards the end of 2000s, with 20 states average being ₹ 653/ha that increased to ₹ 2328/ha. The states that have registered public GCFA below the national average include Assam, Kerala, Uttar Pradesh, Madhya Pradesh, Bihar, West Bengal, Tamil Nadu, Rajasthan, and Punjab. Similarly, private investment at the national level has also increased manifold since 1981-82 from ₹ 471/ha to ₹ 687/ha and then to ₹ 1645/ha in 2012-13. Among all, farmers in Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Maharashtra and Punjab have made significant strides, perhaps due to better banking infrastructure and opportunities.

Futuristic Investment Requirements for Accelerating Farm Income

This section provides estimates on the futuristic investment requirements under private and public heads, based on the estimated ICORs and targeted rate of growth in real farm income. The estimates on ICOR reveal a definite pattern over the Five-Year plan periods from 1981-82 to 2013-14. On private investment, ICOR was at a level of 0.78 during the Sixth and Seventh Five-Year Plans, 1981-85 and 1985-91, which increased to 1.33 during the Ninth Plan (1997 - 2002) and then to almost 0.71 during the successive period. Compared to private investment, the ratios on public account show wide fluctuations, mainly due to investments in major and medium irrigation systems. Taking the average ICOR of public investments *'for'* agriculture, it turned out to be low at 1.2 during the 1980s, 0.75 from 1992-97, and then increased at 2.49 during 1997-02 and decreased to almost 2.0 from 2002-07 and 2007-12. It has shown some improvement in the efficiency of investment during the Tenth Five-Year Plan (2002-2007) on the irrigation head.

Table 4. Major economic heads of public expenditure at 2004-05 prices (₹ Billion) in TE 2014

State	Public expenditure (revenue and capital) (₹ billion)		Share of capital expenditure in total expenditure (%)		Annual rate of growth of expenditure (revenue and capital):1981-2014 (%)	
	Rural Roads-Transport	Rural Energy	Rural Roads-Transport	Rural Energy	Rural Roads	Rural Energy
Andhra Pradesh	15.04	9.72	52.79	0.92	6.53	11.33
Assam	9.42	0.01	57.58	74.36	4.11	44.11
Bihar-Jharkhand	33.75	1.04	78.13	10.61	9.31	6.65
Gujarat	21.6	8.16	40.00	26.98	6.28	21.05
Haryana	12.29	7.42	41.03	8.09	3.77	15.16
Himachal Pradesh	10.63	0.01	37.23	52.88	6.66	—
Jammu &Kashmir	3.20	0.92	72.04	10.36	4.91	5.09
Karnataka	21.63	13.9	69.42	10.36	8.90	27.16
Kerala	17.82	0.04	53.65	41.89	7.75	44.48
Madhya Pradesh - Chhattisgarh	22.08	7.53	62.79	31.44	6.54	15.67
Maharashtra	26.13	12.43	45.99	25.63	9.95	8.74
Odisha	12.11	0.03	67.76	93.30	6.22	0.68
Punjab	4.06	7.51	38.7	—	0.94	21.03
Rajasthan	11.82	18.33	53.44	41.31	4.07	17.39
Tamil Nadu	17.45	4.38	73.06	52.23	6.93	—
Uttar Pradesh–Uttarakhand	39.39	7.71	74.22	50.26	6.84	—
West Bengal	9.49	0.42	52.44	14.74	5.01	8.73
All states	289.76	102.95	60.4	24.66	6.59	12.37

Table 5 provides state-wise values of ICOR, averaged 2007-12 and 2012-14 together with the targeted rate of growth for DFI and farm income to be realized by 2022-23 at 2015-16 prices. For private investment, the ICOR varies from nearly 2.0 in Punjab and Himachal Pradesh to as low as 0.10 each in Bihar, Chhattisgarh and Jharkhand, the all-India average being 0.72. In the case of public investment *'for'* agriculture, the ICOR value is high at 2.11, which may be explained by the inclusion of infrastructural requirements, existence of a large unutilised capacity, gestation lag and inefficiencies, structure of growth in agriculture and demand patterns. There is hardly any pattern in the respective ratios across the states. Relatively higher capital intensity may be required in irrigation at almost 1.08, followed by roads-transport at 0.70, agriculture at 0.22 and energy at 0.11. The ICOR turned out to be the highest at 7.53 in Jammu & Kashmir; 6.06 in Gujarat, 3.56 in Maharashtra, 3.31 in Odisha, and almost 1.0 each in Assam, Madhya Pradesh, and Punjab; 0.67 each in Jharkhand and Rajasthan and was the lowest in West Bengal at 0.50. Taking private and public GCFA together, the estimated ICOR is 2.83, which may further go up if North Eastern states and UTs are also considered[11]. Without delving into an optimum size of ICOR that each state should have and the level of efficiency under each investment head, the analysis suggests that the less-developed states have relatively lower ICORs, which implies that a small increase in capital in these states would generate higher additional income compared to that in the developed states.

[11] It is clear from the large variations in the ICOR, that a single estimate of it at the national level used in the planning process may not be appropriate for resource allocation to agriculture and its development across states.

Table 5. Estimated ICOR (averaged 2007-12 and 2012-14) and targeted farm income in 2022-23 (₹ billion at 2015-16 base)

State	Private investment		Public investment					Private & Public	Targeted growth in farm income (%)	Targeted farm income (₹ billion)
	Agriculture	Irrigation	Agriculture	Irrigation	Energy	Road-Transport	*'for'* agriculture			
Andhra Pradesh	0.36	0.11	0.01	2.04	0.002	0.18	2.22	2.59	8.52	631
Assam	0.19	0.01	0.01	0.45	0.002	0.69	1.15	1.33	9.57	417
Bihar	0.11	0.01	0.03	0.33	0.021	1.20	1.57	1.68	8.66	331
Gujarat	1.03	0.48	0.46	4.47	0.24	0.90	6.06	7.09	9.60	546
Haryana	0.64	0.18	0.40	0.46	0.16	0.43	1.44	2.08	9.27	399
Himachal Pra Pradesh	1.82	0.20	0.23	0.89	0.003	1.94	3.07	4.89	9.33	85
Jammu & Kashmir	0.82	0.02	2.51	1.72	0.30	3.00	7.53	8.35	9.84	116
Karnataka	0.46	0.20	0.02	1.36	0.11	0.49	1.98	2.44	9.82	797
Kerala	1.43	0.14	0.29	0.19	0.004	1.52	2.00	3.43	8.76	138
Madhya Pradesh	0.44	0.14	0.02	0.59	0.095	0.30	1.02	1.46	10.95	1110
Maharashtra	1.20	0.44	0.41	2.57	0.12	0.47	3.56	4.76	8.99	789
Odisha	0.47	0.06	0.12	1.92	0.003	1.27	3.31	3.78	10.77	317
Punjab	2.28	0.28	0.03	0.50	0.01	0.41	0.94	3.23	8.67	405
Rajasthan	0.89	0.30	0.05	0.24	0.22	0.17	0.68	1.57	9.35	633
Tamil Nadu	0.77	0.39	0.81	0.69	0.28	1.00	2.78	3.55	10.42	374
Uttar Pradesh	1.22	0.05	0.24	0.45	0.17	0.83	1.70	2.92	8.29	1722
West Bengal	0.24	0.01	0.10	0.10	0.015	0.28	0.50	0.74	8.27	266
Chhattisgarh	0.11	0.01	0.06	0.78	0.024	0.54	1.40	1.51	10.88	244
Jharkhand	0.10	0.01	0.01	0.30	0.0001	0.34	0.66	0.76	9.76	210
Uttarakhand	0.59	—	0.39	1.33	0.05	2.47	4.24	4.82	8.36	83
All states	0.72	0.18	0.22	1.08	0.11	0.70	2.11	2.83	9.23	9746

Note: Private investment in agriculture and allied activities included irrigation also. Separate estimates for irrigation are given to gauge their importance across states. Karnataka ICOR relates to 2007-12; ICOR for 20 selected states is estimated separately.

Table 6. Investment rate required to facilitate targeted growth by 2022-23

State	Private investment		Public investment					Private & Public investment
	Agriculture	Irrigation	Agriculture	Irrigation	Energy	Road-transport	'for' agriculture	
Andhra Pradesh	3.1	0.92	0.06	17.4	0.01	1.52	18.9	22
Assam	1.8	0.14	0.11	4.3	0.02	6.6	11.0	12.8
Bihar	0.96	0.06	0.24	2.8	0.18	10.4	13.6	14.6
Gujarat	9.9	4.57	4.39	42.9	2.28	8.6	58.2	68.1
Haryana	5.9	1.66	3.70	4.2	1.5	4.0	13.3	19.3
Himachal Pradesh	16.9	1.83	2.15	8.3	0.03	18.1	28.6	45.6
Jammu &Kashmir	8.1	0.16	24.7	16.9	2.97	29.5	74.1	82.1
Karnataka	4.5	1.92	0.23	13.3	1.11	4.8	19.5	24.0
Kerala	12.5	1.26	2.53	1.7	0.03	13.3	17.5	30.0
Madhya Pradesh	4.8	1.58	0.26	6.5	1.04	3.3	11.1	15.9
Maharashtra	10.8	3.94	3.64	23.1	1.09	4.2	32.0	42.8
Odisha	5.1	0.65	1.27	20.7	0.03	13.6	35.6	40.7
Punjab	19.8	2.44	0.25	4.3	0.08	3.5	8.2	28.0
Rajasthan	8.3	2.82	0.50	2.2	2.05	1.6	6.4	14.7
Tamil Nadu	8.1	4.07	8.41	7.2	2.90	10.4	29.0	37.0
Uttar Pradesh	10.1	0.43	2.02	3.7	1.44	6.9	14.1	24.2
West Bengal	1.97	0.08	0.81	0.9	0.12	2.4	4.1	6.1
Chhattisgarh	1.21	0.16	0.63	8.5	0.26	5.8	15.2	16.4
Jharkhand	0.93	0.08	0.13	2.9	0.001	3.3	6.5	7.4
Uttarakhand	4.9	0.02	3.24	11.1	0.41	20.7	35.4	40.3
All states	6.62	1.60	2.03	10.0	1.02	6.5	19.5	26.1

Note: Based on gross estimates, i.e. inclusive of expenditure on inventory (stock) and depreciation of assets, each roughly estimated between 5 and 10 per cent.

The ICOR ratios were multiplied with the targeted income to find the investment rate needed to enable an increase in the income levels of farmers from 'farm income' by 2022-23 in each state. The targeted rate of growth for the purpose is estimated to be 9.23 per cent at all- India. To achieve this, the required investment rate would be 26.12 per cent (19.5% on account of public investment and 6.62 per cent on account of private investment) by 2022-23 (Table 6). The investment rate for creation of public infrastructure varies from 4 per cent in West Bengal to 75 per cent in Jammu &Kashmir and is found to be much lower in the eastern and rainfed states. Similarly, on private account, it varies from 19.8 per cent in Punjab to almost 1 per cent in Bihar, Jharkhand and Chhattisgarh. It indicates a strong need for an adequate flow of credit to less-developed states for accelerating agricultural growth and farm income. In this pursuit, the government should also consider the changing asset preferences of farmers away from wells/tubewells towards transport, farm machinery and implements.

These investment rates when multiplied with the targeted farm income provided the additional investment required in the next successive seven years. The current (2015-16) investments provided in Annexure Table 2, show private GCFA at ₹ 610 billion and public GCFA at ₹ 1169 billion. For accomplishing the goal of DFI, the cumulative private capital of ₹ 645 billion is projected by 2022-23, which should increase at an annual rate of 10.86 per cent per annum from 2015-16 (Tables 7 and 8). The same on public account, presuming marginal efficiency of investment on each economic head would remain unchanged, is estimated at ₹ 1900 billion, and must increase annually at average 14.8 per cent. The sum total of additional

Table 7. Additional investment required by 2022-23 for DFI (in billion ₹ at 2015-16 prices)

State	Private investment		Public investment					Private & Public investment
	Agriculture	Irrigation	Agriculture	Irrigation	Energy	Road-transport	'for' agriculture	
Andhra Pradesh	19.6	5.8	0.37	109.5	0.09	9.6	120	139
Assam	7.5	0.59	0.47	17.8	0.09	27	46	53
Bihar	3.2	0.20	0.78	9.4	0.6	34	45	48
Gujarat	54.0	25	23.9	234.2	12.4	47	318	372
Haryana	23.6	6.6	14.7	16.9	5.8	16	53	77
Himachal Pradesh	14.5	1.6	1.8	7.1	0.03	15	24	39
Jammu &Kashmir	9.4	0.2	28.7	19.6	3.5	34	86	95
Karnataka	35.9	15.3	1.8	106	8.8	38	155	191
Kerala	17.2	1.7	3.5	2.3	0.05	18	24	41
Madhya Pradesh	53.7	17.5	2.8	72.2	11.5	37	123	177
Maharashtra	85.2	31.1	28.8	182.1	8.6	33	252	338
Odisha	16.1	2.1	4.0	65.5	0.1	43	113	129
Punjab	80.2	9.9	1.0	17.5	0.3	14	33	113
Rajasthan	52.7	17.8	3.2	13.9	13.0	10	40	93
Tamil Nadu	30.1	15.2	31.4	27.1	10.8	39	108	138
Uttar Pradesh	174	7.4	34.9	64.4	24.8	119	243	417
West Bengal	5.2	0.20	2.2	2.3	0.32	6.3	11	16
Chhattisgarh	2.9	0.38	1.5	20.7	0.64	14	37	40
Jharkhand	1.96	0.17	0.27	6.2	0.002	6.9	14	16
Uttarakhand	4.05	0.02	2.7	9.2	0.34	17	29	33
All states	645	156	198	972	99	630	1900	2546

gross public and private GCFA for all states together are estimated at ₹ 2546 billion. Of the total projected public GCFA, ₹ 198 billion is estimated for agriculture, ₹ 972 billion for minor, medium and major irrigation systems, ₹ 99 billion for rural energy, and ₹ 630 billion for rural roads- transport, each increasing at an annual rate of 18.6 per cent, 14.1 per cent, 48.3 per cent and 13.6 per cent, respectively. Since the already achieved real rates of growth in private and public GCFA are 9.15 per cent and 10.5 per cent per annum, it is certain that the futuristic investments, which are at slightly higher rates, will be achieved[12].

Across the states, additional public capital requirements are found to be much higher in Andhra Pradesh (₹ 120 billion), Gujarat (₹ 318 billion), Karnataka (₹ 155 billion), Maharashtra (₹ 252 billion), Uttar Pradesh (₹ 243 billion), which in a way indicates the need to improve efficiency in large irrigation projects. However, some of these states may require more resources to increase irrigation capacity and develop other infrastructure. The resource allocations under each head need to be rationalized in view of the actual requirements. Keeping in view the goal of DFI, public investment needs in the poorer and agriculture-dominant states, viz., Assam Jammu & Kashmir, Bihar, West Bengal, Rajasthan and Chhattisgarh are less than ₹ 50 billion each, implying higher returns from investments in these states, perhaps due to initial low investment base. Similarly, on the private account, Karnataka, Gujarat, Maharashtra, Punjab, and

[12] The government has mobilized resources through non-budgetary sources, like creation of corpus funds of ₹ 40,000 crore to complete long pending Accelerated Irrigation Benefit Programme (AIBP), ₹ 5,000 crore for accelerating micro-irrigation coverage, and ₹ 10,881 crore for Dairy Processing & Infrastructure Development Fund (DIDF) during 2017-18 to 2028-29 (www.agricoop.nic.in).

Table 8. Required annual rate of growth in investment for DFI from 2015 to 2022 at 2015-16 prices (%)

State	Private investment		Public investment				
	Agriculture	Irrigation	Agriculture	Irrigation	Energy	Road-transport	*'for'* agriculture
Andhra Pradesh	6.3	7.8	7.6	7.4	6.9	6.5	7.3
Assam	15.9	12.9	10.0	17.8	24.7	17.6	17.5
Bihar	6.3	8.0	2.1	7.2	8.8	5.3	5.5
Gujarat	12.1	18.8	24.6	19.7	10.7	19.5	19.3
Haryana	17.4	22.7	10.2	17.7	28.4	11.4	13.3
Himachal Pradesh	12.4	—	18.2	18.9	14.9	16.1	16.9
Jammu &Kashmir	16.4	59.9	24.1	27.9	53.7	33.5	28.7
Karnataka	7.6	6.8	7.7	14.1	5.9	9.3	11.6
Kerala	6.9	7.0	14.3	8.1	9.0	8.7	9.1
Madhya Pradesh	7.2	7.1	13.5	12.5	21.7	14.8	13.7
Maharashtra	10.7	12.5	14.5	15.7	12.8	12.4	14.9
Odisha	22.1	6.7	29.8	21.2	9.4	17.7	19.9
Punjab	20.7	27.8	17.5	30.5	65.8	25.3	27.4
Rajasthan	8.6	10.6	13.0	13	5.9	6.6	7.9
Tamil Nadu	21.8	23.8	16.9	17.6	10.7	12.3	14.3
Uttar Pradesh	12.5	18.5	52.9	18.3	19.9	15.2	18.1
West Bengal	6.8	3.6	4.6	8.8	22.6	6.6	6.5
Chhattisgarh	10.6	17.3	12.6	9.5	4.0	9.2	9.3
Jharkhand	5.0	2.0	4.4	6.1	23.8	5.1	5.5
Uttarakhand	19.3	—	2.6	10.8	11.1	11.7	8.7
All states	10.9	12.4	18.6	14.1	48.3	13.6	14.8

Rajasthan, may require relatively higher amounts of increase in capital at ₹ 36 billion, ₹ 54 billion, ₹ 85.2 billion, ₹ 80.2 billion, and ₹ 52.7 billion, for DFI respectively. In contrast, lesser amounts (below ₹ 10 billion) will be spent by the farmers in the poorer states to facilitate DFI.

For the respective state governments to incur this expenditure, it is important to ascertain an annual rate of growth under each head by 2022-23. Table 8 shows that investments in agriculture and irrigation should grow at 18.6 per cent and 14.1 per cent and in energy and road-transport at 48.3 per cent and 13.6 per cent per annum respectively. Except Andhra Pradesh, Bihar, Kerala, Chhattisgarh and Jharkhand, each state is required to have a higher rate of growth in irrigation capital, far above the national average. The Eastern and rainfed states require relatively lower rates of growth in investment, which indicates that the government should prioritize investments in these states due to greater productivity increasing effects as compared to that in many developed states. This strategy will not only address the past deficit in investments but also ensure a balanced regional development in due course.

In sum, the analysis has recommended a substantial increase in resource allocation to the agricultural sector along with institutional credit to cover as many farmers as possible[13]. An increased output expected due to higher investments should be encouraged for value addition and exports as India has a growing demand as well as comparative advantage in agricultural commodities. Apparently, the projected capital requirements on public account are more as compared to those on private account, which in a way highlight the key role of the government in this sector, especially in the agriculturally-dominant poorer states. A lower

[13] The institutional credit has seen a robust increase from ₹ 8 lakh crore in 2014-15 to ₹ 10 lakh crore in 2017-18. Of ₹ 10 lakh crore, a sum of ₹ 3.15 lakh crore is meant for capital investment, while the balance is towards crop loans (www.agricoop.nic.in).

ICOR in the eastern and rainfed states indicates that additional investments in these will have larger productivity impacts. It would, therefore, be imperative for the government to maintain the desired growth rate in investment. The futuristic capital requirements can be further reduced by improving the efficiency in their use in various projects, which is currently low and by promoting private corporate investments.

Acknowledgements

I am very grateful to Dr. Ashok Dalwai, Dr. Rajesh Chadha, Dr. Prem S. Vashishtha, and Mr. Devender Pratap for their valuable suggestions.

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Annexure Table 1

State-wise per hectare private and public investments 'in' and 'for' agriculture at 2004-05 price (in ₹)

State	Year	Public Investment		Private investment	State	Public Investment		Private investment
		'in' Agriculture & allied activities	'for' Agriculture			'in' Agriculture	'for' Agriculture	
Andhra	TE 1981-83	788	917	604	Odisha	1127	1243	120
Pradesh	TE 1991-93	903	1043	562		804	1144	133
	TE 2001-03	1406	2433	681		968	1300	374
	TE 2011-13	5793	6535	1250		2519	4305	558
Assam	TE 1981-83	661	1068	257	Punjab	631	825	1602
	TE 1991-93	703	1320	115		549	663	999
	TE 2001-03	377	1030	172		308	784	1376
	TE 2011-13	1248	3232	512		474	1100	2799
Gujarat	TE 1981-83	806	921	468	Rajasthan	326	464	282
	TE 1991-93	1007	1125	385		360	530	576
	TE 2001-03	1107	1351	751		412	786	970
	TE 2011-13	4412	6072	1762		351	1253	1256
Haryana	TE 1981-83	813	1065	961	Tamil Nadu	454	623	745
	TE 1991-93	630	830	1066		379	607	1274
	TE 2001-03	278	1004	2312		844	1829	1427
	TE 2011-13	2368	4013	1611		2157	6780	1076
Himachal	TE 1981-83	863	2846	663	West Bengal	257	414	253
Pradesh	TE 1991-93	837	3013	1407		341	530	328
	TE 2001-03	1242	4645	2508		247	799	262
	TE 2011-13	3208	10735	7772		628	1647	593
Jammu &	TE 1981-83	1453	2519	550	Bihar-	1001	1145	237
Kashmir	TE 1991-93	1502	3544	431	Jharkhand	437	512	209
	TE 2001-03	2263	6464	966		663	1262	64
	TE 2011-13	5811	12264	2273		2052	8215	540
Karnataka	TE 1981-83	536	635	406	Madhya	529	625	224
	TE 1991-93	905	1162	901	Pradesh-	417	559	719
	TE 2001-03	1913	2189	386	Chhattisgarh	567	890	161
	TE 2011-13	3339	5200	1659		1681	2899	1173
Kerala	TE 1981-83	1351	1720	1147	Uttar	636	821	684
	TE 1991-93	1149	1655	1179	Pradesh-	311	534	770
	TE 2001-03	808	1719	1532	Uttarakhand	798	1634	1184
	TE 2011-13	1794	6757	5447		1206	3812	2791
Maharashtra	TE 1981-83	718	832	399	All states	653	809	471
	TE 1991-93	994	1143	733		644	849	672
	TE 2001-03	927	2404	664		986	1528	687
	TE 2011-13	3358	4562	1843		2328	4224	1645

Note: Based on NSA; Private investment corresponds to years when NSS-AIDIS was carried out.

Annexure Table 2

Capital expenditure in 2015-16 (in billion ₹ at current price)

State	Private investment		Public investment					Private & Public investment
	Agriculture	Irrigation	Agriculture	Irrigation	Energy	Road-transport	'for' agriculture	
Andhra Pradesh	36.8	8.5	0.6	170.2	0.15	17.1	188.1	225
Assam	4.1	0.4	0.5	8.3	0.03	13.0	21.8	26
Bihar	6.0	0.3	5.0	15.0	0.73	78.4	99.1	105
Gujarat	43.8	10.7	6.5	92.9	12	18.9	130.4	174
Haryana	11.3	2.1	15.1	7.9	1.23	13.9	38.1	49.4
Himachal Pradesh	11.4	2.3	0.8	3.0	0.02	8.4	12.2	24
Jammu &Kashmir	5.0	—	8.1	4.2	0.18	5.2	17.8	23
Karnataka	53.8	26.4	2.7	69.8	17.8	44.6	134.9	189
Kerala	28.8	2.9	2.3	3.2	0.1	23.2	28.7	58
Madhya Pradesh	85.4	28.6	2.0	56.3	3.89	22.6	84.8	170
Maharashtra	82.3	24.3	18.3	102.6	6.5	26.1	153.5	236
Odisha	5.3	3.6	0.8	23.1	0.1	20.2	44.2	49.5
Punjab	29.3	2.2	0.5	3.2	0.01	3.7	7.4	37
Rajasthan	67.9	17.3	2.3	10.2	26.4	18.0	56.9	125
Tamil Nadu	10.1	4.4	15.7	12.8	10.5	30.9	70.0	80
Uttar Pradesh	136	3.3	1.9	28.7	9.64	69.8	110.0	246
West Bengal	8.9	0.7	5.9	2.8	0.10	11.1	19.9	29
Chhattisgarh	2.9	0.2	1.2	23.3	2.02	16.6	43.1	46
Jharkhand	4.9	1.1	0.8	12.2	0.001	16.8	29.7	35
Uttarakhand	1.7	—	13.4	8.7	0.32	14.6	37.1	39
All states	610	123	85.7	638	6.7	438	1169	1778

Source: NSS-AIDIS and GOI-Finance Accounts.
Note: Public investment is based on moving averages. Rate of growth from 2000 to 2013 was used to estimate investment for 2015-16. The same for private investment was based on rate of growth from 2002 to 2012.